

stated that leaking occurs mainly in older cows. An effect of lactation stage was obvious for most farmers. Most milk leakage was observed in the postpartum period by 66% of farmers, whereas in later stages leaking was observed in < 10% of farms. Milk leakage occurring mainly in cows with high milkability was stated by 76% of the farmers. Only some answered that leaking occurs in cows with average (19%) and low (3%) milkability. 49% of farmers stated that milk leakage is a problem of high yielding cows mainly. A significant correlation ( $p < 0.01$ ) between herd milk yield the frequency of milk leakage could be calculated. The handling of leaking cows was different from not-leaking in 9% of the farms, mostly reflected in a shortening or omission of udder preparation before milking. The theory that milk leakage was a risk factor for mastitis was abandoned by 70% of the farmers. 87% of farmers did not acknowledge leaking as a risk factor for the health of the herd. In conclusion, milk leakage occurs frequently in dairy farms of all herd sizes. In most cases and in contrast with some scientific results, farmers do not consider milk leakage as an animal health problem.

**Key Words:** Milk Leakage, Survey, Dairy Cows

**W182 Relationship of cow cleanliness during the close-up period and milk quality following calving.** M. Chahine<sup>\*1</sup>, J. K. Reneau<sup>2</sup>, R. J. Norell<sup>3</sup>, J. C. Dalton<sup>4</sup>, and J. M. Lukas<sup>2</sup>, <sup>1</sup>University of Idaho, Twin Falls, <sup>2</sup>University of Minnesota, St. Paul, <sup>3</sup>University of Idaho, Idaho Falls, <sup>4</sup>University of Idaho, Caldwell.

## Ruminant Nutrition: Feed Additives and Feedstuffs

**W183 Tea saponins affect in vitro fermentation and methanogenesis in faunated and defaunated rumen fluid.** W.-L. Hu<sup>\*</sup>, Y.-M. Wu, J.-X. Liu, and Y.-Q. Guo, Zhejiang University, Hangzhou, P. R. China.

The effect of tea saponins (TS) on rumen fermentation and methane emission was examined using an in vitro gas production technique named Reading Pressure Technique. Three levels of TS addition (0, 0.2, 0.4 mg/ml) were evaluated in the faunated and defaunated rumen fluid. Compared to the control, TS addition decreased the 24h gas production in the faunated rumen fluid, but had a minor effect on gas yield in the defaunated rumen fluid. The TS significantly reduced methane production in vitro. In the faunated rumen fluid, 0.2 or 0.4 mg/ml TS decreased the 24h methane emission by 12.7% or 14.0%, respectively. Rumen fluid pH value was affected neither by TS addition nor by defaunation. The TS addition had only minor effects on volatile fatty acids, but the yield and pattern of volatile fatty acids were greatly affected by defaunation. While the molar proportion of acetate was not affected by defaunation, the propionate was significantly increased and the butyrate significantly decreased. Ammonia-N concentration and microbial protein yield were influenced by TS inclusion and defaunation. Inclusion of 0.4 mg/ml TS increased the microbial protein mass by 18.4% and 13.8% and decreased the ammonia-N concentration by 8.3% and 19.6% in the faunated and defaunated rumen fluid, respectively. Protozoa counts were significantly reduced by TS inclusion. The current study demonstrated the beneficial effect of TS on methane production and rumen fermentation, and indicated that this may be due to the effect of the associated depression on protozoa counts.

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**Key Words:** Tea Saponin, Ruminant Fermentation, Methane

The objective of the study was to determine the effect of cow cleanliness during the close-up period on milk quality following calving during the summer season. Seven open-lot commercial herds located in Southern Idaho were used in the study. A scoring system from 1 to 5 was selected. Score 1 indicates a cow that is absolutely clean while a score 5 indicates a very dirty cow. A total of 681 close-up cows were hygiene scored at least twice during the close-up period. Each cow was scored for cleanliness of udder (HU) and lower rear legs (HL). Udder and lower rear legs scores were averaged and a composite score was created (HUL). SCC data were obtained from DHI and converted to a linear score (LS). HU, HL, and HUL were correlated to SCC and LS using PROC CORR and regression analyses were conducted using PROC REG of SAS. SCC for the 681 cows on their first DHI test date following calving averaged  $251 \times 10^3$  cells/ml. HU, HL, and HUL averaged  $2.3 \pm 0.02$ ,  $3.1 \pm 0.01$ , and  $2.7 \pm 0.01$ , respectively. HU were significantly correlated to HL ( $P < 0.001$ ,  $R^2 = 0.57$ ). There were no significant correlations between SCC and the hygiene scores ( $P > 0.05$ ). LS was significantly correlated to HU and HUL ( $P < 0.03$ ) but not correlated with HL ( $P > 0.05$ ). However, using a linear regression model in which HU and HUL were the explanatory variables and LS was the dependent variable resulted in a very low  $R^2$  ( $R^2 < 0.10$ ). Thus, the dependence of first SCC and LS following calving on hygiene scores during the close-up period in the high desert area of Southern Idaho is either absent or relatively small in cattle housed in open-lot facilities during the dry summer season.

**Key Words:** Milk Quality, Hygiene Scores, Cleanliness

**W184 Feed intake, nutrient digestibility, milk production, and milk composition in cows fed cinnamaldehyde, yucca saponins extract, and condensed tannins.** C. Benchaar<sup>\*1</sup>, T. A. McAllister<sup>2</sup>, and P. Y. Chouinard<sup>3</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville, QC, Canada, <sup>2</sup>Agriculture and Agri-Food Canada, Lethbridge, AB, Canada, <sup>3</sup>Laval University, Quebec, QC, Canada.

Four lactating cows (BW=730 kg; DIM=87 d) were used in a 4x4 Latin square design (3 wk/period) to study the effects of no additive (CO), or cinnamaldehyde (CIN, 1g/d), yucca saponins extract (YUC, 60 g/d), and condensed tannins (CT, 150 g/d) addition on feed intake, nutrient digestibility, milk production, and milk composition. Cows were fed for *ad libitum* intake a TMR consisting of 40% of grass silage and 60% of concentrate (DM basis). Effects of treatments were determined (PROC MIXED, SAS) by orthogonal contrasts: CO vs. all additives, CIN vs. (CT+YUC) and CT vs. YUC. Significance was declared at  $P \leq 0.05$ , and tendencies at  $0.05 < P \leq 0.10$ . DMI was similar between CO and supplemented diets (22.9 kg/d), but was lower (-1.7 kg/d) with YUC than with CT. Apparent DM (63.7%), OM (65.9%) and NDF (54.8%) digestibilities were similar between CO and supplemented diets. Digestibility of CP tended to be lower (58.2 vs. 61.2%) and that of ADF was reduced (45.3 vs. 49.9%) with CT than with YUC. Milk production (33.1 kg/d), 4%FCM (34.5 kg/d), BW change (0.73 kg/d), milk fat content (4.31%), and milk protein content (3.52%) remained unchanged between treatments. Lactose content tended to decrease with supplemented diets as compared with CO (4.44 vs. 4.52%), and tended to be lower for CT+YUC compared to CIN (4.42 vs. 4.45%). Milk urea nitrogen was similar between CO and supplemented diets (17.8 mg/dl) and tended to decrease with YUC compared to CT (16.3 vs. 18.3 mg/dl). Except for milk protein yield which tended to increase with CIN compared to CT+YUC (1.17 vs. 1.10 kg/d), yields of other milk components did not differ among treatments. This study suggests that the addition of CIN, CT and YUC has small effects on nutrient digestibility, milk production and milk composition in dairy cows. More investigation is needed to evaluate the potential of adding plant extracts compounds in dairy cow diets to improve feed efficiency.

**Key Words:** Plant Extracts, Digestion, Milk

**W185 Effects of cinnamaldehyde, yucca saponins extract and condensed tannins on fermentation characteristics, and ciliate protozoal populations in the rumen of lactating dairy cows.** C. Benchaar<sup>\*1</sup>, T. A. McAllister<sup>2</sup>, and P. Y. Chouinard<sup>3</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville, QC., Canada, <sup>2</sup>Agriculture and Agri-Food Canada, Lethbridge, AB., Canada, <sup>3</sup>Laval University, Quebec, QC., Canada.

Four ruminally cannulated lactating cows (BW=730 kg; DIM=87 d) were used in a 4x4 Latin square design (3 wk/period) to study the effects of no addition (CO), or the addition of cinnamaldehyde (CIN, 1g/d), yucca saponins extract (YUC, 60 g/d), and condensed tannins (CT, 150 g/d) on ruminal fermentation characteristics and ruminal ciliate protozoal populations. Cows were fed for *ad libitum* intake a TMR consisting of 40% of grass silage and 60% of concentrate (DM basis). Effects of treatments were determined (PROC MIXED, SAS) by orthogonal contrasts: CO vs. all additives, CIN vs. (CT+YUC) and CT vs. YUC. Significance was declared at  $P \leq 0.05$ , and tendencies at  $0.05 < P \leq 0.10$ . Ruminal pH was unaffected by treatments (6.67). Ruminal ammonia concentration tended to be lower with supplemented diets than with CO (142.4 vs. 159.5 mg/l). Total VFA concentration was unaffected by dietary supplements (134.5 mM). Molar proportions of acetate, propionate and butyrate were similar between CO and supplemented diets. However, acetate tended to be higher for CIN than for CT+YUC (65.2 vs. 64.9%). Compared to YUC, CT tended to reduce acetate (64.7 vs. 65.1%). Propionate was higher with CT+YUC than with CIN (19.8 vs. 19.2%). Butyrate was not changed by dietary treatments (11.2%). Acetate:propionate ratio was similar between CO and supplemented diets (3.33), but it was lower for CT+YUC compared to CIN (3.29 vs. 3.41). Total protozoa numbers were similar between CO and supplemented diets ( $7.0 \times 10^5$ /ml), but tended to be lower with CT+YUC compared to CIN (6.3 vs.  $8.6 \times 10^5$ /ml). Treatments had no effect on the numbers of *Dasytricha*, *Diplodinium*, *Entodinium*, *Ophryoscolex*, and *Ostracodinium*. However, *Isotricha* numbers were reduced by CT+YUC compared to CIN ( $1.5$  vs.  $2.9 \times 10^5$ /ml). This study suggests that plant extracts have small effects on ruminal fermentation characteristics and protozoa numbers. Further work is required to evaluate the potential of plant compounds to manipulate ruminal fermentation in dairy cows.

**Key Words:** Plant Extracts, Ruminal Fermentation, Protozoa

**W186 Effects of cinnamaldehyde, yucca saponins extract and condensed tannins on ruminal in sacco degradation of soybean meal, grass silage, and corn in lactating dairy cows.** C. Benchaar<sup>\*1</sup>, T. A. McAllister<sup>2</sup>, and P. Y. Chouinard<sup>3</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville, QC., Canada, <sup>2</sup>Agriculture and Agri-Food Canada, Lethbridge, AB., Canada, <sup>3</sup>Laval University, Quebec, QC., Canada.

Four ruminally cannulated lactating cows were used in a 4x4 Latin square design to study the effects of no additive (CO), or cinnamaldehyde (CIN, 1g/d), yucca saponins extract (YUC, 60 g/d), and condensed tannins (CT, 150 g/d) addition on ruminal in sacco degradation of soybean meal, grass silage and corn. Cows were fed for *ad libitum* intake a TMR consisting of 40% of grass silage and 60% of concentrate (DM basis). Effects of treatments were tested (PROC MIXED, SAS) by orthogonal contrasts: CO vs. all additives, CIN vs. (CT+YUC) and CT vs. YUC. Significance was declared at  $P \leq 0.05$ , and tendencies at  $0.05 < P \leq 0.10$ . For soybean meal, the rapidly degradable fraction (a) of CP tended to increase for supplemented diets compared to CO (13.7 vs. 11.1%). The slowly degradable fraction (b) and the degradation rate (c) were not different among treatments (88.9% and 7.87%/h, respectively). However, the lag time (L) was higher with the plant extracts compared to CO (3.0 vs. 1.2 h). The effective degradability (ED) of CP tended to be lower with supplemented diets than with CO (54.3 vs. 57.7%). For grass silage, ADF degradation kinetics were similar among treatments. The NDF fraction (a) was similar between CO and supplemented diets (2.1%), but tended to be lower with YUC than with CT (1.37 vs. 2.75%). The fraction (b) of NDF tended to decrease with plant extracts (76.4 vs. 83.6%). The NDF degradation rate was similar between treatments (2.9%/h). (L) was not different between CO and supplemented diets, but tended to be lower with YUC compared to CT (0.82 vs. 3.1 h). The ED of NDF was similar among treatments (31.8%). For corn DM degradation, (a) (b) and (c) were not changed by treatments. (L) tended to be lower with CT than with YUC (0.11 vs. 2.0 h). The ED tended to be lower with supplemented diets than

with CO (58.9 vs. 60.6%) and with CT compared to YUC (57.8 vs. 60.2%). This study suggests that feeding cows with plant extracts modifies ruminal degradabilities of soybean meal CP and corn DM. The effect on grass silage NDF degradability is however small.

**Key Words:** Plant Extracts, Ruminal In Sacco Degradation, Feed Components

**W187 Ruminal degradation kinetics of corn silage with different additives.** P. A. Katsuki<sup>1</sup>, E. S. Pereira<sup>2</sup>, B. M. O. Ramos<sup>1</sup>, F. B. Moreira<sup>1</sup>, E. L. A. Ribeiro<sup>1</sup>, M. A. Rocha<sup>1</sup>, A. P. Pinto<sup>1</sup>, V. R. Loyola<sup>1</sup>, R. Salmazo<sup>1</sup>, T. R. Casimiro<sup>1</sup>, T. C. Alves<sup>1</sup>, and I. Y. Mizubuti<sup>\*1</sup>, <sup>1</sup>Universidade Estadual de Londrina, Londrina, Paraná, Brazil, <sup>2</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brazil.

Dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) degradabilities of corn silage were evaluated in a 4x4 Latin square assay (four Holstein males and four incubation periods) in ruminal ambient adapted or not with different feed additives. The products containing additives were inoculated daily, directly in the rumen through ruminal cannula, as indicated by the manufacturers. The following treatments were used: corn silage without additive inoculation (CCS); corn silage inoculated with five grams of dehydrated and lyophilized ruminal and intestinal bacteria (SLB); corn silage inoculated with 15 g of cellulolytic enzymes (SCE); and corn silage inoculated with three mg of sodium monensin (SSM). The treatments SLB and SCE did not affect the potentially degradable fraction (b) of corn silage nutrients. The sodium monensin reduced the fraction b of DM and OM, with mean adjust values of DM fraction b of (%): 54.64, 55.92, 56.31 and 51.01 and OM fraction b of: 56.85, 57.81, 58.41 and 53.17 for CCS, SLB, SCE and SSM, respectively ( $P < 0.05$ ). The sodium monensin also reduced the DM and OM potential degradabilities, with mean adjust values of DM potential degradability of (%): 76.06, 76.87, 77.57 and 72.33 and OM potential degradability of: 76.89, 77.45, 78.27 and 73.13 for CCS, SLB, SCE and SSM, respectively ( $P < 0.05$ ). Among all the additives studied, the sodium monensin provided the largest NDF indigestible fraction, with respective treatments averaging (%): 36.16, 29.46, 33.17 and 45.57, and the largest ADF indigestible fraction, 38.29, 28.37, 34.74 and 47.88 ( $P < 0.05$ ), reducing the disappearance of these fractions after 48 h of intra-ruminal incubation. It was concluded that the different feed additives did not improve the DM, OM, CP, NDF and ADF effective degradabilities of corn silage.

**Acknowledgements:** The work was partially funded by CNPq.

**Key Words:** Cellulolytic Bacteria, Lyophilized Bacteria, Sodium Monensin

**W188 Effects of adding polyethylene glycol 4000 or urea to high tannin high moisture sorghum grain on ruminal degradation in beef cattle.** M. D. Montiel<sup>\*1,2</sup>, J. C. Elizalde<sup>1,2</sup>, L. Giorda<sup>3</sup>, and F. Santini<sup>1,2</sup>, <sup>1</sup>CONICET, Argentina, <sup>2</sup>Fac. Cs. Agrarias UNMDP-INTA Balcarce, Argentina, <sup>3</sup>EEA INTA Manfredi, Argentina.

We studied the use of polyethylene glycol 4000 (PEG) or urea (U) to reduce the anti-nutritional effects of tannins in a high moisture sorghum grain. Ruminal dry matter (DM), crude protein (CP) and starch (ST) in situ degradability of high moisture sorghum grain treated with different doses of PEG or U, incubated during 0, 16 and 33 hours, were evaluated in three ruminally cannulated heifers. Sorghum grain, DA 49 hybrid with high tannin content, was harvested with 35 or 25% moisture content and treated with different levels of PEG (0, 0.1 and 1 g PEG/g CP) or U (0, 2 and 4% U based DM), and conserved under anaerobic conditions in PVC microsiles. In situ DM and ST degradability were higher ( $P < 0.05$ ) in sorghum treated with PEG than U (38.8 vs 32.3% and 40.4 vs 33.8% for DM and ST, respectively). However, U had higher ( $P < 0.05$ ) CP ruminal degradability than PEG (32.9 vs 28%, respectively). Interaction moisture\*level(PEG or U) for DM, CP and ST degradability was significant ( $P < 0.05$ ). When grain was harvested with 25% moisture there were not responses ( $P > 0.05$ ) to treatment with either PEG or U on DM and ST degradability. However, CP ruminal degradability was higher ( $P < 0.05$ ) with 1 or 4%U (22.2 and

48.2%, respectively) than 0 g PEG or 0%U (14.1% and 15%, respectively). Sorghum harvested with 35% of moisture and treated with 1 g PEG-4000 showed highest ruminal DM, CP and ST degradability, and increased digestion 52, 61 and 27% higher respect to 0 g PEG for DM, CP and ST, respectively. Treatment with 2%U presented higher DM, CP and ST ruminal degradability respect to 0%U, and the improvements were 26, 31 and 20%, respectively. Treatments of high-moisture sorghum grain with PEG-4000 or U were effective to reduce the anti-nutritional effects of tannins, but the improvement was affected by moisture at harvest and PEG and U levels.

**Key Words:** High Moisture Sorghum, Tannin, Polyethylene Glycol and Urea

**W189 Fermentation and fatty acid biohydrogenation in continuous cultures fed soybean meal with and without added lecithin.** C. M. Thompson<sup>\*1</sup>, S. J. Freeman<sup>1</sup>, P. W. Jardon<sup>2</sup>, and T. C. Jenkins<sup>1</sup>, <sup>1</sup>Clemson University, Clemson, SC, <sup>2</sup>West Central Soy, Ralston, IA.

Despite earlier findings that phospholipids are extensively degraded by ruminal microorganisms, some recent reports have indicated possible resistance of soybean phosphatides to microbial degradation. As a result, soybean lecithin might serve to enhance the flow of unsaturated fatty acids and choline to the intestines of dairy cattle. This study was designed to determine if outflow of unsaturated fatty acids from continuous cultures of mixed ruminal microorganisms increased following the addition of lecithin. Two blended diets of alfalfa pellets and concentrate (1:1) contained either soybean meal alone (control diet) or soybean meal with lecithin-containing gums (lecithin diet). Each diet was fed to four dual flow continuous fermenters maintained for 10 d at 0.10 h<sup>-1</sup> liquid dilution rate and average pH 6.1. Culture samples from d 10 were analyzed for pH and volatile fatty acids. Samples of outflow were taken daily over d 8, 9, and 10 of each period, composited, freeze-dried and then analyzed for fatty acids and NDF. Fatty acid outflows for the control and lecithin diets did not differ and averaged 228 and 216 (SEM = 17) mg/d for oleic acid, 182 and 164 (SEM = 23) mg/d for linoleic acid, and 28 and 26 (SEM = 2) mg/d for linolenic acid, respectively. Biohydrogenation (fatty acid lost as a percentage of fatty acid intake) was not affected by diet for any unsaturated fatty acid. Total VFA concentration (148 and 127 mol/100 mol, SEM = 13), acetate to propionate ratio (1.68 and 1.66, SEM = 0.14), and digestibilities of NDF (34.9 and 37.7, SEM = 3.7) also were the same for the control and lecithin diets, respectively. The results of this continuous culture study suggest no advantage on either fermentation or on fatty acid biohydrogenation from adding lecithin-containing gums to soybean meal.

**Key Words:** Continuous Culture Fermentation, Biohydrogenation, Lecithin

**W190 Effects of eugenol and thymol on rumen microbial fermentation in continuous culture.** L. Castillejos, S. Calsamiglia<sup>\*</sup>, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Eight dual flow continuous culture fermenters (1320 mL) were used in 3 periods (6 d of adaptation and 3 d of sampling) to study the effects of thymol and eugenol on rumen microbial fermentation and nutrient flow. Fermenters were fed 95 g/d of DM of a 60:40 forage:concentrate diet (18% CP; 30% NDF). Treatments were: control (CTR), thymol at 5 mg/L (T5), 50 mg/L (T50) and 500 mg/L (T500), eugenol at 5 mg/L (E5), 50 mg/L (E50) and 500 mg/L (E500), and monensin at 10 mg/L (MON), and were randomly assigned to fermenters within periods. During the last 3 days of each period, samples were taken at 0, 2, 4 and 6 h after the morning feeding and analyzed for peptide, AA and ammonia N concentrations, and total and individual VFA concentrations. Differences were declared at P < 0.05. Monensin and T500 reduced DM, OM, NDF and ADF digestion. The T500 and E500 reduced total VFA concentration. Monensin, T500, and E500 reduced the proportion of acetate, branch-chained VFA concentration and acetate to propionate ratio, and increased the proportion of propionate, and T500 and E500 also increased the proportion of butyrate. However, T500 reduced the proportion of valerate and E500 increased it. The T5 tended to reduce the proportion of acetate and increased the proportion of bu-

tyrate without affecting total VFA concentration and nutrient fermentation. The concentration of peptide N was higher in T5, T500 and E500, suggesting that proteolysis was stimulated or peptidolysis was inhibited. The concentration of AA N was higher in T500. The accumulation of AA N suggests that proteolysis and peptidolysis were stimulated for T500. The concentration of ammonia N tended to be higher in MON. Eugenol and thymol demonstrated their antimicrobial activity decreasing total VFA concentration and modifying fermentation profile, MON modified fermentation profile but inhibited nutrient fermentation, and T5 modified the fermentation profile without decreasing total VFA concentration and nutrient fermentation.

**Key Words:** Thymol, Eugenol, Rumen Fermentation

**W191 Effects of different dose levels of essential oils compounds on in vitro methane production by mixed ruminal bacteria.** J. Chiquette<sup>\*</sup> and C. Benchaar, *Dairy and Swine Res. & Dev. Centre, Lennoxville, Quebec, Canada.*

The objective of this study was to examine the effects of essential oils compounds on in vitro methane (CH<sub>4</sub>) production by mixed ruminal bacteria isolated from a fistulated cow fed a diet consisting of 50% forage 50% concentrate. Mixed bacteria were incubated anaerobically in serum bottles (40 ml of incubation fluid) containing 0.4 g of ground (1mm) substrate (50% forage, 50% concentrate). Several dilutions of the following constituents of essential oils: thymol, carvacrol and eugenol were prepared as anaerobic solutions and added to the triplicate culture tubes. Monensin (5 ppm) was used as a positive control for the reduction of CH<sub>4</sub> concentration. The incubations were repeated on three consecutive weeks. Following 24 h incubation, total gas production was measured as well as methane and CO<sub>2</sub> concentration. The incubation milieu was sampled for VFA analysis and pH measurement. Data were analyzed using PROC MIXED of SAS. Significance was declared at P ≤ 0.05. Compared to the control, monensin decreased CH<sub>4</sub> concentration (-37%), total gas production (-11%) and slightly increased pH (5.85 vs 5.71) and CO<sub>2</sub> concentration (18.95 vs 18.30 mM). Acetate was decreased (-20%) and propionate was increased (+45%) with monensin compared to the control. Up to 260 ppm of thymol, 225 ppm of carvacrol and 500 ppm of eugenol, CH<sub>4</sub> concentration was not different from that of the control. At concentration ranging from 280 to 300 ppm of thymol, 500 to 600 ppm of eugenol and 225 to 250 ppm of carvacrol, CH<sub>4</sub> concentration was similar to that obtained with monensin. At those levels of essential oils, CH<sub>4</sub> was decreased by 46%, 42% and 23% and total gas production was decreased by 29%, 22% and 12%, with carvacrol, eugenol and thymol, respectively, compared to the control. Similarly to the effect of monensin, pH and CO<sub>2</sub> concentration were also increased with the addition of essential oils after 24 h incubation, compared to the control.

**Acknowledgements:** F. Markwell and C. Roy for technical assistance

**Key Words:** Essential Oils, Methane, In Vitro Incubations

**W192 The effects of adverse environmental conditions on controlled-release property of Optigen® 1200.** V. Akay<sup>\*</sup>, *Alltech, Inc., Nicholasville, KY.*

Optigen® 1200 (Alltech, Inc., Nicholasville, KY) is a polymer coated controlled-release non-protein nitrogen source for ruminants. Feedstuffs are exposed to adverse environmental conditions during the time between production and consumption. Therefore, a series of experiments were conducted to evaluate the effects of adverse environmental conditions on the controlled-release property of Optigen® 1200. The adverse environmental conditions were: 1) elevated temperature (room temperature vs. 50°C for 7 d); 2) exposure to sunlight (no sunlight vs. exposure to sunlight for 14 d from May 4 to 18, 2004); 3) freeze-thaw cycles (no freeze-thaw cycles vs. 3 times freeze-thaw cycles); and 4) mechanical degradation (tumbled 0, 5, 10, 15 and 20 min in a rock tumbler). After exposure of Optigen® 1200 to adverse environmental conditions, 20 g of Optigen® 1200 was placed into a 125 ml Erlenmeyer flask containing 100 ml distilled water at 39.4°C. The flask was then capped, swirled 3 times and placed into a 39.4°C water bath. The flask was swirled 3 times at the end of 3 h of incuba-

tion, and nitrogen content of the water was measured by Kjeldahl method. Treatments were run in triplicate and data were analyzed as a completely randomized design using GLM procedure of SAS. Exposure of Optigen® 1200 to elevated temperature, sunlight, freeze-thaw cycle, and mechanical degradation had no effect ( $P > 0.05$ ) on the controlled-release property of Optigen® 1200. For elevated temperature, nitrogen content of water was 3.847 and 3.530 g/dl for control and treated Optigen® 1200, respectively. Nitrogen content of water was 3.264 and 3.511 g/dl for control and sunlight exposed Optigen® 1200, respectively. Exposure of Optigen® 1200 to freeze-thaw cycles resulted in 3.656 g/dl nitrogen in water compared to 3.660 g/dl nitrogen in water for control. Nitrogen content of water was 3.432, 3.749, 3.642, 3.796 and 3.908 g/dl for Optigen® 1200 tumbled 0, 5, 10, 15 and 20 min, respectively. These results indicate that polymer coating on Optigen® 1200 is strong and controlled-release property of Optigen® 1200 was not affected under present treatment conditions.

**Key Words:** Optigen® 1200, Controlled-Release Nitrogen, Kjeldahl

**W193 The effect of a fibrolytic enzyme mixture on the performance of lactating dairy cows and digestibility of the total mixed ration.** R. S. Teller<sup>\*1</sup>, R. J. Schmidt<sup>1</sup>, C. N. Mulrooney<sup>1</sup>, B. M. Moulder<sup>1</sup>, J. St. Amand<sup>1</sup>, L. Kung, Jr.<sup>1</sup>, W. Steinberg<sup>2</sup>, and I. Immig<sup>2</sup>, <sup>1</sup>University of Delaware, Newark, <sup>2</sup>DSM Nutritional Products Ltd., Basel, Switzerland.

We examined the effects of a mixture of fibrolytic enzymes (Roxazyme G2, DSM Nutritional Products, Ltd.), applied to a total mixed ration (TMR), on the performance of lactating dairy cows and the digestibility of the TMR. Sixteen multiparous and 10 primiparous Holstein cows averaging about 40 kg of milk/d and  $93 \pm 45$  d in milk (DIM) were fed a TMR comprised of 50% concentrate, 30% corn silage, 10% alfalfa haylage, and 10% alfalfa hay on a DM basis. Cows were fed to obtain a 5% daily refusal and housed in a research barn with freestalls and Calan gates. After a 3-wk pretreatment period, cows were blocked by milk production, dry matter intake (DMI), DIM, parity, and body weight, before being randomly assigned to one of two treatments. The study was designed as a cross over experiment with two 7-wk periods. The TMR was treated while mixing with either 1) no enzyme or 2) Roxazyme G2 (hemicellulase, cellulose, and beta-glucanase) prepared fresh with water and sprayed daily onto the TMR at an enzyme inclusion rate of 4 ml/kg DM. A similar amount of water was applied to the control TMR. Milk production, 3.5 % milk production, milk fat (% and yield), milk protein (% and yield), SCC and MUN were not affected by treatment. There was a trend ( $P < 0.07$ ) for an increase in DMI for the cows fed the treated TMR. Body weight change was greater ( $P < 0.05$ ) for cows fed the treated than untreated TMR (0.71 vs. 0.32 kg/d). After period 2, eight of the highest producing cows from each treatment remained on study for an additional 10 d to determine apparent nutrient digestibility via fecal collections and the use of indigestible NDF as a marker. There were no differences in digestibility of DM, OM, NDF, ADF, or starch between treatments. However, there was an increase ( $P < 0.05$ ) in digestibility of CP for the TMR treated with enzymes (61.9 vs. 56.7 %). Treating a TMR with fibrolytic enzymes has the potential to improve animal performance.

**Key Words:** Fibrolytic Enzymes, Digestibility

**W194 Identifying exogenous enzyme candidates that enhance degradation of alfalfa hay in vitro.** J.-S. Eun<sup>\*1</sup>, K. A. Beauchemin<sup>1</sup>, H.-E. Yang<sup>2</sup>, and H. Schulze<sup>3</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, <sup>2</sup>Korea University, Seoul, Korea, <sup>3</sup>Genencor International B. V., Leiden, The Netherlands.

Use of exogenous enzymes can significantly improve fiber digestibility of forages, but not all products are effective. The objective of this study was to identify enzyme candidates that improve fiber degradation. Commercial enzyme products (18) containing primarily endoglucanases and hemicellulases were investigated for their effects on in vitro gas production (GP) and degradability of alfalfa hay. Fresh, milled alfalfa hay (0.5 g DM) was weighed into small bags. A low or high level of each enzyme product was added to the alfalfa hay (0.75 or 1.5  $\mu$ L/g DM substrate, respectively). The bags were heat-sealed and placed in gas-tight serum culture vials. Strained ruminal fluid obtained from

two cannulated lactating dairy cows was dispensed (5 mL per vial) into the vials. Headspace GP was measured during 18 h of incubation, whereas degradability of DM and fiber was sequentially measured after terminating the incubation at 18 h. At the high dose level, all except two products increased GP ( $P < 0.05$ ) throughout fermentation, whereas four products improved DM degradability ( $P < 0.05$ ). The highest response in DM degradability was an 11.3% improvement. In that case, the enzyme product also increased degradability of NDF ( $P < 0.001$ ) by 20%, but ADF degradability was not affected, suggesting that this product mostly improved hemicellulose degradability. Meanwhile, at the low dose level, only two enzyme products increased GP ( $P < 0.05$ ), but no products affected degradability of DM or fiber, suggesting that the low dose level was insufficient to improve in vitro degradation of alfalfa hay. This study indicates that some fibrolytic enzyme products effectively increase the degradation of alfalfa hay. The focus of our current research is to identify the key enzyme activities and doses needed to improve degradability of various forages in order to improve forage utilization by ruminants.

**Key Words:** Exogenous Enzymes, Alfalfa Hay, In Vitro Degradation

**W195 Application of carbohydrase inhibitors to moderate rumen fermentation: In vitro evaluation.** S. M. Speight<sup>\*</sup> and D. L. Harmon, University of Kentucky, Lexington.

While carbohydrase inhibitors have been widely investigated for regulating human carbohydrate assimilation, their application to animal nutrition has been ignored. Four experiments were conducted to determine how commercially available  $\alpha$ -amylase and  $\alpha$ -glucosidase inhibitors affect rumen fermentation. *In vitro* incubations were conducted in 50-mL test tubes containing an inhibitor, 0.5 g ground corn, and 40-mL buffered rumen fluid inoculum. Rumen fluid donors were fed a 100% forage diet in Exp 1 and a 50:50 concentrate:forage diet in Exp 2-4. Incubations were conducted in duplicate at 37°C and replicated on consecutive days with pH and VFA concentrations measured at 1.5, 3, 4.5, 6, 9, 12, 18, and 24 h. Treatments for Exp 1 and 2 were: no additive (CON); 12.5-37.5 mg acarbose (ACB), miglitol (MIG), or glipizide (GLI); 12.5-75 mg trestatin (TRE); and 25-100 mg Alpha-Trim W<sup>®</sup> (ATW), CarboTame<sup>®</sup> (CT), starch blocker (SB), or wheat amylase inhibitor (RWI). ACB and TRE increased ( $P = 0.02$ ) pH and decreased ( $P \leq 0.06$ ) acetate, butyrate, propionate, and total VFA in Exp 1 and 2 in a non-dose-dependent manner. The remaining six treatments (MIG, GLI, CT, ATW, RWI, and SB) failed to affect pH and VFA concentrations. ACB and TRE doses were decreased to 1.2-9.5 mg and MIG and GLI doses were increased to 50-200 mg in Exp 3. ACB increased ( $P = 0.01$ ) pH and decreased ( $P \leq 0.04$ ) acetate, propionate, butyrate, and total VFA concentrations dose-dependently. GLI decreased ( $P < 0.001$ ) pH and increased ( $P \leq 0.03$ ) VFA concentrations beyond CON. MIG again failed to have any effect on pH or VFA. TRE increased ( $P < 0.001$ ) pH and decreased ( $P < 0.001$ ) VFA concentrations in a non-dose-dependent manner. Decreasing TRE doses to 0.1-1.1 mg in Exp 4 increased ( $P < 0.001$ ) pH and decreased ( $P < 0.001$ ) VFA concentrations in a dose-dependent manner. Although these data suggest that trestatin is ten times more potent than acarbose, both inhibitors have the potential to slow fermentation, and could help prevent rumen acidosis in addition to resulting in greater amounts of starch reaching the small intestine where its assimilation is more efficient.

**Key Words:** Carbohydrase Inhibitors, Rumen Fermentation Modulators, In Vitro

**W196 Fibrolytic enzyme and diets for cattle and sheep I. In vitro disappearance of dry matter and fiber.** R. Moreno-Jaramillo<sup>1</sup>, S. González<sup>\*2</sup>, J. Pinos-Rodríguez<sup>3</sup>, G. Mendoza-Martínez<sup>2</sup>, R. Bárcena-Gama<sup>2</sup>, J. Herrera-Haro<sup>2</sup>, and L. Miranda-Romero<sup>4</sup>, <sup>1</sup>Universidad Autónoma Gabriel René Moreno de Santa Cruz de la Sierra, Santa Cruz de la Sierra, Santa Cruz, Bolivia, <sup>2</sup>Colegio de Postgraduados, Montecillo, Estado de México, México, <sup>3</sup>Universidad Autónoma de San Luis Potosí, San Luis Potosí, México, <sup>4</sup>Universidad Autónoma Chapingo, Texcoco, Estado de México, México.

To determine the effect of an exogenous fibrolytic enzyme (Fibrozyme; enzyme) on *in vitro* disappearance of dry matter (IVDMD) and neutral detergent fiber

(IVNDFD), diets (40, 50, 60% concentrate), each with or without enzyme, were incubated at 3, 6, 12, 24, 48 and 72 h (two runs; first phase of Tilley and Terry). A randomized block design with a factorial arrangement of treatments (3 x 2 x 6) was utilized; data was analyzed with SAS and means were compared with Tukey. The IVDMD in diets with 40 and 50% grain was not different ( $P \geq 0.05$ ), but they were lower than that with 60% concentrate ( $P \leq 0.05$ ). The IVNDFD was larger for the diet with 50% grain ( $P \leq 0.05$ ), without differences between 40 and 60% concentrate diets ( $P \geq 0.05$ ). The addition of the enzyme to the diets increased IVDMD and IVNDFD ( $P \leq 0.05$ ). The IVDMD and IVNDFD were directly proportional to incubation time ( $P \leq 0.05$ ). Within each diet (with or without enzyme) for equivalent times, the enzyme increased IVDMD and IVNDFD ( $P \leq 0.05$ ), with a larger disappearance in the first 12 h. The interaction between diets x time, and enzyme x time affected IVDMD ( $P \leq 0.01$ ). Besides, the interaction between diets x enzyme ( $P \leq 0.05$ ) and between enzyme x time ( $P \leq 0.01$ ) affected *in vitro* disappearance of NDF. It may be concluded that Fibrozyme increased *in vitro* NDF disappearance for diets with a higher fiber content.

**Key Words:** Fibrolytic Enzyme, *In vitro* Digestibility, Dry Matter and Fiber

**W197 Fibrolytic enzyme and diets for cattle and sheep II. *In vitro* disappearance of dry matter and neutral detergent fiber.** R. Moreno-Jaramillo<sup>1</sup>, S. González\*<sup>2</sup>, J. Pinos-Rodríguez<sup>3</sup>, G. Mendoza-Martínez<sup>2</sup>, R. Bárcena-Gama<sup>2</sup>, J. Herrera-Haro<sup>2</sup>, and L. Miranda-Romero<sup>3</sup>, <sup>1</sup>Universidad Autónoma Gabriel René Moreno de Santa Cruz de la Sierra, Santa Cruz de la Sierra, Santa Cruz, Bolivia, <sup>2</sup>Colegio de Postgraduados, Montecillo, Estado de México, México, <sup>3</sup>Universidad Autónoma de San Luis Potosí, San Luis Potosí, México, <sup>4</sup>Universidad Autónoma Chapingo, Texcoco, Estado de México, México.

With the objective of determining *in situ* dry matter (ISDMD) and neutral detergent fiber (ISNDFD) disappearance for diets with an exogenous fibrolytic enzyme (Fibrozyme; enzyme), six Rambouillet lambs (58 7.4 kg BW) with ruminal cannula were utilized. There were six treatments: three diets (40, 50, 60% concentrate), each with or without enzyme; diets were incubated at 3, 6, 12, 24, 48 and 72 h. A Cross-Over design with a factorial arrangement of treatments (3 x 2) was used; data analysis was done with PROC MIXED for repeated measurements, and means were compared using Tukey and Least Significant Difference. Concentrate level did not affect ISDMD ( $P \geq 0.05$ ), but *in situ* disappearance of NDF decreased when grain was increased in the diet ( $P \leq 0.05$ ). The enzyme increased ISDMD and ISNDFD ( $P \leq 0.05$ ), and values for these variables were larger at 72 h. Within each diet (with or without enzyme), for equivalent times, the enzyme increased ISDMD and ISNDFD ( $P \leq 0.05$ ), with a larger disappearance in the first 24 h. The interactions between diets x time (ISDMD), and enzyme x time (ISDMD; ISNDFD) were significant ( $P \leq 0.05$ ). According to these results, Fibrozyme increased *in situ* disappearance of DM and NDF mainly in the first 24 h of incubation.

**Key Words:** Fibrolytic Enzyme, *In situ* Disappearance, Dry Matter and Fiber

**W198 Effects of fibrolytic enzymes and soybean oil on dairy sheep performance and nutrient digestibility.** M. A. Bouattour, R. Casals\*, E. Albanell, E. González, X. Such, and G. Caja, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain.

Two experiments were conducted with the aim of studying the effects of a fibrolytic enzyme complex (E) and soybean oil (SBO) on lactational performance and digestibility in dairy sheep. In Exp. 1, 24 Lacaune (LC) and 24 Manchega (MN) ewes (49 DIM) were blocked in 4 pens of 6 ewes per breed, and used in a replicated 4 x 4 Latin square for periods of 20 d. Dietary treatments were: 1) C (control); 2) SBO (2.8% of TMR on DM basis); 3) E (Promote, 2 ml/kg TMR on DM basis); and, 4) SBO plus E. Total mixed rations consisted of 60% forage (alfalfa and fescue dehydrated mixture, 1:1) and 40% concentrate. Diets were isonitrogenous (16.2% CP), but ether extract varied from 2.3 to 3.7% according to SBO addition. Breed responses to treatments were similar despite the differences between breeds (LC vs. MN;  $P < 0.001$ ); DMI (3.06 vs. 2.43 kg/d), milk yield (2.07 vs. 1.08 L/d), and fat (5.60 vs. 6.63%)

and casein (3.70 vs. 4.13%) milk contents. Feed intake (2.74 kg DM/d) did not vary between treatments. Addition of SBO increased milk and milk fat yields (6.2 and 5.3%, respectively;  $P < 0.05$ ), and long chain fatty acids (38%;  $P < 0.001$ ), but decreased ( $P < 0.001$ ) milk protein, CN, and medium and short chain fatty acids. Increases in C18:1, C18:2 and CLA were 56, 22 and 300% ( $P < 0.05$ ), respectively. Addition of enzymes increased milk and true protein yields (6.1 and 4.2%, respectively;  $P < 0.05$ ), but decreased ( $P < 0.05$ ) fat, total and true protein, and CN milk contents. In Exp. 2, the digestibility of the diets used in Exp. 1 was measured in 8 dry and open MN ewes in randomized block design (two periods of 20 d). When used alone, SBO increased ether extract digestibility ( $P < 0.001$ ) but did not vary DM (64.4%), OM (67.9%) and NDF (53.6%) digestibilities. Moreover, the E treatment increased ( $P < 0.05$ ) DM (8%), OM (7%) and NDF (12%) digestibilities. With regard to the SBO plus E treatment, SBO decreased ( $P < 0.05$ ) DM (8%), OM (9%) and NDF (14%) digestibilities, and E complex was unable to recover the control values. Surface effects of soybean oil may have been responsible for the decrease of enzyme activity.

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**Key Words:** Fibrolytic Enzymes, Soybean Oil, Dairy Sheep

**W199 Effect of exogenous polysaccharide-degrading enzyme preparations on ruminal fermentation and total tract digestibility of nutrients in lactating dairy cows.** A. N. Hristov\*<sup>1</sup>, C. E. Basel<sup>1</sup>, A. Melgar<sup>1</sup>, A. E. Foley<sup>1</sup>, J. K. Ropp<sup>1</sup>, C. W. Hunt<sup>1</sup>, and J. M. Tricarico<sup>2</sup>, <sup>1</sup>University of Idaho, Moscow, <sup>2</sup>Alltech, Biotechnology Center, Nicholasville, Kentucky.

The objective of this study was to evaluate the effect of three exogenous polysaccharide-degrading enzyme preparations (EPDE) on ruminal fermentation and total tract apparent digestion of nutrients in lactating dairy cows. Four late-lactation, ruminally cannulated Holstein cows were allocated to dietary treatments in a 4 x 4 Latin square design. The basal diet fed to the cows contained 40% alfalfa and grass hays, 44% corn and barley grains, 8% whole cottonseed, and 8% protein and mineral/vitamin supplements. The EPDE preparations, a blank, a predominantly amylase, a predominantly xylanase, and an amylase/xylanase combination were dosed into the rumen through the cannula daily, during the morning feeding (0600) at 10 g/cow. Treatments did not affect ruminal pH ( $P = 0.97$ ), ammonia concentration ( $P = 0.96$ ), protozoal counts ( $P = 0.97$ ), total and individual VFA concentration ( $P = 0.42$  to 0.99), acetate:propionate ratio ( $P = 0.57$ ), and solid ruminal digesta passage rate ( $P = 0.35$ ). Carboxymethylcellulase, xylanase, and amylase activities of whole ruminal contents at 2, 4, and 6 h following EPDE dosing were also not affected ( $P = 0.20$  to 0.99) by the treatments. Intake of DM and nutrients and total tract apparent digestibility of starch, NDF, and ADF did not differ ( $P = 0.24$  to 0.28) among treatments. Digestibilities of DM, OM, and N were reduced ( $P = 0.06$  to 0.07) by the amylase/xylanase combination compared with the amylase or xylanase EPDE. Given the conditions of this experiment, EPDE dosed intraruminally at 10 g/head/d did not affect ruminal fermentation, did not increase the polysaccharide-degrading activities of ruminal contents, and did not affect total tract apparent digestion of nutrients compared to the control.

**Key Words:** Dairy Cow, Exogenous Enzyme, Digestion

**W200 The effects of supplemental yeast culture fed during the periparturient period: Implications of milk production and feed intake of high producing dairy cows.** R. Vogel\*<sup>1</sup>, J. N. Spain<sup>1</sup>, and I. Yoon<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Diamond V Mills, Cedar Rapids, IA.

Objective of this study was to determine the effect of yeast culture fed during late gestation and early lactation on dry matter intake and milk production of Holsteins. Mature cows (n = 36) and heifers (n = 33) were grouped by expected calving date, parity, milk production potential (mature cows only) and body weight. Animals were then randomly assigned within block to treatment. Dietary treatments were control (C), Diamond V yeast culture (XP), and Diamond V XP concentrate, designed to deliver the same effect of XP at 25% feeding rate

(XPC). Yeast cultures XP and XPC were fed at 56 g and 14 g/d, respectively, and added as part of the vitamin/mineral pre-mix. Cows were housed in a freestall barn except at calving when animals were housed in a calving pen. Cows were fed experimental diets twice daily for ad libitum consumption via electronic feeding gates (American Calan) with feed intake measured daily. Prepartum treatment diets began 21 d prior to expected day of calving. At calving, cows were fed standard lactation TMR which was formulated based on NRC 2001 recommendations for the first 10.5 wk of lactation. Cows were milked twice daily. Milk samples were collected at two consecutive milkings and analyzed for fat, true protein, MUN, and SCC. Blood samples were collected on day -10, -3, -1 and day of calving. Postpartum blood samples were collected on d 1, 3, 7, 10 and 14 of lactation then twice weekly until d 75. Blood samples were analyzed for plasma NEFA and glucose. Body weight and condition scores were collected twice weekly. Data were analyzed using mixed model ANOVA. DMI did not differ prepartum or after calving. Milk production was greater for cows fed XP and XPC compared to C (32.6, 32.3 vs. 28.2 kg FCM;  $P = 0.08$ ). Inclusion of yeast culture increased milk yield without changing dry matter intake when fed to Holstein cows beginning 3 wk prior to calving through 75 d of lactation.

**Key Words:** Yeast Culture, Periparturient Cows, Milk Yield

**W201 Effect of feeding a *Saccharomyces Cerevisiae* yeast culture on reproduction, body condition score (BCS) and lameness in dairy cows under heat stress.** R. G. S. Bruno\*, H. M. Rutigliano, R. L. A. Cerri, P. H. Robinson, and J. E. P. Santos, *University of California, Tulare.*

Multiparous Holstein cows, 723, from two dairy farms were blocked at calving by parity and previous lactation milk yield and, within each block, randomly assigned to one of two treatments: a diet containing no yeast (Control;  $n = 361$ ) or 30g/d of *Saccharomyces cerevisiae* (Amax Extra, ViCor, IA; Yeast;  $n = 362$ ) from 20 to 140 d in milk (DIM). The study was conducted from May to December of 2004 and cows calving during May to August were enrolled. Lameness score (1 to 5 scale) was evaluated at study enrollment and again at 100 d postpartum. The BCS (1 to 5 scale) was evaluated at calving, 28, 58 and 140 DIM. Cows received 2 injections of PGF2a at 37±3 and 51±3 DIM, and those observed in estrus were inseminated. Cows not in estrus were enrolled in a timed AI protocol at 65±3 DIM and inseminated at 75±3 DIM. Ovaries were examined by ultrasonography at 37±3 and 51±3 DIM to determine cyclicity by the presence of a CL in at least one of the two examinations. Pregnancy was diagnosed at 31, 38 and 66 d after the first AI and at 38 and 66 d after the second and third AI. Data were analyzed by the MIXED and LOGISTIC procedures of SAS (2001), and days open by survival analysis with censoring at 140 DIM. At 51 d postpartum, treatment did not affect ( $P=0.36$ ) cyclicity and 8.2% of the cows were anovular. Detection of estrus in the 7 d after the second injection of PGF2a at 51 DIM was similar for Control and Yeast (52.9 vs 53.9%;  $P=0.75$ ). For Control and Yeast, conception rates at first (35.5 vs 35.1%;  $P=0.75$ ) and second (39.3 vs 34.2%;  $P=0.21$ ) postpartum AI, and pregnancy loss from d 31 to 66 after first AI (17.4 vs 23.0%;  $P=0.28$ ) did not differ. The median days open for Control and Yeast (96 vs 103 d) was similar did not differ ( $P=0.39$ ). Treatment did not affect ( $P=0.77$ ) BCS throughout the study and it averaged 2.89. For Control and Yeast, incidence of lameness (18.6 vs 14.9%;  $P=0.23$ ) and the mean lameness score (2.3 vs 2.2;  $P=0.10$ ) were similar. Feeding a yeast culture of *S. cerevisiae* had no impact on reproduction, lameness and BCS of multiparous cows under heat stress.

**Acknowledgements:** Vi-Cor and NRICGP USDA

**Key Words:** Dairy Cows, Reproduction, Yeast

**W202 Effects of feeding yeast culture and propionibacteria on milk yield and milk components in Holstein cows.** K. V. Lehloeny<sup>1</sup>, D. R. Stein<sup>1</sup>, M. M. Aleman<sup>1</sup>, T. G. Rehberger<sup>2</sup>, D. T. Allen<sup>1</sup>, D. A. Jones<sup>1</sup>, and L. J. Spicer<sup>1</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>Agtech Products, Inc., Waukesha, WI.

To determine the effect of supplemental feeding of Diamond V-XP Yeast Culture (XPY) alone or in combination with Propionibacteria strain P169 on milk

production and milk components, 31 primiparous (PP) and multiparous (MP) Holstein cows were fed one of three dietary treatments between 2 wk prepartum to 30 wk postpartum: 1) Control ( $n = 10$ ), fed a corn silage-based total mixed ration (TMR); 2) XPY ( $n=11$ ), fed Control TMR plus XPY (at 56 g/head/d); and 3) XPY+P169 ( $n = 10$ ), received Control TMR plus XPY plus P169 (at 6 x 10<sup>11</sup>/head/d). After parturition, daily milk weights were recorded, and milk samples were collected twice weekly for milk component analyses. Daily uncorrected milk and solids-corrected milk (SCM) production tended ( $P < 0.09$ ) to be affected by dietary treatment such that SCM for cows (averaged across PP and MP cows) fed P169+XPY (38±2 kg/d) was 8% and 5% greater than Control and XPY cows, respectively. Dietary treatment did not affect ( $P>0.20$ ) 4% fat-corrected milk production (FCM) likely because percentage of milk fat was greater ( $P<0.02$ ) in Control than XPY and P169+XPY groups. Milk lactose percentage was affected by diet x parity ( $P < 0.001$ ) with XPY+P169 fed MP cows having greater lactose levels than Control and XPY MP cows; milk lactose in PP cows did not differ ( $P>0.20$ ) among diet groups. Diet x parity tended ( $P<0.08$ ) to affect milk protein percentage such that milk protein increased in MP cows fed XPY but decreased in PP cows fed XPY compared to the other groups. Percentage of SNF tended to be greater in XPY+P169 fed MP cows than Control and XPY MP cows (diet x parity,  $P<0.10$ ). In conclusion, supplemental feeding of P169 in combination with XPY tended to increase uncorrected milk and SCM production in Holstein cows, and thus may hold potential as a natural direct-fed microbial to enhance lactational performance.

**Key Words:** Yeast Culture, Propionibacteria, Milk Production

**W203 Production, intake, feed efficiency, and economic responses from feeding a concentrated yeast culture to lactating cows on commercial dairies.** W. K. Sanchez<sup>1</sup>, I. Yoon<sup>1</sup>, M. E. Engstrom<sup>1</sup>, and N. R. St-Pierre<sup>2</sup>, <sup>1</sup>Diamond V Mills, Cedar Rapids, IA, <sup>2</sup>The Ohio State University, Columbus.

Yeast Culture (XP) is fermented yeast and growth media fed to stimulate rumen fermentation. Improvements in adsorbent properties of the grain substrate have made it feasible to create an XP concentrate (XPC) that is equivalent to XP at 25% of the feeding rate. The objective of these trials was to evaluate the production, feed efficiency and economic responses from feeding XPC to lactating cows on commercial dairy farms. Two mixed model statistical designs were conducted. In trial one, six pens of cows were randomly assigned to two treatments in a double blind study. Dietary treatments consisted of a daily top dress of either 54g XP or 14g XPC for 60 d blended in a distillers dried grains carrier. Only cows that were in the pens for a preceding month and at least 1 of 2 monthly tests were included in the analysis. Cows fed XPC yielded more ( $P < 0.05$ ) milk fat (1.54 vs. 1.34 kg/d) and 3.5% FCM (42.1 vs. 37.1 kg/d) than cows fed XP, respectively. Pen DMI were numerically lower and thus FCM/DMI efficiencies were higher for cows fed XPC. Cows appeared to respond quicker to XPC than XP but by 60 d differences were less evident. In trial two, pairs of herds within three regions (CA, OR, and WI) were randomly assigned to a double blind switch back arrangement of treatments. One herd in each pair was fed either 14g of XPC or placebo in the first 60 d period then switched to the other treatment during the next period. Only animals that were 80 DIM or greater and had at least one monthly milk test per period were included in the analysis. With herd as the experimental unit differences were non significant ( $P > 0.1$ ) but feeding XPC resulted in 0.84 kg/d more FCM, 0.09 kg/d less DMI and thus greater FCM/DMI. With milk valued at \$12/45 kg, TMR at \$0.032/kg DM and XPC at \$0.04/cow per d, XPC returned an additional \$0.20/cow per d or 5:1 return on investment. Both trials together indicate that XPC is economically beneficial in-vivo.

**Key Words:** Yeast Culture, Lactation, Feed Efficiency

**W204 Effects of live yeast supplementation on ruminal pH of loose-housed dairy cattle.** A. Bach<sup>1,2</sup>, C. Iglesias<sup>2</sup>, M. Devant<sup>2</sup>, and N. Rafols<sup>2</sup>, <sup>1</sup>Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain, <sup>2</sup>Unitat de Remugants, Institut de recerca i Tecnologia Agroalimentàries (IRTA), Barcelona, Spain.

The aim of this study was to determine the effects on rumen pH of live yeast supplementation in loose-housed dairy cows. Three multiparous lactating ru-

men-cannulated cows receiving the same basal ration (50:50 forage:concentrate) were supplemented with 5 g/d (equivalent to  $10^{10}$  CFU/d) of *Saccharomyces cerevisiae* strain CNCM 1077 (Levucell SC2, Lallemand, France) alternately for periods of 2 wk following a cross-over design. The three cows were maintained in loose-house conditions in a group of 70 cows in total, and thus they had to adjust their eating pattern to social interactions as it occurs in commercial herds. During the last 8 d of each period, rumen pH was monitored every 15 min. These pH measurements were recorded with an automatic pH meter that was placed inside a custom-made PVC pipe with about 300 g of lead to ensure that the device remained in the ventral part of the rumen throughout all readings. The rumen was only accessed once every 2 d during samplings. The data were analyzed using a mixed model with repeated measures accounting for the random effect of each cow, and the fixed effects of yeast, the day of sampling, the time since last TMR eating bout, the time since previous concentrate consumption, and the interaction of yeast with the remaining fixed effects. Average rumen pH was greater ( $P < 0.01$ ) when yeast was supplemented compared with control (6.04 vs 5.46, respectively). Rumen pH decreased ( $P < 0.001$ ) as time since last TMR or concentrate bouts increased, but this decrease was independent of treatments. Also, the percentage of pH values below 5.6 was lower ( $P < 0.001$ ) when yeast was supplemented compared with control (26 vs 67%, respectively). The results indicate that live yeasts have a beneficial effect on ruminal pH with cows kept in loose-house conditions receiving rations similar to the one of this study. Furthermore, the yeast effects may be evident starting 1 wk after their supplementation.

**Key Words:** Rumen, pH, Yeast

**W205 Effect of feeding a *Saccharomyces Cerevisiae* yeast culture on lactation performance of dairy cows under heat stress.** R. G. S. Bruno\*, H. M. Rutigliano, R. L. A. Cerri, P. H. Robinson, and J. E. P. Santos, *University of California, Tulare*.

Multiparous Holstein cows, 723, from two dairy farms were blocked by parity and previous lactation milk yield and, within each block, randomly assigned to one of two treatments at calving: a diet containing no yeast (Control;  $n = 361$ ) or 30g/d of *Saccharomyces cerevisiae* (Amax Extra, ViCor, IA: Yeast;  $n = 362$ ) fed from 20 to 140 d in milk (DIM). The study was conducted from May to December of 2004 and cows calving during the hot months (May-August) were enrolled. Cows were milked twice daily and production of milk and milk components were measured every 2 weeks. Group DM intakes from 6 pens were measured daily and individual pen temperature and humidity was evaluated hourly with electronic data loggers (June to November). Rectal temperature was taken from 88 (22/trt/dairy) cows once weekly, during 4 weeks. Blood was sampled from a subset of 120 cows at  $58 \pm 3$  and  $100 \pm 3$  DIM for measurements of plasma glucose and nonesterified fatty acids. Data were analyzed by the MIXED procedure of the SAS (2001) program. For Yeast and Controls, respectively, average daily maximum temperature ( $30.7$  vs  $30.6$  C;  $P=0.70$ ) and humidity ( $86.5$  vs  $87.6\%$ ;  $P=0.56$ ) in pens, and group DM intake ( $27.2$  vs  $27.4$  kg/d;  $P=0.91$ ) did not differ. Cows fed Yeast produced more milk ( $43.3$  vs  $42.1$  kg/d;  $P<0.05$ ), milk protein ( $1.213$  vs  $1.187$  kg/d;  $P<0.05$ ), solids nonfat ( $3.678$  vs  $3.583$  kg/d;  $P<0.05$ ) and lactose ( $2.074$  vs  $2.016$  kg/d;  $P<0.04$ ) than Controls, but 3.5% fat-corrected milk was similar ( $43.1$  vs  $42.4$  kg/d;  $P=0.23$ ) because of lower fat content in milk of cows fed Yeast than Controls ( $3.49$  vs  $3.59\%$ ;  $P<0.001$ ). However, concentrations of protein ( $2.82$  vs  $2.84\%$ ;  $P=0.19$ ), solids nonfat ( $8.58$  vs  $8.50\%$ ;  $P=0.52$ ), and lactose ( $4.83$  vs  $4.83\%$ ;  $P=0.91$ ) were similar between Yeast and Control cows. The linear somatic cell count score was not affected ( $P=0.85$ ) by treatment and averaged 2.71. Rectal temperatures for Yeast and Control cows were similar ( $P=0.21$ ) and averaged  $38.52$  and  $38.47$  °C, respectively. Feeding a yeast culture of *S. cerevisiae* improved yields of milk and milk components in heat-stressed multiparous Holstein cows.

**Acknowledgements:** Vi-Cor and NRICGP USDA

**Key Words:** Dairy Cows, Yeast, Heat Stress

**W206 Effects of yeast culture and natural saponin sources on ruminal microbial populations and tropical forage digestion *in vitro*.** H. R. Jimenez<sup>1</sup>, O. Pacheco<sup>1</sup>, H. Blanco<sup>1</sup>, D. R. Chamorro<sup>1</sup>, and J. M. Tricarico<sup>\*2</sup>, <sup>1</sup>*Corpoica, Cundinamarca, Colombia*, <sup>2</sup>*Alltech Inc., Nicholasville, KY*.

We conducted a series of experiments to examine the effects of yeast culture (Yea-Sacc<sup>®</sup>, Alltech Inc., Nicholasville, KY) and natural saponins from wingleaf soapberry (*Sapindus saponaria* L., SS) and quinoa (*Chenopodium quinoa*, CQ) on ruminal protozoal and bacterial concentrations and *in vitro* degradation of kikuyugrass (*Pennisetum clandestinum*). We used batch cultures in a completely randomized-repeated measures design. Triplicate cultures were established with 100 mg of substrate and received one of the following six treatments: 1) no supplement, 2) 0.5 mg Yea-Sacc<sup>®</sup> (YS), 3) 1.5 mg CQ, 4) 6.0 mg SS, 5) 0.5 mg YS + 1.5 mg CQ, or 6) 0.5 mg YS + 6.0 mg SS. Microbial enumerations were performed on all cultures after 8, 12, 24 and 48h incubations. Degradation of kikuyugrass DM, NDF and ethanol insoluble residue (EIR) was determined by measuring *in vitro* gas production. Cumulative gas data from each fraction were fitted with the Gompertz equation to estimate maximum gas volume, specific rate of gas production and lag time. Supplementation with SS reduced ( $P<0.01$ ) total protozoa and endodiniomorphs after 24h and reduced isotrichs and dasytrichs below detectable limits after 48 h. The defaunation activity of SS was further enhanced by YS addition. Supplementation with CQ increased ( $P<0.05$ ) total protozoa after 24h but the CQ-YS combination reduced ( $P<0.05$ ) total protozoa after 48h. After 12 h, cellulolytic bacteria concentrations were greater ( $P<0.05$ ) in cultures receiving YS, CQ, or SS and tended ( $P<0.10$ ) to be greater in cultures receiving the saponin-YS combinations. Supplementation with SS reduced ( $P<0.05$ ) the maximum gas volume from DM, the lag time from NDF and the specific rate and lag time from EIR. The CQ-YS combination reduced ( $P<0.05$ ) the maximum gas volumes from DM and EIR and increased ( $P<0.05$ ) the lag time from DM. Although saponins and the saponin-YS combinations reduced protozoa and increased cellulolytic bacteria concentrations they also reduced the rate and extent of DM, NDF and EIR degradation.

**Key Words:** Saponin, Yeast, Fermentation

**W207 Lactation response of dairy goats fed sugar cane silage treated with *Lactobacillus buchneri*.** C. Q. Mendes, I. Susin\*, A. V. Pires, L. G. Nussio, I. U. Packer, and R. C. Araujo, *ESALQ/University of São Paulo, Piracicaba, SP, Brazil*.

Sugar cane silage is an alternative feed for ruminants. Studies have shown that sugar cane ensiled without additive results in low quality roughage. A high concentration of ethanol, present in sugar cane silage, may reduce voluntary feed intake affecting animal performance. Our objective was to evaluate the effects of feeding sugar cane silage treated with *Lactobacillus buchneri* on milk yield and milk composition. Thirty-nine Saanen goats ( $83 \pm 5$  DIM) were assigned to a complete randomized block design according to milk production, DIM and number of lactation. Goats were housed individually in a tie stall for a period of 10 weeks. Does were fed a 50:50 (concentrate:roughage ratio) TMR. Experimental treatments were: fresh sugar cane (FSC), sugarcane silage without additive (SCS) and sugar cane silage treated with *Lactobacillus buchneri* (SCS+Lb,  $5 \times 10^4$  cfu/g wet basis). DMI was higher ( $P<0.01$ ) for goats fed FSC diet ( $2.82$  kg/d) when compared to SCS ( $2.22$  kg/d) and SCS+Lb ( $2.42$  kg/d). Milk production (MP) and fat corrected milk yield (FCM 3.5%) were similar among diets (MP 1.65, 1.42, 1.48 kg/d and FCM 1.48, 1.56, 1.41 kg/d for FSC, SCS and SCS+Lb, respectively). However, feed efficiency was greater for goats fed the silage diets (0.52, 0.64 and 0.64 kg FCM 3.5% / kg DMI for FSC, SCS and SCS+Lb, respectively). Milk fat and total solids were higher for diets containing silages. SCS+Lb diet had higher ( $P<0.01$ ) milk fat content (3.8%) than SCS (3.46). Sugar cane silages reduced DMI, however, had no detrimental effects on lactation performance of Saanen does.

**Key Words:** Silage Additive, Milk Production, Saanen

**W209 Influence of dietary silymarin on hematic parameters and oxidative stress in periparturient dairy goats.** D. Tedesco<sup>\*1</sup>, S. Galletti<sup>2</sup>, S. Spaguolo<sup>1</sup>, P. Abrescia<sup>3</sup>, and L. Ferrara<sup>2</sup>, <sup>1</sup>University of Milan, Milan, Italy, <sup>2</sup>ISPAAM-CNR, Naples, Italy, <sup>3</sup>Università di Napoli Federico II, Naples, Italy.

Silymarin, a hepatoprotective and antioxidant extract from seeds of *Silybum marianum* L. (Gaertn) (milk thistle), has shown to prevent fat accumulation in liver in periparturient dairy goats and to have positive effects on milk production in cows and goats. Aim of the present study was to determine the effects of silymarin extract fed in the peripartum period on hematic parameters and antioxidant status in dairy goats. A total of 24 dairy goats in their second pregnancy were divided into two groups according to body condition score (BCS), health condition and previous milk production. From 5 d prior to the expected kidding date to 15 d postpartum, the treated goats received 10 mL/d of silymarin (Silyvet<sup>®</sup>, Indena S.p.A., Milan, Italy) as a water suspension, administered as oral drenches. Plasma samples were collected weekly from 5 d prior to kidding date to 21 d after kidding, and analysed for NEFA, BHBA, triglyceride, cholesterol, glucose, retinol,  $\alpha$ -tocopherol, and nitrotyrosine, a biomarker of in vivo oxidative damage. Data were analysed as repeated measures using PROC MIXED of SAS. Silymarin treatment did not influence levels of NEFA, BHBA, triglyceride, cholesterol, and glucose in the peripartum period. Liposoluble antioxidants levels were not influenced by treatment; in both groups retinol and  $\alpha$ -tocopherol were lower at kidding day and increased at 7 and 14 d after kidding. Nitrotyrosine plasma level significantly increased in control goats on 7, 14, and 21 d after parturition, indicating an oxidative stress. In silymarin treated goats nitrotyrosine level at kidding was lower with respect to the observed prepartum value and the nitrotyrosine concentration at 0, 7, 14 and 21 d after kidding was significantly lower with respect to control ( $P < 0.001$ ). From these results we can affirm that oxidative stress occur in periparturient dairy goats, and the antioxidant effect of silymarin can contribute to prevent oxidative damage.

**Key Words:** Silymarin, Dairy Goat, Oxidative Stress

**W210 Sorghum grain physical, chemical and genotype characteristics influence ruminal degradation in cattle.** M. D. Montiel<sup>\*1,2</sup>, J. Elizalde<sup>1,2</sup>, L. Giorda<sup>3</sup>, and F. Santini<sup>1,2</sup>, <sup>1</sup>CONICET, Argentina, <sup>2</sup>Fac. Cs. Agrarias UNMDP-INTA Balcarce, Argentina, <sup>3</sup>EEA INTA Manfredi, Argentina.

We studied the influence of genotype, physical and chemical characteristics of sorghum grain hybrids on ruminal in situ degradation using flint and dent corn hybrids as controls. Two digestion trials were conducted with three ruminally cannulated heifers. Ruminal dry matter (DM), crude protein (CP) and starch degradability of 14 sorghum hybrids, with different tannin content and endosperm structure, and 4 corn hybrids, incubated during 16 and 33 hours, were evaluated in the fist trial. Physical (test weight, milling ratio, percentage of floating grain, apparent density) and chemical (tannins, CP, starch and kafirins) characteristics were evaluated. Ruminal degradability of sorghum grain related with physical and chemical characteristics were used in order to predict digestion. In situ DM, CP and starch degradability were different between corn and sorghum genotypes ( $P < 0.05$ ), however two sorghum hybrids were not different from three corn hybrids. Physical characteristics were not related to ruminal degradability. Tannins content affected in situ DM, CP and starch degradability and was the best predictor of DM, CP, and starch degradability ( $R^2 = 0.5, 0.45$  and  $0.73$ , respectively). The kinetics of ruminal digestion of six sorghum hybrids with different tannin content (high-HT-, medium-MT-, and low tannin-LT-) and two corn grains (flint and dent) were evaluated in the second experiment. Degradability of LT sorghum was higher ( $P < 0.05$ ) than HT (49.5 vs. 43.9%, 47.1 vs. 34.2%, 51.6 vs. 39%, for DM, CP and starch, respectively). The LT sorghum had higher ( $P < 0.05$ ) degradability than the HT hybrids, although LT were less digestible ( $P < 0.05$ ) than corns. Ruminal degradability of sorghum grain was highly dependent on the genotypes, and can not be predicted from physical characteristics. However, tannin content was most reliable predictor of DM, CP and starch degradability.

**Key Words:** Sorghum Grain, Genotype, Physical and Chemical Characteristics

**W211 Nitrogen fractions and fibers of commercial nonforage fiber sources for ruminants in central Iran.** G. R. Ghorbani<sup>\*1</sup> and A. Nikkhah<sup>2</sup>, <sup>1</sup>Isfahan University of Technology, Isfahan, Iran, <sup>2</sup>University of Manitoba, Winnipeg, Manitoba, Canada.

A thorough knowledge of the variability in chemical composition of the commercial by-products fed to ruminants is imperative for high predictability of animal response on-farm. The objective of this study was to analyze the fibers and nitrogen (N) fractions of wheat bran (WB) and beet pulp (BP), as the common nonforage fiber sources used in ruminant rations in Iran. Feed samples were collected from 14 dairy farms across Isfahan province. Cell wall fibers (NDF and ADF) were determined and crude protein (CP) was fractionated into nonprotein nitrogen (NPN) or A, quickly degradable true CP (B1), moderately degradable true CP (B2), slowly degradable true CP (B3), and unavailable N (C) based on the Cornell Net Carbohydrate and Protein System (CNCPS). Descriptive statistics for all fiber and N fractions, and correlation coefficients between fibers and N fractions were obtained. Data were analyzed in a completely randomized design using the General Linear Model Procedure of SAS. The fiber and all N fractions of WB except for fraction C differed significantly ( $P < 0.001$ ) across farms. The unavailable N (31.4 vs. 22.6 g/kg), B3 (31.5 vs. 26.5 g/kg) and NPN (31.4 vs. 22.6 g/kg) were greater ( $P < 0.01$ ), but CP (161.9 vs. 171 g/kg), B2 (64.2 vs. 83.4 g/kg), and NDF (424 vs. 510 g/kg) were lower ( $P < 0.01$ ) in WB of this study as compared to that reported in recent CNCPS feed library. The higher CP (108.6 vs. 98.0 g/kg,  $P < 0.01$ ) and lower NDF (420 vs. 446 g/kg,  $P < 0.01$ ) content of BP in this study compared to the CNCPS feed library were translated into more soluble fiber and thus more ruminally available energy in the samples of this study. The N fractions of A (38.7 vs. 25.4 g/kg) and C (17.6 vs. 10.8 g/kg) in BP were greater ( $P < 0.01$ ) than those in CNCPS library. Results uncovered the regional variability in the fiber and N fractions of the commercial by-products fed to ruminants in central Iran, emphasizing the necessity of further investigations on other nutrients.

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**Key Words:** Nitrogen Fractions, Beet Pulp, Wheat Bran

**W212 Intake and apparent digestibility in Holstein Steers fed diets containing Tifton 85 hay with different particle sizes.** E. S.s Pereira<sup>\*1</sup>, A. M. V.a Arruda<sup>1</sup>, and I. Y. Mizubuti<sup>2</sup>, <sup>1</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brasil, <sup>2</sup>Universidade Estadual de Londrina, Londrina, Paraná, Brasil.

This work had the objective of evaluating the effect of different particle sizes of Tifton 85 hay (5, 7, 10 millimeters and whole) in the diet of Holstein steers, with the average weight of 300 kg and 20 months of age, on the intake of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), total carbohydrates (TC), non structural carbohydrates (NSC), neutral detergent fiber (NDF), acid detergent fiber (ADF) and total digestible nutrients (TDN), and the apparent digestibilities of DM, OM, CP, EE, TC NDF, ADF and NSC. It was used a  $4 \times 4$  Latin square experimental design, with four steers and four periods of sixteen days for each one. Intakes of DM, NDF, OM, CP, EE, TC and NSC, expressed in different ways, were not influenced by the different granulometric profiles of the experimental diets. DM coefficients of digestibility were significant for five percent and influenced by the granulometric profile; values ranged from 54.95 to 67.3% for the diets constituted by 10 and 7 millimeters of particle sizes, respectively. There were no differences significant in the CP coefficients of digestibility for the diets constituted by 5 and 7 millimeters and whole particle sizes; average value was 69.39%. Digestibility coefficients for EE, TC, NDF and ADF did not differ among experimental diets. NSC digestibilities were different for five percent for the diets constituted by 10 millimeters and whole hay (76.64 and 87.19%, respectively). However, these values were similar to the ones from diets with 5 and 7 millimeters particles, which presented an average value of 83.33%. It can be concluded that diets with Tifton 85 hay with particles sizes of 5 and 7 millimeters resulted in similar nutrients intake and digestibilities.

**Key Words:** Food Intake, Nutrient Digestibility, Particle Size

**W213 The determination of fermentation characteristics of Iranian beet pulp, sunflower head and forages using gas production technique.** M. Ziabakhsh, A. Taghizadeh\*, H. Abdoli, G. A. Moghaddam, A. Tahmasbi, and P. Yasan, *Tabriz University, Tabriz, East Azarbaijan, Iran.*

In vitro gas production technique was used to measure the gas production from Iranian beet pulp (BP), sunflower head (SFH), alfalfa hay (AH) and barley straw (BS) as test feeds. Two sheep (38±4 kg) were used. The sheep were fed a diet consisting of 600 g kg<sup>-1</sup> concentrate and 400 g kg<sup>-1</sup> forage containing DE (3.35 Mcal/kg DM) and CP (160 g/kg DM) and used as ruminal fluid donors for the preparation of inoculums. The production of gas was measured in each vial after 2, 4, 8, 12, 15, 24, 48, 72 and 96 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered. Gas production data were in triplicate fitted to a equation of  $p=a+b(1-e^{-ct})$ ; where (p) is the gas production at time, t, (a) is intercept and ideally reflects the fermentation of soluble and readily available, (b) is fermentation of the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The soluble fraction (a) for SFH, BP, AH and BS was (ml/g) 61.83, 91.63, 42.28 and 25.51, respectively. The insoluble (but with time fermentable) fraction (b) was (ml/g) 164.02, 237.05, 281.46 and 180, respectively. The fractional rate (c) was (%/h) 0.036, 0.029, 0.01 and 0.018, respectively. The results showed the soluble fraction (a) of BP was higher than the other feedstuffs, while the insoluble (but with time fermentable) fraction (b) of AH was significantly (P<0.05) higher than the other test feeds. The fractional rate (c) of SFH was significantly (P<0.05) higher than the other feedstuffs. The results showed that the differences between chemical composition of feedstuffs caused to change fermentation parameters determined by in vitro gas production technique.

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**Key Words:** Gas Production, Beet Pulp, Sunflower Head

**W214 Relationship between in vitro dry matter disappearance and gas production of some feedstuffs.** H. Abdoli, A. Taghizadeh\*, and A. Tahmasbi, *Tabriz University, Tabriz, East Azarbaijan, Iran.*

Test feeds including barley grain (BG), soybean meal (SBM) and wheat bran (WB) were evaluated using in vitro techniques. Two sheep (38±4 kg) were used and fed a diet consisting of 600 g kg<sup>-1</sup> concentrate and 400 g kg<sup>-1</sup> forage containing DE (3.35 Mcal/kg DM) and CP (160 g/kg DM) and used as ruminal fluid donors for the preparation of inoculums. The production of gas and in vitro DM disappearances of test feeds were measured in each vial after 0, 2, 12, 24 and 48 h of incubation. The results were analyzed using completely randomized design (CRD) in each incubation time with Duncan's multiple range test used for the comparison of means. The in vitro DM disappearances and gas production data in triplicate were fitted to a equation of  $p=a+b(1-e^{-ct})$ ; where (p) is the gas production and DM disappearance at time, t, (a) is the fermentation of soluble fraction, (b) is fermentation of the insoluble (but with time fermentable) fraction, (c) is the fractional rate at which b is fermented per hour. The gas production of soluble fraction (a) for BG, SBM and WB was (ml/g) 99.1, 56.7 and 79.2, respectively. The gas production of insoluble fraction (b) was (ml/g) 191.6, 170.2 and 165.3, respectively. The gas production rate of fermentation (c) was (%/h) 0.12, 0.04 and 0.06, respectively. The DM soluble fraction (a) for BG, SBM and WB was (%) 29.7, 39.6 and 29.6, respectively. The insoluble (but with time fermentable) fraction (b) was (%) 57.9, 50.2 and 47.3, respectively. The fractional rate of fermentation (c) was (%/h) 0.13, 0.05 and 0.05, respectively. There was a close relationship between in vitro disappearance results and the gas production in incubation times, especially at 24 h of incubation was indicated more relationship (P<0.01). The relationship of DM disappearance and gas production results in BG, SBM and WB were obtained (P<0.05): 90.3, 91.7 and 84.6, respectively. The high relationship of ruminal DM disappearance and gas production data showed that in vitro disap-

pearance technique can be proper replacement assay for gas production technique.

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**Key Words:** Gas Production, Dry Matter, Disappearance

**W215 Nutritive value of pistachio hulls and effect on feed intake, milk production and composition in lactating dairy cows.** P. Vahmani\*, A. A. Naserian, J. Arshami, and M. Ghafurian, *Ferdowsi University of Mashhad, Khorasan, Iran.*

Pistachio hulls (Pericarp) are a by-product of de-hulling of pistachio nuts soon after harvest. This experiment was carried out to evaluate the effect of dried pistachio hulls (DPH) as a feed ingredient for lactating dairy cows. Eight multiparous Holstein dairy cows (606±24kg BW and 160±18 DIM) were used in a replicated 4×4 latin square design. Cows were housed in a tie-stall barn, fed a TMR ration ad libitum. Control diet contained (DM basis) 22% corn silage, 18% alfalfa hay, 23% barley, 10% cottonseed meal, 8% beet pulp, 7% corn grain, 5.50% wheat bran, 5% soybean meal, 0.6% limestone, 0.3% vitamin premix and 0.3% salt. The treatments were 0 (control diet), 2, 4 or 6% DPH in dietary dry matter. The DPH substituted for beet pulp in the control diet. Each experimental period was for 21 days, which included 14 days of adaptation followed by 7 days sampling period. Dry matter intake (DMI), ruminal pH, blood urea nitrogen (BUN), milk production and composition were determined in sampling period. Chemical analysis indicated that DPH contained 12% CP, 5% ether extract, 45% NDF, 34% ADF, 5.20% ash and 8% tannin (DM basis). Increasing levels of DPH in diets had no significant effect on DMI, ruminal pH, BUN, milk yield, milk fat, milk protein, lactose and SNF (P>0.05), but there was a trend for decreased DMI (23.24, 23.19, 23.01 and 22.70 kg/day, respectively) as dietary DPH content increased. The decline of the DMI may be attributed to reduced palatability, because of increasing tannin content with increasing DPH in diets. Results from the chemical composition and production responses indicate that the use of low levels of DPH did not adversely affect animal performance. However additional research projects are needed to determine the effect of higher levels of DPH on dairy cows or other ruminants.

**Key Words:** Pistachio Hulls, Tannin, Dairy Cows

**W216 The influence of urea treatment on in vitro gas production of pomegranate peel.** R. Feizi\*, A. Ghodratnama<sup>1</sup>, M. Zahedifar<sup>2</sup>, M. Danesh Mesgaran<sup>3</sup>, and M. Raisianzadeh<sup>1</sup>, <sup>1</sup>*Agricultural and Natural Resources Research Center of Khorasan, Mashhad, Khorasan, Iran,* <sup>2</sup>*Animal Science Research Institute Iran, Karaj, Tehran, Iran,* <sup>3</sup>*Ferdowsi University of Mashhad, Mashhad, Khorasan, Iran.*

Pomegranate peel (the rind of the fruit) is poor in protein and rich in tannins. Tannins components of Pomegranate peel (PP) prevents its optimal use. The objective of this experiment was to evaluate the effect of different levels of urea on in vitro gas production (GP) without and with the phenol binding agent polyvinylpyrrolidone (PVP) to ensiled pomegranate peel (EPP). In this experiment 4 levels of urea (0, 2.5, 5 and 7.5% of dry matter) were added to PP (6 replicates per treatment) and ensiled for two periods of 30 and 60 days. In vitro GP from the samples were measured during 96 h incubation without PVP or with 300 mg dry weight of PVP. GP data were analysed in a randomized complete block design using the GLM procedure of SAS. The results indicate that addition of urea and then storage decreased (P<0.05) total extractable tannins (TET) content (206, 177, 169 and 170 mg/g respectively). In vitro GP after 24 and 48 h was higher for EPP treated with 0% urea (40.37 and 45.20 ml without PVP; 43.23 and 50.29 ml with PVP respectively) and lower for EPP treated with 7.5% urea (30.21 and 34.91 ml without PVP; 31.95 and 39.24 ml with PVP respectively) (P<0.05). There was a negative correlation between the CP content of EPP and in vitro GP. Also non-fiber carbohydrate (NFC) level was positively correlated with GP potential. Against the previous studies, in this study, the relationship between the TET content and volume of GP was not

negative which may be related to the fact that different sources of tannins have different natures and different biological responses. This study shows that tannins have negative effect on in vitro rumen fermentation and increase the volume of gas produced with PVP, revealed the inhibitory effects of tannins on fermentation.

**Key Words:** Pomegranate, In Vitro Gas Production, Urea

**W217 Carbohydrate and protein fractions and ruminal kinetics of Tifton 85 grass (Cynodon Spp.) silages.** E. S. Pereira<sup>\*1</sup>, A. M. V. Arruda<sup>1</sup>, and I. Y. Mizubuti<sup>2</sup>, <sup>1</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brasil, <sup>2</sup>Universidade Estadual de Londrina, Londrina, Paraná, Brasil.

The objective of this work was to evaluate the fractionation and the degradation kinetics of the nitrogenous compounds and of the carbohydrates in five silages prepared with Tifton 85 grass forage. Silages were: 1-exclusive Tifton 85, 2-Tifton 85 silage with 16.5% of corn industrial residue added, 3-Tifton 85 silage with 16.5% corn meal added, 4-Tifton 85 silage inoculated with lactobacillus (1 g for each 3 liters of water for ton of fresh material) and 5-beforehand dry Tifton 85 silage, with the drying time of 90 minutes. The non-protein nitrogenous compounds, soluble and insoluble nitrogen in borate-phosphate buffer, neutral and acid detergent insoluble nitrogen were analyzed for protein composed fractions. The degradation rates of the protein fractions were obtained by in vitro incubation of the foods with proteases isolated from ruminal ambient. The total carbohydrates (TC), C and B2 fractions and neutral detergent soluble components were determined by Cornell System. The values of 73.86; 2.97; 13.71; 8.91 and 0.55 percentage of the fraction B2 of the nitrogenous compounds were observed for exclusive Tifton 85, Tifton 85 silage added of corn industrial residue, Tifton 85 silage with corn meal added, Tifton 85 silage inoculated with lactobacillus and beforehand dry Tifton 85 silage, respectively. The values of TC varied from 63.21 to 73.12, the B2 fraction varied from 52.27 to 35.09 percentage; and non structural carbohydrate fraction varied from 8.61 to 38.03 percentage. Tifton 85 silage with corn residue added and Tifton 85 silage with corn meal added, showed higher soluble component fraction, and higher potentially degradable fiber and repletion effect (4.6 hour). The corn residue and corn meal used for silage production favored the effective degradation of B2 fraction, and offered small effect in ruminal fill or repletion, and consequent higher availability of energy in the gastrointestinal tract.

**Acknowledgements:** Fundação Araucária-Paraná-Brasil

**Key Words:** Feed, Fiber, Nutrition

**W218 Ensiling legume and grass pastures: Effects of wilting time and bacterial inoculation on silage fermentation, quality and degradability.** L. O. Abdelhadi<sup>1</sup> and J. M. Tricarico<sup>\*2</sup>, <sup>1</sup>Est. El Encuentro, Reserach and Extension in Ruminant Nutrition, Coronel Brandsen, Buenos Aires, Argentina, <sup>2</sup>Alltech Inc., Nicholasville, KY.

A completely randomized design with a 3x3 factorial arrangement of treatments was used to evaluate the effects of wilting time (WT) and microbial inoculation during ensiling of red clover (63.2% red clover, 22.2% perennial ryegrass and 14.5% tall fescue; DM basis) and tall fescue (54% tall fescue, 34.1% alfalfa and 11.9% white clover; DM basis) based pastures. Pastures were cut and allowed to wilt for 0, 6 or 10h before ensiling for 120 d in triplicate mini silos constructed from PVC pipe. Pastures received no inoculant (control) or were inoculated with Sil-All<sup>®</sup> or Sil-All4x4<sup>®</sup> (Alltech Inc. Nicholasville, KY) at a rate of 10 g/tonne of fresh forage. Samples collected before and after ensiling were analyzed for DM, OM, NDF, CP, true protein (TP), NH<sub>3</sub>-N, pH, and OM degradability (OMD) after incubation with ruminal fluid from 3 to 72h. Forage DM increased ( $P<0.05$ ) with increasing WT in both pastures. Wilting also reduced ( $P<0.05$ ) CP and increased ( $P<0.05$ ) NDF and TP content of the tall fescue-based pasture and increased ( $P<0.05$ ) OMD of the red clover-based pasture. When ensiling tall fescue-based pasture, WT reduced ( $P<0.05$ ) pH, NH<sub>3</sub>-N content and DM recovery (DMR) and increased ( $P<0.05$ ) OMD, DM and CP

content of silage. Microbial inoculation did not affect fermentation but reduced ( $P<0.05$ ) DM content of tall fescue-based silage. When ensiling red clover-based pasture, WT increased ( $P<0.05$ ) DMR and TP and reduced ( $P<0.05$ ) NDF content of silage. Inoculation increased ( $P<0.05$ ) CP content of red clover silage across WT. Inoculation x WT interactions were significant for NH<sub>3</sub>-N, pH, DM, OM and OMD in ensiled red clover. Microbial inoculation reduced ( $P<0.05$ ) NH<sub>3</sub>-N and pH and increased ( $P<0.05$ ) OM content and OMD in non-wilted silage, and reduced ( $P<0.05$ ) DM content at 6 and 10h WT. We conclude that microbial inoculation is valuable when ensiling legume-based pastures but WT is more important when grass is the main component of the silage.

**Key Words:** Silage, Inoculation, Wilting

**W219 Effects of bacterial inoculation on fermentation, chemical composition and degradability of sorghum by-product and whole-plant soybean silages.** L. O. Abdelhadi<sup>1</sup> and J. M. Tricarico<sup>\*2</sup>, <sup>1</sup>Est. El Encuentro, Research and Extension in Ruminant Nutrition, Coronel Brandsen, Buenos Aires, Argentina, <sup>2</sup>Alltech Inc., Nicholasville, KY.

Ensiling whole-plant soybean and sorghum by-product represents an attractive alternative for on-farm preservation of high quality feedstuffs for Argentine farmers. We conducted two experiments to evaluate the effects of microbial inoculation on fermentation, chemical composition, DM recovery (DMR) and OM degradability (OMD) of sorghum by-product and whole-plant soybean silages. We used triplicate mini silos constructed from PVC pipe and a completely randomized design in both experiments. In experiment 1, wet sorghum by-product received no inoculant (control) or 10 g/tonne Sil-All<sup>®</sup> (Alltech Inc., Nicholasville, KY) and was ensiled for 4 months. In experiment 2, whole-plant soybean, harvested at the R6 stage of maturity, received no inoculant (control) or was inoculated with Sil-All<sup>®</sup> or Sil-All4x4<sup>®</sup> (Alltech Inc., Nicholasville, KY) at 10 g/tonne of forage and was ensiled for 3 months. Samples collected before and after ensiling were analyzed for DM, CP, true protein (TP), NDF, pH, NH<sub>3</sub>-N and OMD after incubation in ruminal fluid for 72h. Microbial inoculation had no effects on fermentation, chemical composition or OMD of sorghum by-product. Ensiling whole-plant soybean increased DM (31.7 vs. 35.8 g/kg,  $P=0.03$ ) and decreased CP (144.7 vs. 124.3 g/kg DM,  $P=0.08$ ), TP (616 vs. 471 g/kg CP,  $P=0.02$ ) and NDF (480 vs. 407 g/kg DM,  $P=0.02$ ) content of silage without affecting OMD. Microbial inoculation increased the CP content ( $P=0.07$ ) and reduced the pH ( $P<0.01$ ) of whole-plant soybean silage without affecting DMR or OMD. We conclude that microbial inoculation provides no additional benefits when ensiling sorghum by-product but is valuable for improving the nutrient preservation of whole-plant soybean silage.

**Key Words:** Silage, Soybean, Sorghum By-Product

**W220 Ensiling corn and sorghum: Effects of bacterial inoculation on fermentation, quality and degradability of eight different silage hybrids.** L. O. Abdelhadi<sup>1</sup> and J. M. Tricarico<sup>\*2</sup>, <sup>1</sup>Est. El Encuentro, Research and Extension in Ruminant Nutrition, Coronel Brandsen, Buenos Aires, Argentina, <sup>2</sup>Alltech Inc., Nicholasville, KY.

We conducted two experiments to evaluate the effects of two bacterial inoculants (Sil-All<sup>®</sup> and Sil-All4x4<sup>®</sup>; Alltech Inc., Nicholasville, KY) on fermentation, chemical composition, DM recovery (DMR) and OM degradability (OMD) of corn and sorghum silages (Dekalb, Colon, Argentina). We ensiled four corn hybrids (DK780S, DK790S, M369 and SIL-3) in experiment 1 and four sorghum hybrids (DK39T, DK61T, DK68T and SX-121) in experiment 2. We used a randomized complete block design with three blocks (plots) in both experiments. Each corn and sorghum hybrid received no inoculant (control) or were inoculated with Sil-All<sup>®</sup> (SA) or Sil-All4x4<sup>®</sup> (4x4) at 5 g/tonne of fresh forage before ensiling for 120 d in mini silos constructed from PVC pipe. Samples collected before and after ensiling were analyzed for DM, NDF, starch, CP, true protein (TP), total N, NH<sub>3</sub>-N, pH, and OMD after incubation with ruminal fluid for 3, 6, 12, 24, 48 and 72h. Before ensiling, corn hybrid SIL-3 had a greater ( $P=0.03$ ) TP content than DK780S, DK790S, M369 and sorghum hybrid SX-

121 had greater NDF ( $P=0.07$ ) and lower starch ( $P=0.01$ ) and TP ( $P=0.01$ ) contents than DK39T, DK61T and DK68T. In addition, OMD was similar across corn and sorghum hybrids before ensiling. In experiment 1, inoculation did not affect fermentation, chemical composition, DMR or OMD of M369 silage. Reductions in silage DM contents were observed with 4x4 inoculation of DK780S silage ( $P=0.06$ ) and SA inoculation of DK790S silage ( $P=0.07$ ). Both inoculants increased 6h OMD in DK780S silage ( $P=0.02$ ) and NDF ( $P=0.08$ ) content and 72h OMD ( $P=0.07$ ) in SIL-3 silage. In experiment 2, microbial inoculation did not affect fermentation, chemical composition, DMR or OMD of DK39T and DK61T silages. Inoculation with 4x4 increased total N ( $P=0.06$ ) and CP ( $P=0.06$ ) content in DK68T silage. Inoculation with SA increased TP ( $P=0.02$ ) content in DK68T silage and reduced NDF ( $P=0.09$ ) content in SX-121 silage. We conclude that the beneficial effects of microbial inoculation of corn and sorghum silages depend on the particular hybrid and inoculant used.

**Key Words:** Silage, Corn, Sorghum

**W221 Fermentation characteristics and microbial succession of silage from organic residues of orange (*Citrus sinensis*) and pineapple (*Ananas comosus*) processing plants.** S. Pagán\*, A. Rodríguez, and E. Valencia, *University of Puerto Rico, Mayagüez, Puerto Rico.*

Two experiments were conducted to evaluate the microbial succession and fermentation end-products of organic residues from orange (*Citrus sinensis*, **CS**) and pineapple (*Ananas comosus*, **PS**) fruit processing plants. Residues composed of pulp, skins and seeds were fermented in PVC micro-silos for 0, 4, 7, 11, 29 and 65 days. Triplicate samples from each residue and fermentation period (d) were analyzed for pH, microbial succession (coliforms, **C**; lactic acid-producing bacteria, **LAPB**; molds and yeast, **MY**), and fermentation end-products (organic acids). Data within each fermented residue were analyzed as a completely randomized design using the General Linear Model. Bonferroni test was used for means separations. Final pH was 3.32 and 3.21 for **CS** and **PS**, respectively. During the whole fermentation and, for both silages, **C** populations were not detected, while **LAPB** and **MY** had a typical microbial growth. After 65 d of fermentation lactic acid was the main end product associated with the fermentation process, (0.90 and 1.02% for **CS** and **PS** respectively), low percentages of acetic acid were also detected (0.19% **CS** and 0.98% **PS**). Butyric acid was not detected on both fruit residues silages. These results indicate that silage production is an alternative for the disposal of organic residues from orange and pineapple fruit processing plants. Inclusion of these fruit silages on farm animal's diets must be evaluated.

**Key Words:** Organic Residues, Silage, Fermentation

**W222 Silages carbohydrate fractions and degradation rates estimated by gas production technique.** E. S. Pereira<sup>\*1</sup>, A. M. V. Arruda<sup>1</sup>, and I. Y. Mizubuti<sup>2</sup>, <sup>1</sup>Universidade Estadual do Oeste do Paraná, Marechal Cândido Rondon, Paraná, Brasil, <sup>2</sup>Universidade Estadual de Londrina, Londrina, Paraná, Brasil.

The objective of this work was to determine the total carbohydrates composed fractions, and to estimate the digestion rate of the non fiber carbohydrate (NFC) and neutral detergent insoluble fractions of five silages prepared with Tifton 85 grass forage using the gas production technique. Silages were: 1-exclusive Tifton 85, 2-Tifton 85 silage with 16.5% of corn industrial residue added, 3-Tifton 85 silage with 16.5% corn meal added, 4-Tifton 85 silage inoculated with lactobacillus (1 g for each 3 liters of water for ton of fresh material) and 5-beforehand dry Tifton 85 silage, with the drying time of 90 minutes. The total carbohydrate fraction and C, B2 and NFC fractions were determined by laboratory methods (Cornell system). The statistical analyses performed including general variation analyses and comparative means by tukey test in five percent probability. The in vitro gas production from dry matter (DM), neutral detergent fiber (NDF) and NFC in the silages were determined by laboratory anaerobic incubations. The Tifton 85 silage with corn industrial residue and Tifton 85 silage with corn meal additive, showed highest potential digestible content of NFC and B2 carbohydrate fractions. The Tifton 85 silage dry presented lower gas production. The beforehand dry Tifton 85 silage with corn industrial residue and Tifton 85 silage with corn meal additive showed highest gas production from NFC carbohydrate fraction. The rate of digestion to the NFC and NDF carbohydrate fraction in the Tifton 85 silages in this work showed a range of 0.0652 to 0.2273%/hour and a range of 0.0315 to 0.0552%/hour, respectively. More studies with the by-products used in this work as additives for silage were necessary for knowing your influence on the nutritional quality and future recommendations.

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**Key Words:** Carbohydrate Fractions, Gas Production Technique, Silages

## Ruminant Nutrition: Protein and Amino Acids

**W223 Use of Synchrotron FTIR microspectroscopy to determine the effect of heat treatment on protein secondary structures of brown and golden flaxseeds at a cellular level in relation to nutritive value of protein: A novel approach.** P. Yu<sup>\*1</sup>, J. J. McKinnon<sup>1</sup>, H. W. Soita<sup>1</sup>, C. R. Christensen<sup>2</sup>, and D. A. Christensen<sup>1</sup>, <sup>1</sup>University of Saskatchewan, Saskatoon, SK, Canada, <sup>2</sup>Canadian Light Source, Saskatoon, SK, Canada.

An understanding of the structure of the whole protein is often vital to understanding its digestive behavior and nutritive value in animals. Protein secondary structures include  $\alpha$ -helix and  $\beta$ -sheet. The percentage of these two structures influences protein nutritive value and quality. High percentage of  $\beta$ -sheet structure may cause low access to gastrointestinal digestive enzymes, which results in a low protein value. The objective was to use the synchrotron FTIR microspectroscopy (S-FTIR) to reveal chemical features of protein secondary structures of flaxseed tissues affected by varieties and heating in relation to protein nutritive value. The results showed that with the S-FTIR, the structural-chemical makeup and nutritive characteristics of the flaxseed tissues could be revealed. The protein secondary structure differed between the golden and the

brown seed coat types. The golden contained higher percentage of  $\alpha$ -helix ( $47.1 \pm 3.2$  vs.  $36.9 \pm 4.7\%$ ,  $n=20$ ), lower percentage of  $\beta$ -sheet ( $37.2 \pm 3.4$  vs.  $46.3 \pm 4.0\%$ ,  $n=20$ ) and higher ratio of  $\alpha$ -helix to  $\beta$ -sheet (1.3 vs. 0.8) ( $P < 0.05$ ), indicating higher protein nutritive value and availability in the golden. The effects of roasting on protein secondary structures depended on the variety. The roasting reduced percentage of  $\alpha$ -helix (47.1 to 36.1%), increased percentage of  $\beta$ -sheet (37.2 to 49.8%) and reduced  $\alpha$ -helix to  $\beta$ -sheet ratio (1.3 to 0.7) of the golden variety ( $P < 0.05$ ). However, roasting did not affect protein secondary structures of the brown. These results indicated that: 1) different sensitivities of protein secondary structure to the heat processing between the varieties; 2) roasting affected protein value and availability in the golden but not in the brown. The results demonstrate the potential of highly spatially resolved S-FTIR to reveal protein secondary structures. Further study is needed to quantify the relationship between protein secondary structures and protein nutrient availability in animal models.

**Key Words:** Synchrotron FTIR, Protein Secondary Structures, Nutritive Value