

## Ruminant Nutrition: Dairy Cattle

**T297 Effect of concentration of flax hulls in the diet on intake, digestion, milk production, and milk composition of dairy cows.** H. V. Petit\*, *Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada.*

A total of 45 lactating Holstein cows averaging 617 kg of BW were allotted at wk 20 of lactation to 9 groups of 5 cows blocked for similar DIM to determine the effects of feeding different concentrations of flax hulls (FH) on DMI, milk production, milk composition, and digestion. Cows within each block were assigned to one of the 5 isoenergetic TMR containing 0, 5, 10, 15 or 20% FH. The experiment was carried out from wk 20 to 24 of lactation and diets were fed for ad libitum intake. Milk samples were obtained from 2 consecutive milkings on wk 5 of the experiment and were analyzed separately to determine milk composition. Total tract digestibility was determined on wk 5. Data recorded during the digestibility trial were analyzed as a randomized block design and block and treatment were the main sources of variation. Data on production were analyzed as repeated measurements using PROC MIXED of SAS. Treatment sum of squares were partitioned to provide linear, quadratic, and cubic contrasts after a significant F-test (i.e.,  $P < 0.05$ ). There was no significant cubic effect of treatment on any parameter measured. Intake of DM averaged 20.9 kg/d and was similar among treatments. Concentration of FH in the diet had no effect on milk yield, proportions of protein and fat and yields of protein, fat and lactose. There was a linear increase in proportion of lactose in milk and a quadratic effect of feeding level of FH on somatic cell count. Total tract apparent digestibility of DM, ADF, and NDF was similar among diets. Ether extract digestibility increased with higher proportions of FH in the diet but the increase was more important from 0 to 50 g/kg. These data suggest that corn and barley can be partially substituted by flax hulls (up to 20% of the DM) as the energy source in the diet of mid-lactating dairy cows.

**Key words:** dairy cattle, flax, milk production

**T298 Body condition score at the initiation of bST supplementation does not affect milk response in dairy cows of Chile.** F. Bargo<sup>1</sup>, S. Follert\*<sup>1</sup>, A. Hinostroza<sup>1</sup>, L. Lastra<sup>2</sup>, and R. Navarrete<sup>2</sup>, <sup>1</sup>*Elanco Animal Health, Southern Cone (Argentina & Chile)*, <sup>2</sup>*Ancali Dairy, Los Angeles, Chile.*

Three hundred Holstein dairy cows (150 primiparous and 150 multiparous) from the commercial dairy farm Ancali (Los Angeles, Chile) were used to evaluate the interaction between body condition score (BCS) at the beginning of recombinant bovine somatotropin (bST) supplementation at 67 DIM and milk response to bST in a completely randomized design. Cows were sorted out by lactation (primiparous vs. multiparous) in 2 free-stall corrals and within each corral randomly assigned to 2 treatments: control or bST (Lactotropina, Elanco Animal Health). Cows on bST received a total of 15 subcutaneous injections of 500 mg bST every 14 d during 210 d starting June 13th at 67 DIM. Daily milk yield (Alpro, De Laval), monthly BCS (scale 1 to 5 by 2 independent experienced observers), and days open (DC305) were measured. Data were analyzed by ANOVA with a repeated measures mixed model using the PROC MIXED procedure of SAS (1999) where cows nested within treatment were considered as random effect. A significant interaction between health status and milk response to bST was found ( $P < 0.05$ ). Healthy cows showed a milk response to bST of 5.2 kg/d ( $P < 0.05$ ), while cows with mastitis or foot problems did not respond to bST ( $P > 0.05$ ). The interaction between BCS at 67 DIM

( $\leq 2.75$  vs.  $\geq 3.00$ ) and milk response to bST was not significant ( $P = 0.67$ ). Cows on bST did not lose BCS and at the end of supplementation gained 0.19 points of BCS (3.03 at 67 DIM vs. 3.22 at 277 DIM;  $P < 0.05$ ). Days open did not differ ( $P > 0.05$ ) between treatments and averaged 105.5 and 97.5 d in primiparous and multiparous cows, respectively. When bST supplementation was initiated at 67 DIM in healthy Holstein cows, milk response to bST was not related to initial BCS averaging 5.2 kg/d without affecting days open.

**Key words:** body condition score, bST, milk response

**T299 Associations among digestive tract lesions and abnormal serum chemistries in cull dairy cattle.** M. B. Hall\*<sup>1</sup>, G. R. Oetzel<sup>2</sup>, G. B. Huntington<sup>3</sup>, F. M. Moore<sup>4</sup>, and D. M. Hertzke<sup>4</sup>, <sup>1</sup>*U.S. Dairy Forage Research Center, USDA-ARS, Madison, WI*, <sup>2</sup>*School of Veterinary Medicine, Univ. of Wisconsin, Madison*, <sup>3</sup>*Dept. of Animal Science, Univ. of North Carolina, Raleigh*, <sup>4</sup>*Marshfield Labs Veterinary Services, Marshfield, WI.*

All animals accrue tissue damage with age, but types and prevalence of damage are not known. Tissue lesions could signal impaired organ function, which could affect performance. The study objective was to assess prevalence of microscopic lesions in digestive tracts of cull dairy cows, and determine associations among lesions and with abnormal serum chemistry values. Cull dairy cows (79) were sampled at 3 commercial abattoirs on 5 occasions. Tissue samples from reticulorumen (RR), small intestine (SI), large intestine, pancreas (PAN), cecum, and liver (LIV), and a blood sample were obtained immediately postmortem. Additionally, jugular blood samples and RR biopsies of papillae were obtained from 19 clinically normal live, noncull, ruminally cannulated Holsteins (11 lactating cows and 8 nonlactating bred heifers). Associations among lesions and with serum chemistries were evaluated with logistic regression analysis. Odds ratios for pairs of lesions described the increased likelihood of presence of both if 1 was found. Infiltration by lymphocytes observed in all SI, large intestinal and cecal samples suggests that this is normal, possibly related to barrier immune function. Serum chemistries were generally not good predictors of specific tissue lesions. Noncull animals had lower prevalence of RR inflammation and pustules than cull cows ( $P < 0.03$ ). For cull animals, no lesions were detected in 36% of RR, 49% of SI, and 64% of PAN samples. Only 8% of LIV samples showed no lesions. Associations among lesions were found between RR and PAN, and among PAN, SI, and LIV. Among the odds ratio results: 4.7 for RR pustules and PAN inflammation ( $P = 0.12$ ), 8.7 for SI hemosiderin laden macrophages (HLM) and decreased PAN zymogen ( $P < 0.01$ ), and 3.0 for HLM and LIV mineralization ( $P = 0.06$ ). Interrelatedness of lesion prevalence suggests that impact of disorders that created the lesions was not confined to a single organ. With implications for improved animal health, well-being, longevity, and performance, further investigation is warranted into how treatment or prevention of primary disorders and traits of economic importance relate to development of tissue damage.

**Key words:** dairy cattle, digestion

**T300 Influence of a reduced-starch diet with or without exogenous amylase on lactation performance by dairy cows.** L. F. Ferraretto\*<sup>1</sup>, R. D. Shaver<sup>1</sup>, M. Espineira<sup>1</sup>, H. Gencoglu<sup>2</sup>, and S. J. Bertics<sup>1</sup>, <sup>1</sup>*Department of Dairy Science, University of Wisconsin-Madison*

ison, Madison, <sup>2</sup>Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, University of Uludag, Bursa, Turkey.

The objective of this trial was to determine lactation performance responses in high-producing dairy cows to a reduced-starch (RS) with or without exogenous amylase addition versus a normal-starch (NS) diet. Forty-five multiparous Holstein cows,  $68 \pm 29$  DIM and  $696 \pm 62$  kg body weight (BW) were randomly assigned to 1 of 3 treatments in a completely randomized design; a 2-wk covariate adjustment period with cows fed the NS diet followed by a 10-wk treatment period with cows fed their assigned treatment diets. The NS TMR did not contain exogenous amylase (NS-). The RS diets, formulated by partially replacing corn grain and soybean meal with whole cottonseed and wheat middlings, were fed without (RS-) and with (RS+) exogenous amylase addition to the TMR. Starch and NDF concentrations averaged 27.0% and 30.9%, 22.1% and 35.0%, and 21.2% and 35.3% (DM basis) for the NS-, RS-, and RS+ diets, respectively. Cows fed RS-tended ( $P < 0.06$ ) to consume 1.9 kg/d more DM than NS-. Expressed as a percentage of BW, DMI was greater for cows fed RS- than NS- ( $P < 0.01$ ) or RS+ ( $P < 0.05$ ). Intake of NDF ranged from 1.09% to 1.30% of BW among the treatments with RS- being 21% greater ( $P < 0.001$ ) than NS-. Milk yield tended ( $P < 0.07$ ) to be 2.2 kg/d greater for cows fed NS- than RS- and was 2.6 kg/d greater ( $P < 0.04$ ) for cows fed NS- than RS+. Milk fat content and yield were unaffected ( $P > 0.10$ ) by treatment. Milk protein content and yield were greater for cows fed NS- than RS- ( $P < 0.04$ ) and RS+ ( $P < 0.01$ ). The MUN concentrations were greater ( $P < 0.001$ ) for cows fed RS diets than the NS- diet. BW, BW change, and BCS were unaffected by treatment ( $P > 0.10$ ), except for a trend for BW change of cows fed RS- to be greater than RS+ ( $P < 0.09$ ). Feed conversion (kg milk/kg DMI) was 10% greater on average for cows fed NS- than for cows fed the RS diets ( $P < 0.001$  and  $P < 0.03$ ), and tended to be 6% greater for cows fed RS+ than RS- ( $P < 0.09$ ). Feeding a RS diet compared with a NS diet without addition of exogenous amylase to either diet reduced ( $P < 0.001$ ) milk and component-corrected feed conversions.

**Key words:** amylase, lactating cow, starch

**T301 Effects of different ratios of extruded soybeans and whole cottonseeds on production performance of cows and conjugated linoleic acids (CLA) in milk fat.** R. Yan<sup>\*1,2</sup>, S. Y. Chen<sup>2</sup>, C. Jiang<sup>1</sup>, Y. J. Zhang<sup>1</sup>, and J. G. Han<sup>1</sup>, <sup>1</sup>Department of Grassland Science, China Agricultural University, Beijing, China, <sup>2</sup>Department of Agronomy, University of Wisconsin-Madison, Madison.

The objective of this study was to investigate effects of different ratios of extruded soybeans (ESB) and whole cottonseeds (WCS) on production performance of cows and conjugated linoleic acids (CLA) in milk fat. 40 multiparous Holstein cows (averaging  $100 \pm 22$  DIM) divided into 6 groups, were used in a randomized block design for a 14-week period. In this study, there were 4 treatments (dry matter basis): adding no ESB or WCS (control), 10% ESB, 5% ES+5% WCS, 10% WCS. All diets included 30% alfalfa hay, 10% corn silage, 10% *Leymus chinensis* and 50% concentrates. After adding ESB or WCS, crude protein content and ether extract content increased. In vitro crude protein digestibility and in vitro ether extract digestibility increased with the supplementation of ESB or WCS. Neutral detergent fiber content and in vitro neutral detergent fiber digestibility increased when 10% WCS was added to the diet. No change of dry matter intake was found in all 4 treatments. Compared with control (30.1kg/d), milk yield increased by 4.6 kg/d, 4.3 kg/d, and 2.1 kg/d respectively for 10% ESB, 5%

ES+5% WCS or 10% WCS treatments. Because of the increase of milk yield, milk protein yield, milk fat yield, milk lactose yield and milk total solid yield increased. Milk cis9, trans11-conjugated linoleic acids content increased when cows were fed ESB or WCS. Cis9, trans11-CLA content in milk was increased comparing with control (0.88 g/100 g fatty acids) and highest when cows were fed 10% ESB (1.43 g/100 g fatty acids), followed by 5% ES+5% WCS (1.48 g/100 g fatty acids) diets and the 10% WCS diet (1.24 g/100 g fatty acids). These results suggested that adding ESB or WCS in the diets could increase milk yield and milk cis9 (trans11-CLA).

**Key words:** production performance, conjugated linoleic acid, extruded soybean and whole cottonseed

**T302 Effects of supplemental whole cotton seeds on production performance and milk fatty acids of dairy cows fed diets with different ratios of corn silage and alfalfa hay.** R. Yan<sup>\*1,2</sup>, S. Y. Chen<sup>2</sup>, R. Z. Zhang<sup>1</sup>, Y. J. Zhang<sup>1</sup>, and J. G. Han<sup>1</sup>, <sup>1</sup>Department of Grassland Science, China Agricultural University, Beijing, China, <sup>2</sup>Department of Agronomy, University of Wisconsin-Madison, Madison.

The objective of this study is to investigate the effects of different ratios of corn silage (CS): alfalfa hay (AH), and whole cotton seeds (WCS) on milk yield, milk compositions, blood metabolites, and fatty acids in milk fat and plasma. 90 multiparous Holstein cows ( $73 \pm 27$  DIM) were arranged in a randomized block design which lasted 14 weeks. There were 3x3 treatments with 3 levels of WCS (0%, 5% and 10%) and 3 levels of forage addition (one is 30% corn silage (CS) and 10% alfalfa hay (AH); another is 20% CS and 20% AH; and the third is 10% CS and 30% AH). When part of CS was replaced by AH, protein content and digestibility, organic digestibility and neutral detergent fiber digestibility increased. After supplementation of WCS in diets, protein and ether extract contents, digestibility of protein and neutral detergent fiber increased. There was no change of dry matter intake when cows were fed the experimental diets. As more AH was added to the diets, milk yield ( $P = 0.004$ ), milk protein content and yield ( $P < 0.01$ ), and trans-9, cis-11 conjugated linoleic acids (CLA) concentration in milk fat and plasma ( $P < 0.01$ ) increased. When WCS were supplemented to the diets, milk yield ( $P = 0.04$ ), and trans-9, cis-11 CLA concentration ( $P < 0.01$ ) in milk fat and plasma increased. When 10% WCS was added to the diet containing 30% AH, trans-9, cis-11 CLA content (1.46 g/100 g of total fatty acids) in milk was the greatest among all treatments. It suggested that AH could replace part of CS and be a good forage source of diet for dairy cows to improve milk yield and milk composition. Meanwhile, WCS could be included in the diet with high AH to improve production performance of dairy cows.

**Key words:** alfalfa hay, whole cottonseed

**T303 Energy expenditure, feeding behavior and locomotion of grazed versus zero-grazed dairy cows throughout the lactation period.** F. Dohme-Meier<sup>\*1</sup>, L. D. Kaufmann<sup>1</sup>, S. Görs<sup>2</sup>, P. Jung-hans<sup>2</sup>, C. C. Metges<sup>2</sup>, and A. Mürger<sup>1</sup>, <sup>1</sup>Agroscope Liebefeld-Posieux, Research Station ALP, Posieux, Switzerland, <sup>2</sup>Research Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf, Germany.

An experiment was conducted to determine the effect of grazing versus zero-grazing on energy expenditure (EE), feeding behavior and locomotion in dairy cows at different time points in lactation. Fourteen Holstein cows were subjected to 2 treatments in a repeated cross over design with 3 experimental series. At the beginning of each series, cows were on average 38, 94 and  $171 \pm 11.1$  DIM, respectively. Each

series consisted of a 7-d adaptation and a 7-d collection period. Cows either grazed on pasture or had ad libitum access to grass cut from the same paddock in a free-stall barn. Grass intake was estimated using the double alkane technique. On each day of the collection period, EE of one cow in the barn and of one cow on pasture was determined by using the  $^{13}\text{C}$  bicarbonate dilution technique, with blood sample collection done either manually in the barn or using an automatic sampling system on pasture. During the same time period cows' locomotion and feeding behavior were recorded over 3 d using pedometers and behavior recorders. The model included production system, experimental series and their interaction as fixed effects (MIXED procedure of SAS). Milk yield decreased with increasing DIM ( $P < 0.05$ ). Grass intake was lower ( $P < 0.01$ ) for grazing cows (16.8 kg DM/d) compared with zero-grazing cows (18.9 kg DM/d). The lowest intake was observed in the first series and the highest in the second series ( $P < 0.001$ ). Within the 6-h measurement period, grazing cows expended more ( $P < 0.001$ ) energy (273 vs. 231 kJ/kg  $\text{BW}^{0.75}$ ) than zero-grazing cows and differences in EE did not change with increasing DIM. Cows on pasture spent proportionally more ( $P < 0.001$ ) time walking and less ( $P < 0.001$ ) time standing and lying than cows in the barn. The proportion of time spent eating was higher ( $P < 0.001$ ) and that of time spent ruminating was lower ( $P < 0.001$ ) for grazing cows compared with zero-grazing cows. In conclusion, the unchanged milk production along with a lower feed intake indicates that grazing cows mobilized body reserves to cover additional energy requirements, which were at least partly caused by more locomotion.

**Key words:** dairy cows, energy expenditure, grazing

**T304 Effects of combinations of probiotics on growth and blood biochemical parameters in preruminant calves.** Y.-Q. Fu, Q.-Y. Diao, Y. Tu\*, N.-F. Zhang, and C.-G. Jiang, *Key Laboratory of Feed Biotechnology of Ministry of Agriculture/Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, P.R. China.*

This study examined the effects of different combinations of probiotics on growth performance and blood biochemical parameters in preruminant Chinese Holstein calves. Twenty-four newborn Holstein calves were randomly divided into 4 groups with 3 males and 3 females each group, and each group was offered a basal diet (a milk replacer and a starter) (control, group I), or the basal diet supplemented with *Bacillus licheniformis* (group II), or *Bacillus licheniformis* + *Bacillus subtilis* (group III), or *Bacillus licheniformis* + *Bacillus subtilis* + *Lactobacillus plantarum* (group IV). The ratio of each strain of *Bacillus* for group III and group IV was 1:1, 1:1:1, respectively. The amount of total probiotics supplemented to corresponding calves was at  $200 \times 10^8$  cfu/(head•d) for 56d. Live weight of each calf was recorded fortnightly and blood samples were collected concomitantly to examine its blood biochemical parameters. Data were analyzed by mixed or GLM procedure of SAS software. Compared with the control, average daily gain of the calves from group II only was significantly higher than group I throughout the trial (0.65 vs. 0.53 kg/d,  $P < 0.05$ ), and the average daily gain of the calves from group II was 15.1% and 14.0% higher than that from groups III and IV, respectively ( $P > 0.05$ ). From 2 to 4 weeks of age, average daily gain of the calves from group II was higher ( $P < 0.05$ ) than that from group I (0.46 vs. 0.28kg/d) or group III (0.46 vs. 0.25kg/d). At the end of the experiment, the serum concentration of globulin or total protein in group II was significantly lower than that in group IV ( $P < 0.05$ ), and the serum concentration of glucose in group II was significantly higher than that in group IV ( $P < 0.05$ ). No significant difference in the serum albumin or urea nitrogen was detected among groups. It was concluded that dietary probiotics,

especially *Bacillus licheniformis*, improved growth of preruminant calves.

**Key words:** calves, probiotics, growth and blood biochemical parameters

**T305 The limiting sequence and proper ratio of lysine, methionine and threonine for calves fed milk replacers containing soy protein.** J.-H. Wang, Y. Tu\*, N.-F. Zhang, X.-C. Xu, and Q.-Y. Diao, *Key Laboratory of Feed Biotechnology of Ministry of Agriculture/Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, P.R. China.*

This study estimated the amino acid (AA) sequence and relative ratio of AA for calves on milk replacers (MR) with 50% milk protein replacement from soy protein concentrate (39.8% CP) by supplementing lysine (Lys), methionine (Met), and threonine (Thr) to the MR. Method of partial deduction of AA was adopted, on the principle that N retention was determined by the intake of the first limiting AA. Twenty-four newborn calves were randomly offered 1 of 4 MR diets (22% CP, 14% fat) for 56 d ( $n = 6/\text{diet}$ , half males and half females): PC (2.34% Lys, 0.72% Met and 1.80% Thr) or the PC with either Lys, Met or Thr reduced by 30%, respectively (i.e., PC-Lys (1.64% Lys, 0.72% Met and 1.80% Thr), PC-Met (2.34% Lys, 0.50% Met and 1.80% Thr), and PC-Thr (2.34% Lys, 0.72% Met and 1.26% Thr)). MR were fed at 11% of BW, adjusted twice weekly as calves grew. Starter (20% CP, 1.03% Lys, 0.30% Met and 0.69% Thr) and hay (3.23% CP, 0.29% Lys, 0.12% Met and 0.23% Thr) were offered ad libitum beginning on d 36 and d 43, respectively. A 3-d total collection of feed refusals, feces, and urine were recorded starting at d 33 and d 54 of age, respectively. Observations of N balance trials were analyzed using the GLM procedure of SAS. The results showed that the limiting sequence of the 3 AA was ranked as Lys, Met and Thr; the proper ratio of Lys, Met and Thr was 100:29:70 for the calves on MR alone and 100:30:60 for the calves on MR, starter and hay. Compared with PC, absorbed N/intake N was significantly lower for calves fed PC-Lys from d 33 to 35 and from d 54 to 56 (67.5% vs. 78.3% and 80.6% vs. 87.7%,  $P < 0.05$ ), and for calves fed PC-Thr from d 33 to 35 (70.3% vs. 78.3%,  $P < 0.05$ ); retained N/intake N was significantly lower for calves fed PC-Lys from d 33 to 35 and from d 54 to 56 (42.2% vs. 62.0% and 63.2% vs. 71.7%,  $P < 0.05$ ), and for calves fed PC-Met from d 54 to 56 (67.5% vs. 71.7%,  $P < 0.05$ ), also for calves fed PC-Thr from d 33 to 35 (45.7% vs. 62.0%,  $P < 0.05$ ). In conclusion, digestion and utilization of N were negatively affected by AA deletion. The average relative ratio of the 3 AA was 100:29.5:65 for calves from 2 to 10 wk of age.

**Key words:** limiting amino acid, milk replacers, soy protein

**T306 Feeding frequency for individually fed early lactation cows: enlightening the perplexing strategy.** A. Nikkhab\*, S. M. Karimzadeh, B. Sorkhroo, S. Asghari, M. Avaz Khanloo, and L. Bahramkhani Zarrin Goli, *University of Zanjan, Zanjan, Iran.*

Due to dependence on several cow, dietary and housing factors, feeding frequency (FF) is a perplexing strategy. The objective was to determine FF effects on feeding behavior, metabolism and production of early lactation cows. Eight multiparous Holstein cows (70 d in milk, 577.5 kg BW) housed in free individual boxes ( $4 \times 3$  m) received either once daily ( $1 \times$ ) at 0700 h, or 4 times daily ( $4 \times$ ) at 0100, 0700, 1300 and 1900 h an alfalfa hay, barley-corn grain based TMR with 63% concentrate (DM-based). The TMR delivered had 81% DM, 17.6%

CP, and 27.3% NDF. The study design was a 2 × 2 crossover with 2 periods of 20 d. Data were analyzed as a linear mixed model with fixed treatment effect, and cow plus period random effects. Once instead of 4 × feeding increased ( $P = 0.05$ ) intakes of DM (21.1 vs. 20.0 kg/d) and NEL (36.4 vs. 34.3 Mcal/d). Orts as a % of the TMR fed were similar between 1 × and 4 × groups (7.6 vs. 10%, respectively). Milk yield (31.5 vs. 30.7 kg/d,  $P = 0.16$ ), milk NEL output (21.7 vs. 21.4 Mcal/d,  $P = 0.72$ ), fat content (3.5 vs. 3.6%,  $P = 0.66$ ), protein content (3.2 vs. 3.2,  $P = 0.81$ ), BW changes (-70 vs. 180 g/d,  $P = 0.53$ ) and fecal pH (6.64 vs. 6.62,  $P = 0.67$ ) were similar between 1 × vs. 4 × FF, respectively. Urine pH was higher for 4 × than 1 × FF (8.12 vs. 8.00,  $P < 0.01$ ). Daily duration of eating (323 vs. 284 min/d,  $P = 0.49$ ), ruminating (302 vs. 326 min/d,  $P = 0.66$ ), total chewing (624 vs. 609 min/d,  $P = 0.37$ ), laying (537 vs. 586 min/d,  $P = 0.40$ ), and standing (691 vs. 640 min/d,  $P = 0.50$ ), were comparable for 1 × vs. 4 × FF, respectively, as were serum glucose, urea, BHBA, albumin, total protein and triglycerides. The first meal length (defined as the time interval between feeding and the first non-eating bout of  $\geq 20$  min) was 106 min in the 1 × cows, while being on average 49 min per feeding and 196 min per day in the 4 × cows ( $P < 0.01$ ). As such, the post-feeding serum insulin and NEFA concentrations were respectively higher and lower with 1 × than 4 ×. Reduced urine pH by 1 × feeding suggests less alkaline extracellular body fluids. Improved energy intake by less frequent feeding possesses metabolic and health implications.

**Key words:** feeding frequency, early lactation, individual

**T307 Prolonged provision of protected methionine improves milk contents and yields of fat and protein in lactating cows.** A. Nikkhah<sup>1</sup>, D. Kianzad<sup>2</sup>, A. Haj Hosseini<sup>2</sup>, A. Zalbeik<sup>2</sup>, and G. Ghorbani<sup>3</sup>, <sup>1</sup>University of Zanjan, Zanjan, Iran, <sup>2</sup>Animal Breeding Center, Karaj, Iran, <sup>3</sup>Isfahan University of Technology, Isfahan, Iran.

Metabolic challenges of early lactation superimposed on environmental stresses such as high ambient temperatures alter lactation curve and compromise cow health. The objective was to establish productive effects of prolonged feeding of protected methionine (PMT) in dairy cows. Twenty 4 fresh Holsteins (27 ± 9 d in milk, 617 kg BW, 2.8 BCS) including 12 s lactation and 12 higher lactation cows were randomly assigned to an either control (CN) or PMT (Smartamine) supplemented TMR (51:49% forage:concentrate), fed continuously for 5 mo. Cows were housed in free stalls, milked 3 times daily at 0000, 0800 and 1600 h in a milking parlor, and offered TMR post-milking plus top-dress alfalfa hay. The study was conducted from May through November of 2009 in central Iranian province of Isfahan. The monthly collected production data were analyzed as a linear mixed model with fixed effects of treatment, parity, time and 2- and 3-way interactions, plus random effects of cow (parity × treatment × time) and residuals. To adjust for correlated repeated measures on the same subject, covariance structures with minimum fit criteria were modeled for all parameters. The PMT group had greater 5 mo-long average milk yield (42.4 vs. 37.4 kg/d,  $P = 0.06$ ), milk fat content (3.30 vs. 2.75%,  $P = 0.007$ ), fat yield (1.40 vs. 1.04 kg/d,  $P = 0.002$ ), milk protein content (2.96 vs. 2.75%,  $P = 0.01$ ) and protein yield (1.25 vs. 1.02 kg/d). Mature cows tended to produce more milk (42.2 vs. 37.6 kg/d,  $P = 0.08$ ) and milk fat (1.30 vs. 1.13 kg/d,  $P = 0.10$ ) than second lactation cows. Findings provide compelling evidence for beneficial effects of prolonged PMT provision (e.g., 5 mo) on milk fat and protein contents and yields in high-producing early-mid lactation cows exposed to summer high ambient temperatures.

**Key words:** Smartamine, methionine, prolonged feeding

**T308 Rumen degradation patterns of ground and steam-processed broomcorn and ground barley.** A. Nikkhah\*, University of Zanjan, Zanjan, Iran.

The objective was to determine rumen disappearance behavior of ground broomcorn (GBC), whole and ground steam-flaked broomcorn (SBC) and ground barley (GB). Three ruminally fistulated Naeini ewes, fed at maintenance an alfalfa hay based partially mixed ration, were used in a randomized complete block design to monitor grain in situ digestion properties. The methodology involved rumen incubation of 8 × 12 cm nylon bags (50 µm pore size) containing approximately 3 g of processed grains. Grains were finely ground by a hammer mill (screen size of 2 mm). Broomcorn was steamed for about 60 min to increase grain moisture up to 18% vs. 13% pre-processing, and flaked between preheated large rollers (46 × 90 cm) for a desired flake density (380 to 400 g/L). Samples were incubated ruminally for 2, 4, 8, 16, 24 and 48 h subsequently and were taken out all at once. For 0 h, bags were put in 39°C water for 15 min. To further differentiate between steam-flaking and particle size effects on rumen degradation, the SBC was incubated as both whole and ground flakes. All bags were rinsed under running tap water until the effluent was clear. The bags were dried at 55°C for 48 h, weighed, and residues were ground to pass a 1-mm screen. Data were analyzed with Mixed Models procedures of SAS program with repeated measures. At 0 h, DM of ground SBC (21.0%) was degraded to a greater extent ( $P < 0.05$ ) than that of whole SBC (13.0%), GBC (14.0%) and GB (13.6%). However, at 2, 4, 8, 16 and 24 h post-incubation, respectively, GB (53, 69, 75, 80, 86%) had greater degradation extent than ground SBC (33, 43, 51, 61, 71%), whole SBC (29, 39, 48, 58, 63%) and GBC (17, 21, 37, 44, 50%). Thus, steam processing compared with grinding considerably increased rumen DM degradation of broomcorn, getting closer to that of GB. Results demonstrate the effectiveness of steam-flaking in improving rumen digestibility of broomcorn, which possesses a harder endosperm than corn and grain sorghum. Given its lower price compared with barley and corn grains, broomcorn may be included in dairy diets at higher levels should it be effectively steam-processed.

**Key words:** rumen degradation, broomcorn, barley

**T309 Steam-flaking of broom sorghum improves effective rumen degradation of DM while controlling that of CP.** A. Nikkhah\*, University of Zanjan, Zanjan, Iran.

The objective was to determine effective rumen DM and CP degradation of ground (GBS) and steam-flaked broom sorghum (SFB) grains comparing ground barley grain (GB). Three ruminally cannulated Naeini sheep were fed at maintenance and utilized in an in situ randomized complete block design study with a 2-week pre-study adaptation period. Grains were finely ground by a hammer mill (2 mm mesh size). Broom sorghum was steamed for 60 min and up to a moisture content of 18% before flaking through preheated corrugated rollers (46 × 90 cm) for a flake density of 380–400 g/L. Nylon bags (8 × 12 cm, 50 µm pore size) containing 3 g of differently processed grains were incubated ruminally for 2, 4, 8, 16, 24 and 48 h to be taken all out at once. For 0 h, bags were put in 39°C water for 15 min. Sample and blank bags were all rinsed under running tap water until clearing the effluent, were dried at 55°C for 48 h, weighed, and residues were ground (1-mm) for wet chemistry analysis. Disappearance patterns data were fitted into a nonlinear equation to estimate rates and extent of rumen CP and DM digestion:  $Y = a + b(1 - e^{-ct})$ ;  $a$  = soluble %,  $b$  = slowly digestible %,  $c$  = disappearance rate/h, and  $t$  = incubation hour. Effective rumen DM and CP degradations were calculated by the equation:

$a + (b \times c)/(c + k)$ ;  $k$  = fractional outflow rate. Data were analyzed with Mixed Models Procedures of SAS program. Steam-flaking compared with grinding considerably increased rumen effective degradation of broom sorghum DM while to some extent reducing that of CP. With rumen outflow rates of 5 and 8%, respectively, effective rumen DM degradation was greater ( $P < 0.01$ ) for GB (74 and 70%), ground SFB (58 and 52%) and whole SFB (53 and 47%) than for GBS (43 and 35%), assuming 5%/h rumen passage rate. The respective modeled values for CP effective degradation were 70 and 63% for GB, 39 and 30% for GBS, 33 and 25% for ground SFB, and, 31 and 24% for whole SFB. Findings provide evidence that steam-flaking under special circumstances can successfully improve rumen degradation of broom sorghum grains without elevating CP degradability.

**Key words:** broom sorghum, degradation, steam-flaking

### **T310 Steam-flaked broom sorghum a viable substitute for ground barley in midlactation dairy rations.** A. Nikkhah\*, *University of Zanjan, Zanjan, Iran.*

An objective was to determine effects of feeding cows ground (GBS) vs. steam-flaked broom sorghum (SFB) vs. ground barley (GB). Ten mid lactation Holstein cows (140 ± 10 d in milk, 570 ± 40 kg BW) in tie stalls were used in a 5 × 5 replicated Latin square design with 5 21-d periods. Each period had 14-d of adaptation. Treatments were diets with 1) GB, 2) GB + GBS, 3) GBS, 4) GB + steam-flaked broom sorghum (SFB), and 5) SFB. Diets were fed as total mixed rations with 30% alfalfa hay, 15% corn silage, and 20% cereal grain (DM based). Data were analyzed as a linear mixed model with fixed effects of diet and period, and random effects of cow (diet) and residuals. Dry matter intake was similar among treatments (19.1–19.7 kg/d). Feeding GB+SFB (66.7%), SFB (64.1%) and GB (63.7%) vs. GBS (55%) improved total tract apparent CP digestibility ( $P < 0.05$ ). Fat corrected milk yield (FCM) increased by 2.3 kg by feeding SFB instead of GBS based diets (24.4 vs. 22.1 kg,  $P < 0.01$ ). The FCM was 2.8 kg greater for GB + SFB than for GBS (24.9 vs. 22.1 kg,  $P < 0.01$ ). Milk contents of fat (3.63% and 3.55% vs. 3.44%), protein (3.02% and 3.04% vs. 2.94%), and total solids (11.86%, 11.88% vs. 11.61%) were greater for SFB and GB than for GBS, respectively, as were milk yields of fat (0.82 and 0.81 vs. 0.73 kg/d), protein (0.68 and 0.68 vs. 0.62 kg/d) and total solids (2.7 and 2.7 vs. 2.47 kg/d). Feeding SFB instead of GBS increased ( $P < 0.05$ ) fecal pH (7.10 vs. 6.87) and feed efficiency (1.26 vs. 1.15). Feeding SFB and GB+SFB compared with GBS and GB+GBS decreased plasma urea (14.8 and 13.4 vs. 18.0 and 16.0 mg/dL) and increased plasma glucose (61 and 58 vs. 55 and 55 mg/dL) concentrations, respectively. Results demonstrate the effectiveness of steam-flaking over grinding in considerably improving feeding value of broom sorghum when included at 20% of diet DM. Hence, SFB may be feasibly fed to midlactation cows both alone and combined with GB.

**Key words:** broom sorghum, steam-flaking, milk

### **T311 Effect of dietary nitrogen levels and yeast supplementation on apparent diet digestibility and microbial population in the rumen content of dairy lactating cows.** D. R. Ouellet\* and J. Chiquette, *Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Sherbrooke (QC) Canada.*

Eight rumen-fistulated Holstein dairy cows (679 kg BW; SEM = 5) were used in a duplicated 4 × 4 Latin square design, with a 2 × 2 factorial arrangement of treatments to evaluate the effect of dietary

nitrogen levels and yeast supplementation on apparent diet digestibility and rumen microbial population of dairy lactating cows. Isoenergetic diets, highly or moderately deficient in metabolizable protein [-22% (HD) or -14% (MD) less than requirements], were fed with or without yeast supplement (10 g/head/d of a mixture of *Aspergillus oryzae* and *Saccharomyces cerevisiae*). Total mixed ration (60:40 grass silage:concentrate barley based) was fed 12 times daily. Apparent digestibility of DM, OM, NDF, ADF and N were measured. Ruminal fluid content was sampled to estimate protozoa using microscopic-counting method, and cellulolytic and total viable bacterial count (TVC) by the most-probable-number method. Plasma urea concentration was determined. There were no interactions between treatments for items evaluated ( $P > 0.10$ ). Apparent digestibility of N (69.5% vs. 65.9%; SEM = 1.6) and urinary N excretion (261g/d vs. 162 g/d; SEM = 6) were higher ( $P < 0.01$ ) in MD than in HD. Apparent digestibility (average %) of DM (72.4; SEM = 1.1), OM (74.4; SEM = 1.1), ADF (52.5; SEM = 2.3), and NDF (57.8; SEM = 2.5) were similar among treatments. Yeast supplementation did not affect apparent digestibility parameters. Compared with MD, HD reduced by 48% plasma urea concentration (10.6 vs. 15.7 mg/dL;  $P < 0.02$ ). Average microbial counts were unaffected ( $P > 0.05$ ) by treatments. Protozoa counts [geometric means (cfu/mL) and 95% confidence interval (CI)] were:  $2.3 \times 10^5$  (CI =  $1.6 \times 10^5$  to  $3.4 \times 10^5$ ), TVC:  $3.1 \times 10^9$  (CI =  $2.6 \times 10^9$  to  $3.7 \times 10^9$ ) and cellulolytic bacteria:  $3.9 \times 10^7$  (CI =  $2.8 \times 10^7$  to  $5.5 \times 10^7$ ). In conclusion, addition of yeast to diets containing up to -22% the requirements in metabolizable protein had no effect on the apparent digestibility of the diet, ruminal content parameters and plasma urea.

**Key words:** direct-fed microbials, metabolizable protein restriction, digestion

### **T312 Ground broomcorn in dairy rations.** A. Nikkhah\*, *University of Zanjan, Zanjan, Iran.*

A main purpose was to determine nutritional effects of feeding ground broomcorn (BC, 1% tannin) vs. ground barley grain (GB) based mixed rations on dairy cow performance. Ten tie-stall-housed Holstein cows (averaged 140 d in milk, 570 kg BW) were fed twice daily alfalfa hay-corn silage based mixed rations with 1) 20% GB, 2) 10% GB + 10% BC, or 3) 20% BC, in a duplicated Latin square design. Each 21-d period had 14-d for adaptation. Diets were balanced for CP (15%), NEL (1.6 Mcal/kg) and NDF (38%). Cows were milked 3 times daily. Data were analyzed as linear Mixed Models with diet and period fixed effects, and cow within diet plus residuals random effects. Total tract apparent CP digestibility was decreased by feeding 20% BC vs. 20% GB (55 vs. 63%,  $P < 0.05$ ). DM intake (kg/d) was maintained by GB+BC (19.7) and BC (19.1) vs. GB (19.1). Fecal pH (7.01, 6.93, 6.87,  $P < 0.05$ ), milk yield (24, 22.2, 22.1 kg/d), feed efficiency (1.26, 1.12, 1.15), and milk total solids percent (11.88, 11.64, 11.61%) and yield (2.70, 2.50, 2.47 kg/d) decreased ( $P < 0.05$ ), and plasma urea increased (14.3, 16.0, 18.0 mg/dL) as BC replaced GB, with similar rumen pH (6.6, 6.7, 6.6), urine pH (8.12, 8.15, 8.16) and plasma glucose (56, 55, 55 mg/dL). The quite similar values for BC vs. GB+BC suggest that cows are able to adapt to high dietary BC levels. These data, while biologically light, may not support feeding BC to high-producing cows at 20% of diet DM, especially if the optimum goal is maximizing milk production. On the other hand, given the lower price of BC (0.20\$/kg) than of BG (0.35\$/kg), where commercially available, BC partially replacing the strategic costly GB in mid and late lactation rations is commercially pursued.

**Key words:** broomcorn, dairy, production

**T313 Effect of naturally extracted vitamin E (RRR- $\alpha$ -tocopheryl acetate) vs. synthetic vitamin E on blood and milk levels of vitamin E in lactating dairy cows.** M. B. de Ondarza\*<sup>1</sup>, K. Daniels<sup>2</sup>, and D. Bunting<sup>2</sup>, <sup>1</sup>*Paradox Nutrition LLC, West Chazy, NY*, <sup>2</sup>*ADM Alliance Nutrition Inc., Quincy, IL*.

The trial objective was to determine the effect of supplementing synthetic vitamin E (545 IU/d) (SYN) vs. naturally extracted vitamin E at one-half the level of milligrams (NAT) on blood and milk levels of vitamin E in high-producing multiparous dairy cows. Half of the cows ( $n = 57$ ) received SYN and half ( $n = 57$ ) received NAT for 6 weeks. Treatment groups were housed in separate pens with ad libitum access to TMR. Cow groups were balanced pre-trial for parity, previous ME305 production, and previous 14-d milk yield. After 14 d, daily milk yield of individual cows was recorded. Individual milk samples were analyzed for component content pre-trial, wk 5 and wk 6. Data was analyzed using JMP statistical software (SAS, Cary, NC) with pre-trial data as covariates. Milk yield (40.95 and 39.80 kg/d for SYN vs. NAT, respectively), % milk fat (3.63 and 3.64% for SYN and NAT, respectively), kg milk fat, % true protein, kg true protein, 3.5% FCM (kg), milk urea nitrogen (mg/dl), and SCC ( $\times 1000$ ) (395 vs. 431 for SYN vs. NAT, respectively) were unaffected ( $P > 0.10$ ) by treatment. Pre-trial and wk 6, blood and milk samples were taken from each cow. Individual blood samples and super-composite milk samples for each treatment group were analyzed for vitamin E and cholesterol. Blood serum vitamin E status was not affected ( $P > 0.20$ ) by treatment with means of 8.98 and 9.04  $\mu\text{g/mL}$  for SYN and NAT, respectively. Blood serum cholesterol was not affected ( $P > 0.20$ ) by treatment with means of 252 and 253 mg/dL for SYN and NAT, respectively. Blood serum vitamin E: cholesterol ratio was not affected ( $P > 0.20$ ) by treatment with means of 3.62 and 3.61 ( $\times 10^{-3}$ ) for SYN and NAT, respectively. Pooled milk vitamin E concentrations were 1.20 and 1.19  $\mu\text{g/mL}$  for SYN vs. NAT, respectively. Considering that naturally extracted vitamin E was fed at one-half the weight amount, this form of vitamin E appears to be at least twice as potent as synthetic vitamin E at NRC recommended levels.

**Key words:** RRR- $\alpha$ -tocopheryl acetate, synthetic vitamin E, lactating dairy cattle

**T314 Large-scale production effects of an intestinally releasable methionine product in dairy cows.** A. Nikkha\*<sup>1</sup>, R. Kowsar<sup>2</sup>, and G. Ghorbani<sup>2</sup>, <sup>1</sup>*University of Zanjan, Zanjan, Iran*, <sup>2</sup>*Isfahan University of Technology, Isfahan, Iran*.

The objective was to determine productive effects of feeding an intestinally releasable methionine product (Met, Mepron-85) in lactating cows. A total of 195 free-stall-housed Holstein cows were fed either a control (C,  $n = 110$ ,  $71 \pm 51$  d in milk,  $47.0 \pm 0.12$  kg milk/d) or a Met-supplemented (M,  $n = 85$ ,  $85 \pm 59$  d in milk,  $47.5 \pm 0.12$  kg milk/d) alfalfa hay-corn silage based mixed ration 4 times daily in a completely randomized design study. The DM in control vs. Met diet had, respectively, 1.78 vs. 1.70 Mcal/kg NEL, 19.6 vs. 19.0% CP, and 34.5 vs. 35.5% NDF. Cows were milked 3 times daily and monitored for 8 weeks. The weekly collected data were analyzed as linear Mixed Models with fixed effects of diet, week and the interaction, and random effects of cow (diet  $\times$  week) plus residuals. To account for correlated repeated measures on the same cow, covariance structures with least fit criteria were adopted. DM intake was greater for M than for C (26.6 vs. 25.8 kg/d,  $P < 0.05$ ), whereas NEL intake tended to be greater for C than for M (45.9 vs. 45.2 Mcal/kg,  $P < 0.10$ ). Actual milk volume (40.1 vs. 40.7 kg/d) and milk lactose content (4.90 vs. 4.95%) were similar

for M vs. C, while protein content was higher for M (3.1 vs. 3.0%,  $P = 0.01$ ) and fat content tended to be higher for C (3.0 vs. 2.9%,  $P = 0.06$ ). As a result, milk energy density (0.63 vs. 0.64 Mcal/kg) and output (25.5 vs. 26.3 Mcal/d) remained similar for M vs. C. Milk urea N (17.6 vs. 18.1 mg/dL) and urine N (4.24 vs. 4.37 g/kg) concentrations were lower for M vs. C ( $P < 0.05$ ), supporting the increased milk protein by M. These data may imply reduced hepatic N detoxification into urea, and reduced environmental N excretion by feeding the rumen protected Met to high-producing cows.

**Key words:** methionine, protection, lactation

**T315 Study on the metabolic mechanism of melamine in dairy cattle.** X. Jin\*, Y. Zhang, S. Li, H. Zhang, and Q. Zhang, *College of Animal Science and Technology, China Agricultural University, Beijing, China*. This trial was conducted to study the effects of dietary supplementation of melamine byproducts on residual concentration of melamine in rumen fluid, blood, urine, feces and milk of dairy cows. The further object was to reveal the metabolic mechanism of action of melamine in dairy cows by single factor experiment. The supplemental levels in the concentrate were 0.516%, 0.860% and 1.204%, respectively. The experiment was divided into 3 phases with 10 d in each phase (7 d for pre-feeding and 3 d for sampling). The same 5 Holstein dairy cows were fed the same experimental diet in each phase. The results showed that the residual concentration of melamine in milk, feces and urine were all increased with the growing supplementation level. The results showed that residual concentration of melamine in each kind of samples was durative increasing. When the melamine byproducts level rose to 0.860% in the concentration, the residual concentration of melamine in samples of milk was significantly different from that of 0.516% ( $P = 0.02$ ), while the residual concentration in other samples were not significantly different; when the melamine byproducts level rose to 1.204%, the residual concentration in ruminal fluid and urine were very significantly different from that of 0.516 ( $P < 0.01$ ), the residual concentration in blood, raw milk were significantly different from that of 0.516 ( $P = 0.02$ ). The residual concentration in feces was not significantly different from that of 0.516% and 0.860% ( $P = 0.27$ ), though the concentration of melamine was durative increasing. The concentration of melamine in the raw milk, feces and urine from the phase with the highest supplemental level were 1.31, 3.30 and 107.75mg/kg, respectively. It is concluded that renal excretion is the primary metabolic pathway of melamine while defecation and lactation are only auxiliary pathways. It was consistent with the report that melamine had negative effect on kidney.

**Key words:** dairy cattle, melamine, metabolic mechanism

**T316 Conjugated linoleic acid (CLA) supplementation around calving affects glucose metabolism in dairy cows.** H. M. Hammon\*<sup>1</sup>, K. Hötger<sup>1</sup>, S. Görs<sup>1</sup>, M. Becker<sup>1</sup>, C. Weber<sup>1</sup>, A. Tröscher<sup>2</sup>, and C. C. Metges<sup>1</sup>, <sup>1</sup>*Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf, Germany*, <sup>2</sup>*BASF, Limburgerhof, Germany*.

CLA (in particular the t10,c12 CLA isomer) is well established for its reducing effects on milk fat content. Although CLA supplementation causes changes in fat metabolism of dairy cows, less is known about CLA effects on glucose metabolism. The objective of the study was to investigate endogenous glucose production (eGP), especially gluconeogenesis (GNG), in German Holstein cows supplemented either with 50 g rumen-protected CLA fat (10% t10,c12 CLA, Lutrell<sup>®</sup> pure, BASF, Ludwigshafen, Germany;  $n = 10$ ) or 50 g linoleic acid (Ctrl;  $n$

= 10) from 14 d before expected calving to 63 DIM. Diets based on grass and corn silage were fed *ad libitum*. DMI and milk yield were recorded daily, BW and milk composition were measured weekly, and BCS and back fat thickness every second week. Plasma concentrations of glucose, nonesterified fatty acids, and  $\beta$ -hydroxybutyrate were determined at 14 and 7 d before calving and once weekly up to 84 DIM. On 21 and 63 DIM, eGP was measured after overnight food withdrawal by primed [ $U$ - $^{13}C$ ]glucose infusion. Additionally, on 21 DIM, cows received 2 oral boli of deuterium-labeled water (70 atom% D) within 4 h ( $n = 7$  per diet) and blood samples were taken to measure fractional GNG ( $GNG_{frac}$ ) using deuterated glucose enrichment in plasma. Data were analyzed by SAS PROC MIXED with diet and time as fixed effects. Milk fat content was reduced ( $P < 0.01$ ) and milk and lactose yield increased in both groups after calving and were higher ( $P < 0.05$ ) from 35 DIM on in CLA cows than in Ctrl, respectively. Energy balance tended to be less negative ( $P < 0.1$ ) in Ctrl than in CLA cows. Plasma concentrations of glucose were higher immediately after calving in CLA cows than Ctrl (diet  $\times$  time interaction  $P < 0.01$ ). The eGP increased ( $P < 0.05$ ) from 21 to 63 DIM and CLA supplement reduced ( $P < 0.05$ ) eGP on 21 DIM, but not on 63 DIM.  $GNG_{frac}$  on 21 DIM tended to be higher ( $P < 0.1$ ) in CLA cows than in Ctrl. These findings suggest a glucose-sparing effect due to CLA supplementation, using less glucose for milk fat synthesis and more glucose for lactose production and other tissues, resulting in an increased milk yield and blood glucose level.

**Key words:** dairy cow, CLA, glucose

**T317 Lactation performance and milk fatty acid profile in dairy cows fed linseed oil in diets with different forage to concentrate ratios.** L. Saliba<sup>\*1,2</sup>, R. Gervais<sup>1</sup>, Y. Lebeuf<sup>1,2</sup>, J.-C. Vuilleumard<sup>1</sup>, and P. Y. Chouinard<sup>1,2</sup>, <sup>1</sup>*Département des sciences animales, Université Laval, Québec, Québec, Canada*, <sup>2</sup>*Institute of Nutraceuticals and Functional Foods (INAF), Québec, Québec, Canada*.

The composition of basal diet is known to influence the response to dietary unsaturated fatty acids (FA) in lactating dairy cows. To evaluate the interaction between the levels of concentrates and linseed oil on milk yield and composition, 24 Holstein cows were used in a randomized complete block design based on DIM with a  $2 \times 2$  factorial arrangement of treatments. Within each block, cows were fed one of 4 experimental diets containing 30% (LC) or 70% (HC) concentrates, with (LO) or without linseed oil (NLO) supplemented at 3% DM. After 4 weeks of treatments body weight was not different among treatments ( $654 \pm 6$  kg). Compared with LC, feeding HC increased ( $P < 0.01$ ) DMI (20.5 vs. 24.7 kg/d), milk yield (26.1 vs. 33.1 kg/d), FCM (26.4 vs. 30.6 kg/d), milk lactose (4.59 vs. 4.76%; 1205 vs. 1582 g/d), and milk protein (3.22 vs. 3.50%; 832 vs. 1148 g/d). Milk fat content was lower (4.15 vs. 3.56%;  $P < 0.01$ ), and milk fat yield tended to be higher (1076 vs. 1162 g/d;  $P = 0.07$ ) for cows fed HC compared with LC. Feeding LO decreased DMI (23.5 vs. 21.7 kg/d;  $P < 0.05$ ), milk fat content (3.99 vs. 3.72%;  $P < 0.01$ ), and milk protein content (3.45 vs. 3.27%;  $P < 0.01$ ) compared with NLO. Interaction between linseed oil and concentrates was observed for milk fat content of c9,c12,c15–18:3 (4.1, 3.2, 5.1, and 5.9 mg/g FA for LC-NLO, HC-NLO, LC-LO, and HC-LO, respectively;  $P < 0.05$ ). Concentrations of c9,t11,c15–18:3 increased with LO compared with LNO (0.5 vs. 0.2 mg/g FA;  $P < 0.001$ ), and decreased with HC compared with LC (0.3 vs. 0.4 mg/g FA;  $P < 0.001$ ), while c9,t13,c15-C18:3 was not detected in any milk samples. Feeding linseed oil increased t11,c15–18:2 in milk fat, especially when cows were fed LC diets (1.6, 0.4, 9.8, and 3.6 mg/g FA for LC-NLO, HC-NLO, LC-LO, and HC-LO, respectively;  $P < 0.01$ ). The

same interaction was observed for t11–18:1 (11.5, 6.6, 24.1, and 11.0 mg/g FA for LC-NLO, HC-NLO, LC-LO, and HC-LO, respectively;  $P < 0.01$ ). In conclusion, the level of concentrates in the basal diet influenced milk fat content of FA originating from rumen biohydrogenation in response to linseed oil supplementation.

**Key words:** concentrate levels, milk fatty acids, linseed oil

**T318 Rumen volume and passage kinetics depend on feeding time (0900 vs. 2100 h).** A. Nikkhah<sup>\*1</sup>, J. C. Plaizier<sup>2</sup>, and A. D. Kennedy<sup>2</sup>, <sup>1</sup>*University of Zanjan, Zanjan, Iran*, <sup>2</sup>*University of Manitoba, Winnipeg, MB, Canada*.

The objective was to determine effects of providing a total mixed ration (TMR) at either 0900 h or 2100 h on rumen volume as well as on fluid and solids retention time and outflow rates in lactating cows. Three primiparous and one multiparous Holstein cows (80 d in milk; 26 kg/d milk yield) with rumen cannula (10 cm d) were used in a crossover design study with 2 6-wk periods. Each period had 3-wk of adaptation. The diet had forage to concentrate ratio of 50.2:49.8 (DM based). Co-EDTA and Cr-mordanted alfalfa were used as markers to measure rumen outflow rates of fluid and solids, respectively. A total of 50 g Co-EDTA was dissolved in 300 mL of distilled water and ruminally infused via cannula at feed deliveries (0900 h vs. 2100 h). Simultaneously, 300 g of Cr-mordanted alfalfa fiber was dosed into 10 different rumen sites. Next, rumen fluid and solids were sampled subsequently at 2, 3, 4, 6, 8, 12, 16, 24, 36, 48, and 72 h post-marker-infusion. The rumen marker concentrations were regressed against time using a first-order exponential equation to acquire passage rates (slopes). Rumen fluid volume was calculated by dividing the amount of Co infused by the intercept for individual cows. Data were analyzed as Mixed Models with fixed feeding time (FT) effect and random period, cow within treatment, and residuals effects. Rumen fluid total volume tended to increase by feeding at 2100 h instead of at 0900 h (107 vs. 89 L;  $P = 0.07$ ). Rumen fluid outflow rate (11.9 vs. 11.7%/h) and retention time (8.2 vs. 8.9 h), and rumen solids retention time (32.8 vs. 31.4 h) were similar between 0900 h and 2100 h FT, respectively. Feeding at 2100 h vs. 0900 h increased ( $P < 0.05$ ) rumen solids outflow rate in primiparous cows (3.7 vs. 3.1%/h). Data suggest that rumen volume and passage kinetics depend on when TMR is delivered to once-daily-fed cows.

**Key words:** feeding time, rumen, kinetics

**T319 Influence of method of surfactant supplementation on characteristics of digestion and feeding value of fat in Holstein steers fed a high-energy finishing diet.** H. Dávila-Ramos<sup>\*1</sup>, A. Gonzalez-Castellon<sup>1</sup>, A. Barreras-Serrano<sup>1</sup>, A. Estrada-Angulo<sup>2</sup>, M. A. López-Soto<sup>1</sup>, J. V. Macias-Zamora<sup>1</sup>, A. Plascencia<sup>1</sup>, S. H. Vega<sup>1</sup>, and R. A. Zinn<sup>3</sup>, <sup>1</sup>*IICV - Universidad Autónoma de Baja California, México*, <sup>2</sup>*FMVZ - Universidad Autónoma de Sinaloa, México*, <sup>3</sup>*Department of Animal Science, University of California, Davis, El Centro*.

Four Holstein steers (271  $\pm$  11 kg) with cannulas in the rumen and proximal duodenum were used to study the influence of method of surfactant (Tween 80) supplementation on characteristics of digestion and feeding value of fat. Treatments consisted of a steam-flaked corn-based finishing diet supplemented with: 1) no supplemental fat, no surfactant; 2) 6% supplemental fat (yellow grease, no surfactant); 3) 5.75% supplemental fat plus 0.25% Tween 80 (TW) added to the diet as part of the premix (TW was mixed with premix before incorporation with grain in the mixer, as second step in diet preparation), and 4) 5.75%

supplemental fat plus 0.25% TW combined directly with the supplemental fat (TW was mixed with supplemental fat before incorporation into the feed mix as penultimate step in diet preparation). The data was analyzed using MIXED procedures (SAS Inst. Inc., Cary, NC) based in a model for 4x4 Latin square experimental design. Treatment effects were tested by means of orthogonal polynomials and differences were considered to be significant when  $P < 0.05$ . There were no surfactant by supplemental fat interactions ( $P > 0.05$ ). Surfactant did not affect ( $P > 0.05$ ) site and extent of OM, starch, N, ADF, and fatty acid digestion, or DE value of diet. Supplemental fat decreased ( $P < 0.05$ ) ruminal and total tract digestion of OM and ADF and increased ( $P < 0.05$ ) the DE value of diet. The decrease in post-ruminal FA digestion was mainly due to decreased ( $P < 0.05$ ) digestion of C18:0. Digestible energy of supplemental fat averaged 6.87Mcal/kg. It is concluded, that independent of method of addition, supplementing high-fat diets with 0.22% of Tween 80 does not influence site and extent of digestion or the feeding value of supplemental fat.

**Key words:** fat supplementation, Holstein steers, surfactant

**T320 Evaluation of limit feeding and bunk management strategies for gravid dairy replacement heifers.** N. M. Esser<sup>1</sup>, J. Larson<sup>1</sup>, P. C. Hoffman<sup>\*1</sup>, C. L. Liu<sup>2</sup>, and W. K. Coblenz<sup>3</sup>, <sup>1</sup>University of Wisconsin, Madison, <sup>2</sup>Northeast Institute of Geography and Agricultural Ecology, CAS, Harbin, Heilongjiang, China, <sup>3</sup>USDA-ARS Dairy Forage Research Center, Marshfield, WI.

To assess effects of bunk access and limit feeding on dairy heifer growth and nutrient intake, 96 Holstein heifers ( $394 \pm 31$  kg) were fed one of 2 diets, and allotted to full (F) or partial (P) bunk access. Pens ( $n = 12$ ) of heifers were limit fed a TMR without (NS) straw or fed a TMR with straw (S). Feed access times for NS and S were 6 and 24 h respectively. Heifers, fed NS or S, were assigned to pens with F (8 stalls/8 heifers) or P (4 stalls/8 heifers) to complete the  $2 \times 2$  factorial arrangement (FS, PS, FNS, PNS). Heifers were evaluated for growth, and nutrient intake. Bunk occupancy time and rate, 0–6 h post-feeding, were evaluated using timed digital photography. Data were analyzed using PROC MIXED with pen replication as the experimental unit. Bunk occupancy for F was longer ( $P < 0.01$ ; 149.8 vs. 111.2 min) than heifers allotted to P. Feeding S (S vs. NS) increased ( $P < 0.02$ ) heifer bunk occupancy by 16.2 min. Bunk occupancy rate was 27.6, 20.0, 24.4 and 18.1 min/h for FS, PS, FNS and PNS respectively. Feeding S increased dietary NDF by 7.0% units and decreased ( $P < 0.04$ ) DMI of heifers 0.28 kg/d as compared with limit feeding NS. Heifers fed S consumed 0.55 kg more ( $P < 0.01$ ) NDF/d but consumed less ( $P < 0.01$ ) CP, and Mcals of ME than heifers fed NS. Bunk access (F vs. P) had no effect ( $P > 0.55$ ) on DMI or the intake of any nutrient. Despite lower CP and ME intakes, the ADG of heifers fed S or NS were similar ( $P > 0.21$ ; 0.90 vs. 0.95 kg/d). Allotting heifers to F or P bunk access likewise had no effect ( $P > 0.39$ ) on ADG (0.95 vs. 0.91 kg/d) and no interactions between bunk access and treatment diet on ADG were observed. Finally, bunk occupancy rate (min/h) and ADG were regressed using PROC REG procedures. For heifers assigned to PS ( $r^2 = 0.25$ ) and FNS ( $r^2 = 0.15$ ) there were weak positive relationships between bunk occupancy rate and ADG. For heifers assigned to FS or PNS there was no relationship between bunk occupancy rate and ADG. Data suggest adding straw to a limit fed diet with partial bunk access did not improve heifer nutrient intake, and induced a more variant relationship between bunk occupancy rate and ADG.

**Key words:** limit feeding, heifers, bunk space

**T321 Effects of cinnamon essential oil, cinnamaldehyde and monensin on milk fatty acid profile of dairy cows.** C. Benchaar<sup>\*1</sup> and P. Y. Chouinard<sup>2</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Sherbrooke, QC, Canada, <sup>2</sup>Université Laval, Département des Sciences Animales, Québec, QC, Canada.

Eight multiparous lactating cows (BW = 614 kg; DIM = 71) were used in a duplicate  $4 \times 4$  Latin square design (28-d periods) to examine the effects of no addition (CTL), or the addition of cinnamon essential oil (1 g/d; CIN), cinnamaldehyde (1g/d; CDH) and monensin (24 mg/kg DM; MON) on milk fatty acid (FA) composition. Analyses of FA were performed on pooled samples collected from 4 consecutive milkings (d 22 to 23). Differences between treatments were declared significant at  $P \leq 0.05$  using the Tukey correction for multiple comparisons and trends were discussed at  $0.05 < P \leq 0.10$ . Feeding CIN and CDH to cows had no effect on milk FA composition (g/100 g of total FA) as compared with feeding CTL. Proportions of C18:0 (7.99 vs. 8.69%) tended to be lower while that of trans-11 C18:1 (0.74 vs. 0.70%) remained unchanged, those of trans-10 C18:1 were higher (0.39 vs. 0.30%), and those of cis-9, trans-11 C18:2 tended to be higher (0.40 vs. 0.35%) in milk fat of cows fed MON than in that of cows fed CTL. Cows fed CIN and CDH had lower proportion of trans-10 C18:1 (0.32%) than cows fed MON (0.39%). The proportion of trans-11 C18:1 was similar for cows fed CDH and those fed MON (0.74 and 0.66%) while it tended to decrease when cows were fed CIN as compared with MON (0.63 vs. 0.74%). The proportion of cis-9, trans-11 C18:2 was higher for cows fed MON than for cows fed CDH and CIN (0.40 vs. 0.35 and 0.34%, for MON, CDH and CIN, respectively). Results show that under the experimental conditions of this study, supplementing dairy cow diets with MON exerted minor effects on milk FA composition while no changes were observed when CIN and CDH were fed.

**Key words:** essential oil, monensin, milk fatty acid

**T322 Fatty acids in milk of dairy cows fed diets containing propolis-based products.** S. C. de Aguiar<sup>1</sup>, S. M. Cottica<sup>1</sup>, R. B. Samensari<sup>1</sup>, E. M. de Paula<sup>1</sup>, S. L. Franco<sup>1</sup>, L. P. P. de Moura<sup>1</sup>, G. T. dos Santos<sup>1</sup>, J. V. Visentainer<sup>1</sup>, W. B. R. dos Santos<sup>2</sup>, E. H. Yoshimura<sup>1</sup>, M. V. Valero<sup>1</sup>, and L. M. Zeoula<sup>\*1</sup>, <sup>1</sup>Universidade Estadual de Maringá, Maringá, Paraná, Brazil, <sup>2</sup>Instituto Federal do Amazonas, Maués, Amazonas, Brazil.

Propolis is a resinous substance collected by bees from plants with various biological properties. The objective was to evaluate the addition of propolis-based products (PBP) in the diet of dairy cows, to decrease the amount of saturated fatty acids (SFA) in milk and the ratio of fatty acids (FA) n-6/n-3, as well as increase the amount of conjugated FA (CFA) and monounsaturated FA (MUFA). Four Holstein cows, with 550 kg of body weight and 147 d of lactation were subjected to 2 daily milkings (0600 and 1500h) and randomly assigned to a  $4 \times 4$  Latin Square. The diets which were formulated with 60.27%:39.73% forage:concentrate, differed due to the inclusion or not of PBP as follows: control (no additives), PBP1, PBP2 and PBP3 (with 30.63, 71.88 and 78.45 mg of quercetin equivalents, respectively). Quercetin, a flavonoid, was used as a marker for flavonoids quantification. The PBP1 and PBP2 differ only in the concentration of propolis and have the same ethanol content, while the PBP3 has the same propolis concentration of PBP2 and higher ethanol content. Milk fat was transesterified and the methyl esters of FA were analyzed by gas chromatography. Quantification of FA was made in relation to the internal standard, methyl tricosanoate and the results expressed in  $\text{mg} \cdot \text{g}^{-1}$  of total lipids (Table 1). There was an increase in the amount of CFA in the milk from

PBP2 treatment when compared with control. Though, milk resulting from the addition of PBP3 treatment showed a significant increase in the amount of MUFA and n-3 FA, and a decrease ( $P = 0.00631$ ) in the amount of SFA. The n-6/n-3 ratio decreased in all PBP treatments when compared with control. Concluded that the addition of PBP in dairy cows diets improves milk quality, which is more beneficial for human consumption.

**Table 1.** Sum of fatty acids in dairy cows milk for the different treatments

Fatty Acids (mg.g <sup>-1</sup> )	Control	PBP1	PBP2	PBP3
CFA	7.57 <sup>c</sup>	8.46 <sup>c</sup>	11.42 <sup>a</sup>	9.62 <sup>b</sup>
Polyunsaturated fatty acids	50.51 <sup>a</sup>	40.12 <sup>c</sup>	44.76 <sup>b</sup>	53.52 <sup>a</sup>
SFA	435.69 <sup>a</sup>	423.99 <sup>ab</sup>	432.90 <sup>a</sup>	403.01 <sup>b</sup>
MUFA	409.41 <sup>b</sup>	409.77 <sup>b</sup>	403.35 <sup>b</sup>	460.21 <sup>a</sup>
n-6	46.21 <sup>a</sup>	35.86 <sup>c</sup>	40.19 <sup>b</sup>	47.67 <sup>a</sup>
n-3	4.30 <sup>b</sup>	4.25 <sup>b</sup>	4.57 <sup>b</sup>	5.85 <sup>a</sup>
n-6/n-3	10.76 <sup>a</sup>	8.45 <sup>b</sup>	8.83 <sup>b</sup>	8.17 <sup>b</sup>
TOTAL	903.18	882.34	892.43	926.36

Different letters in the same line are statistically different ( $P < 0.05$ ).

**Key words:** fatty acids, n-6/n-3 ratio, propolis ethanolic extracts

**T323 Varying dietary dry matter concentration through water addition: Effect on nutrient intake of dairy cows in late lactation.** J. A. Fish and T. J. DeVries\*, *University of Guelph, Kemptville Campus, Kemptville, ON, Canada.*

Recent research suggests that adding water to a TMR containing wet forage sources can limit DMI. The objective of this study was to determine if DMI can be limited in late lactation cows through water addition to a TMR formulated for high production. Twelve lactating Holstein cows ( $214.8 \pm 28.5$  DIM) were exposed to 2 diets in a cross-over design with 28-d periods. Diets had the same ingredient composition (30.9% corn silage, 30.3% alfalfa haylage, 21.2% high-moisture corn, and 17.6% protein supplement; DM basis) and differed only in DM %, which was reduced by the addition of water. Treatment diets were: 1) DRY (61.7% DM) and 2) WET (51.9% DM). DMI and milk production (4% fat corrected milk; FCM) were recorded for the last 14 d of each treatment period. For the final 4 d of each period fresh feed and orts were sampled for particle size analysis. The particle separator had 3 screens (19, 8, 1.18 mm) and a bottom pan, resulting in 4 fractions (long, medium, short, fine). Sorting was calculated as the actual intake of each particle fraction expressed as a % of its predicted intake. Sorting values  $> 100\%$  indicate selection for, while values  $< 100\%$  indicate sorting against. Data were analyzed using a general linear mixed model. All cows sorted against long ration particles ( $P < 0.05$ ); there was no difference in the extent of this sorting between the DRY and WET treatments (72.9 vs. 77.6%; SE = 4.5;  $P = 0.5$ ). Across the study, there was no sorting ( $P > 0.05$ ) for or against medium (99.9%) or small (101.4%) ration particles. There tended to be more sorting for fine ration particles on the DRY treatment compared with the WET (106.3 vs. 104.0%; SE = 1.0;  $P = 0.1$ ). The addition of water had no effect on production parameters, with similar DMI (27.9 vs. 26.5 kg/d; SE = 1.1;  $P = 0.4$ ), 4% FCM (28.7 vs. 27.6 kg/d; SE = 0.9;  $P = 0.4$ ) and efficiency of production (0.98 vs. 1.00 kg 4% FCM/kg DMI; SE = 0.04;  $P = 0.6$ ) between the DRY and WET treatments. The results suggest that, despite a tendency to reduce the degree of feed sorting, addition of water to a TMR had no effect on nutrient consumption and production efficiency of late lactation dairy cows.

**Key words:** dry matter, late lactation, sorting

**T324 Effect of parity and stage of lactation on feed sorting behavior of lactating dairy cows.** T. J. DeVries\*<sup>1</sup>, L. Holtshausen<sup>2</sup>, M. Oba<sup>3</sup>, and K. A. Beauchemin<sup>2</sup>, <sup>1</sup>*University of Guelph, Kemptville Campus, Kemptville, ON, Canada,* <sup>2</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada,* <sup>3</sup>*University of Alberta, Edmonton, AB, Canada.*

The objectives of this study were to determine if feed sorting differs between primiparous (PP) and multiparous (MP) cows, if sorting changes from peak lactation to peak DMI, and whether this sorting affects efficiency of production. Data on DMI, milk production, feed sorting (particle size of offered and refused feed), and plasma NEFA concentration were collected on 30 PP and 30 MP lactating Holstein dairy cows during 3 weeks of lactation. Cows averaged 53, 81, and  $109 \pm 10$  DIM at each recording week. The particle separator had 3 screens (19, 8, 1.18 mm) and a bottom pan, resulting in 4 fractions (long, medium, short, fine). Sorting was calculated as the actual intake of each particle fraction expressed as a % of its predicted intake. Sorting values  $> 100\%$  indicate selection for, while values  $< 100\%$  indicate sorting against. Data were averaged per cow per week and analyzed in a repeated measures mixed model. Over the study period MP cows consumed more DM (25.2 vs. 21.9 kg/d; SE = 0.7,  $P < 0.001$ ) and produced more milk (42.2 vs. 35.0 kg/d; SE = 1.5,  $P < 0.001$ ) than the PP cows, but had similar efficiency of production (1.65 kg milk/kg DMI). Across the study period DMI increased ( $P = 0.002$ ), while milk yield decreased ( $P < 0.001$ ), resulting in decreased efficiency of production ( $P < 0.001$ ) as cows moved further into lactation. All cows had higher plasma NEFA concentrations at 53 DIM compared with at 81 and 109 DIM (128.6 vs. 77.8  $\mu\text{Eq/L}$ ; SE = 12.0;  $P < 0.001$ ), suggesting they were mobilizing more body fat at that earlier stage of lactation. Across weeks all cows sorted against the long ration particles and sorted for fine ration particles. The PP cows sorted more against the long ration particles (92.8 vs. 95.5%; SE = 1.5;  $P = 0.05$ ) and for the fine ration particles (104.0 vs. 102.9%; SE = 0.5;  $P = 0.01$ ) than MP cows across all 3 recording weeks. The PP cows also sorted for the short ration particles (101.0%), while the MP cows did not (100.2%). The results demonstrate that despite changes in DMI, production, and efficiency, feed sorting remained consistent in cows across DIM. Further, our results demonstrate that PP cows engage in more feed sorting than MP cows.

**Key words:** parity, stage of lactation, sorting

**T325 Effects of different physical processing of corn starter on performance of newborn Holstein dairy calves.** A. Soltani<sup>1</sup>, G. R. Ghorbani\*<sup>1</sup>, B. Omidian<sup>3</sup>, M. Khorvash<sup>1</sup>, S. Zaree-Shamsabadi<sup>1</sup>, H. Beiranvand<sup>1</sup>, M. Kazemi-Bonchenari<sup>2</sup>, and M. Mirzaee<sup>1</sup>, <sup>1</sup>*Department of Animal Sciences, Isfahan University of Technology, Isfahan, Iran,* <sup>2</sup>*Department of Animal Sciences, Arak University, Arak, Iran,* <sup>3</sup>*Department of Animal Sciences, Shahrekord University, Shahrekord, Iran.*

The objective of present study was to compare the effects of different corn processing of starter in neonatal dairy calves on feed intake, average daily gain (ADG), feed efficiency, rumen pH, and weaning weight. For this purpose, 20 Holstein dairy calves (10 male and 10 female) were used in a completely randomized block design. Calves were randomly allocated to 2 different treatments consisting of either steam flaked or finely ground corn. Starters were formulated to contain similar ingredients and nutrient compositions. The calves were housed

individually from d 3 after birth until 60 d old and the weaning also was done on 60 d old. Starter consumption was measured daily for each calf. Calves were weighed immediately after birth and also the weights were recorded weekly until 8 weeks. No significant differences were observed between calves received starter containing steam flaked versus finely ground corn for daily starter intake ( $P = 0.28$ ). Calves fed steam flaked corn had significantly higher ADG compared with the calves fed grinded corn (0.89 vs. 0.68,  $P < 0.01$ ). Consequently, feed efficiency was greater in calves consumed steam flaked versus grinded corn (0.73 vs. 0.56,  $P < 0.01$ ). The reason probably is related to, lower rumen passage rate and higher digestibility of starch with steam flaked corn than grinded corn. As a result of higher feed efficiency and ADG, weaning weight tended to be higher for steam flaked corn compared with grinded corn ( $P = 0.06$ ). Comparing the rumen pH on d 56 of experiment showed that no difference was observed between treatments ( $P = 0.43$ ). In general, results of this study indicate that feeding steam flaked corn improve performance of newborn dairy calves in comparison to finely ground corn.

**Key words:** dairy calves, corn processing, starter

**T326 Comparison of dairy cattle performance in Nebraska when fed silage and grain produced from second-generation insect protected (*B.t.*) corn (MON 89034), parental line, or reference corn grown during 2009.** H. A. Paz\*<sup>1</sup>, E. Castillo-Lopez<sup>1</sup>, K. Clark<sup>1</sup>, T. H. Klusmeyer<sup>2</sup>, G. F. Hartnell<sup>2</sup>, and P. J. Kononoff<sup>1</sup>, <sup>1</sup>University of Nebraska-Lincoln, Lincoln, <sup>2</sup>Monsanto Company, St. Louis, MO.

Sixteen Holstein cows were used to evaluate the effects on intake and performance of feeding grain and silage from a genetically modified corn (MON 89034), a parental control or 2 reference hybrids of non-genetically modified corn. Cows were randomly assigned to one of 4  $4 \times 4$  Latin squares and periods lasted 28 d. Dietary treatments were 1) control hybrid DKC63–78 (Control), 2) second-generation insect protected corn MON 89034 (*B.t.*), 3) reference corn hybrid DKC61–42 (Ref 1), and 4) reference corn hybrid DKC62–30 (Ref 2). Diets had similar ingredient composition except for the source of corn silage and corn grain. Intake of DM was highest ( $P = 0.01$ ) for cows consuming the *B.t.* corn diet ( $26.6 \pm 0.59$  kg/d) compared with those consuming other corn hybrids diets (25.4, 25.0,  $25.6 \pm 0.59$  kg/d for the Control, Ref 1, and Ref 2 diets, respectively). Additionally, cows consuming the *B.t.* diet tended ( $P = 0.09$ ) to produce more milk (38.2, 36.4, 36.5, and  $36.1 \pm 0.98$  kg/d for *B.t.*, Control, Ref 1, and Ref 2). Milk percentage and yield of protein ( $3.01 \pm 0.05\%$  and  $1.11 \pm 0.03$  kg/d) and fat ( $3.3 \pm 0.10\%$  and  $1.22 \pm 0.05$  kg/d), 3.5% fat corrected milk (FCM;  $35.7 \pm 1.07$  kg/d), FCM/DMI ( $1.39 \pm 0.03$  kg/kg), and milk urea N ( $14.01 \pm 0.49$  mg/dl) were not different ( $P > 0.10$ ) across diets. Results from this experiment demonstrated that MON 89034 was as nutritious as conventional, non-transgenic corn grain and corn silage when fed to dairy cows.

**Key words:** corn silage, genetically modified corn, dairy cow

**T327 Morphology of the omasum of dairy cows fed of high or low grain content diet before parturition.** D. de O. R. B. Santoro, J. C. de Resende Júnior\*, T. da S. Teófilo, R. F. de Lima, J. L. P. Daniel, M. B. Moreira, P. P. Bueno, T. A. Dell Vale, G. P. Lenzi, T. M. França, and S. de F. Costa, Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil.

The high-energy diet before parturition is able to induce the proliferation of ruminal epithelium. However, nothing is known about the

morphological response of the omasum of dairy cows that consume high-energy diet pre-partum. The aim of this study was to investigate whether the transition diet, with high grain content, is able to induce changes in omasum morphology. Four Holstein cows with cannula in the dorsal sac of the rumen, were allocated to 2 treatments in 2 blocks of 2 cows, defined by the date of the expected parturition. Six weeks before the expected calving, cows were fed a standardization diet and 4 weeks before delivery were subjected to diets with high (HGC) or low (LGC) grain content. After delivery, all cows were fed a high energy lactation diet. Fragments of the omasum and the rumen were collected by biopsy on days –42, –28, –14, –7, 2, 14, 28, 42 and 56 in relation to parturition. Data were submitted to variance analyze considering in the model the effect of the block; treatment; day related to calving; and interactions. The animals that received HGC had higher DMI ( $P < 0.01$ ), greater ( $P < 0.01$ ) intake of CP, NDF, fat and minerals and higher milk production ( $P = 0.04$ ), milk fat ( $P = 0.07$ ) and protein ( $P < 0.01$ ). The mitotic index (MI) of the omasum epithelium tended ( $P = 0.11$ ) to be higher in HGC and was higher ( $P < 0.001$ ) than the MI in the rumen, but it was highly ( $R^2 = 0.80$ ;  $P = 0.01$ ) correlated. The papillae of the omasum in cows that received HGC had greater height and larger area, between one week before and 2 weeks after delivery, a fact demonstrated by the tendency of interaction between treatment and collection day ( $P < 0.09$ ). Cows that received HGC had lower thickness of the keratin layer ( $P < 0.01$ ) and not keratinized layers ( $P = 0.03$ ) of the omasum epithelium, showing that the LGC diet stimulates thick epithelium. We conclude that the mucosa of the omasum of dairy cows responds positively to the diet high in grains before parturition, a fact demonstrated by the higher height and larger area of the papillae and by the higher epithelium MI.

**Key words:** acidosis, histology, transition diet

**T328 Enteric methane production from dairy cows fed different silages with and without rapeseed supplementation.** M. Johannes\*, A. L. F. Hellwing, P. Lund, M. R. Weisbjerg, and T. Hvelplund, Faculty of Agricultural Sciences, Aarhus University, Denmark.

Enteric methane ( $\text{CH}_4$ ) production is closely related to feed composition, mainly NDF, fat and starch content. The aim of the experiment was to study the methanogenic potential of common Danish silages, the effect of fat supplementation as well as the interaction. The study was conducted with six ruminally and intestinally cannulated lactating Holstein-Frisian dairy cows receiving six diets over four periods of 28 days according to an incomplete  $6 \times 4$  Latin square design. The cows were 271 days in milk (sd 67) and had an ECM yield of 24.0 kg/d (sd 6.2). During the third week, samples were taken in order to determine digestibility. Methane production was measured in four open-circuit respiration chambers during the fourth week. The diets were based on early first cut grass silage (EG, harvested May 26th, 329g NDF/kg DM), late first cut grass silage (LG, harvested June 15th, 484g NDF/kg DM) or maize silage (M, 390g NDF/kg DM) supplemented with low fat concentrate (LF) or concentrate with whole crushed rapeseed (high fat, HF). Other concentrate ingredients were wheat and rapeseed meal. Content of fat-free rapeseed was equal for all diets. Fatty acid content was 20 g/kg DM in the LF diets and 50 in the HF diets. All diets were fed as total mixed ration with 64% forage. Absence of interaction between silage and fat supplementation was consistent for all parameters ( $P > 0.7$ ). Later maturity (LG) reduced dry matter intake (DMI) by 1.05 kg DM compared to EG ( $P = 0.02$ ). There was no significant difference in DMI between EG and M ( $P = 0.28$ ). Fat supplementation tended to reduce DMI by 0.58 kg ( $P = 0.09$ ). Silage had a significant effect ( $P < 0.001$ ) on  $\text{CH}_4$  production per kg DMI with most  $\text{CH}_4$  on

LG (31.4 L/kg), 28.4 L/kg for EG and 26.0 L/kg for M. Fat supplementation reduced CH<sub>4</sub> by 1.6 L per kg DMI ( $P = 0.05$ ). Energy loss for the different silages were 6.1, 6.8 and 5.6% of gross energy for EG, LG and M, respectively ( $P < 0.001$ ). Fat supplementation reduced energy loss by 9% ( $P = 0.004$ ). The results confirm that highly digestible forage and fat supplementation can reduce enteric CH<sub>4</sub> production, and that effects were additive.

**Key words:** methane, forage, fat supplementation

**T329 Particle size and endosperm type of dry ground corn alter apparent ruminal synthesis of B-vitamins in lactating dairy cows.** M. Seck<sup>\*1,3</sup>, M. S. Allen<sup>2</sup>, P. Y. Chouinard<sup>3</sup>, and C. L. Girard<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Sherbrooke, Quebec, Canada*, <sup>2</sup>*Department of Animal Science, Michigan State University, East Lansing*, <sup>3</sup>*Departement de sciences animales, Universite Laval, Quebec, Quebec, Canada*.

Effects of dry ground corn varying in particle size and endosperm type on apparent ruminal synthesis (AS) of thiamin (B1), riboflavin (B2), niacin (B3) and vitamin B6 (B6) were evaluated using 8 ruminally and duodenally cannulated dairy cows. The experiment was a duplicated 4 × 4 Latin square design with a 2 × 2 factorial arrangement of treatments. Main effects were corn grain vitreousness (floury or vitreous) and particle size (medium or fine). Endosperm was 25% vitreous for floury treatment and 66% vitreous for vitreous treatment. The fraction of grain passing through a 1.18 mm sieve was 43% for medium, vitreous, 42% for medium, floury, 57% for fine, vitreous and 62% for fine, floury. Diets included alfalfa silage, corn treatments, protein supplement, minerals, vitamins, and contained 29.2% starch, 27.2% NDF and 18.3% crude protein. Corn grain treatments supplied 86.2% of the dietary starch. Grinding and endosperm type had no effects on daily intakes of B-vitamins except for B2 where fine grinding decreased daily intake (175 vs. 181 ± 8.6 mg/d,  $P = 0.04$ ). Reducing particle size increased duodenal flow (DF) of B2 (391 vs. 327 ± 26.6 mg/d,  $P < 0.01$ ), B3 (3513 vs. 2939 ± 317.0 mg/d,  $P = 0.01$ ) and tended to increase DF of B1 (50.7 vs. 40.4 ± 3.7 mg/d,  $P = 0.07$ ). Floury treatment increased DF of B3 (3453 vs. 3000 ± 317.0 mg/d,  $P = 0.04$ ). Fine grinding increased AS of B2 (215 vs. 146 ± 23.8 mg/d,  $P < 0.01$ ), B3 (2671 vs. 2083 ± 289.5 mg/d,  $P < 0.01$ ) and B1 (8.4 vs. -1.4 ± 2.7 mg/d,  $P = 0.05$ ) while floury endosperm increased AS of B3 (2602 vs. 2152 ± 289.5 mg/d,  $P = 0.03$ ). DF and AS of B6 were not affected by treatments ( $P > 0.13$ ). B1 AS was correlated negatively with true ruminal digestibility of organic matter expressed as percentage of intake ( $P < 0.01$ ,  $r = -0.48$ ) or as kg/d ( $P = 0.02$ ,  $r = -0.40$ ). Duodenal flow of microbial nitrogen was correlated positively with AS of B2 ( $P < 0.01$ ,  $r = +0.52$ ), B3 ( $P < 0.0001$ ,  $r = +0.71$ ) and B6 ( $P = 0.02$ ,  $r = +0.41$ ). B-vitamin supply to dairy cows is affected by dry corn particle size and to a lesser extent, by endosperm type.

**Key words:** dairy cow, B-vitamin, corn grain

**T330 Abrupt changes in forage dry matter of one to three days affect intake and milk yield in late lactation dairy cows.** J. Boyd<sup>\*1</sup> and D. R. Mertens<sup>2</sup>, <sup>1</sup>*US Dairy Forage Research Center, Madison, WI*, <sup>2</sup>*Mertens Innovation & Research LLC, Belleville, WI*.

Our objective was to determine if late lactation cows were susceptible to 1, 2, and 3d changes in forage DM. Forty-four Holstein cows (22 primiparous and 22 multiparous), averaging 155 DIM, 42.5 kg/d of milk, and 597 kg body weight, were used in a study conducted from Jan to Mar 2010. Within each parity, cows were assigned to 1 of 11

blocks based on production and DIM and one cow of each parity-block was randomly assigned to 1 of 2 groups. Study design was replicated 2 × 2 Latin Squares for each set of 1, 2, or 3 d treatments. Each period consisted of a 3-d pre-treatment, 1 to 3d treatment, and a 3-d post-treatment phase. Diets contained about 18% alfalfa and 36% corn silage (DM basis) and were control (Ctrl) with no water added and treatment (Trt) with water added to mimic rainfall events on a bunker silo and feeding an imprecise ration based on as-fed ratios of ingredients. Ctrl ration was adjusted daily to maintain constant DM ratios of ingredients during the study. Milk yield was recorded daily and component samples were taken 2x daily. Forages, TMR, and refusals were sampled daily and concentrates sampled 2x weekly. Chemical composition (DM, CP, NDF) of samples were determined by NIR. Alfalfa silage samples dried at 55C for 48h obtained 2%-units higher DM than predicted by NIR. Thus, water addition was underestimated, resulting in a 3%-unit change in forage DM instead of the target 8%-unit change that was planned. Data was analyzed using Proc MIXED of SAS with cow within parity-block as a random variable. On d1, DMI was reduced 1.22 ( $P < 0.0001$ ), 0.67 ( $P = 0.04$ ), and 2.06 kg ( $P = 0.0001$ ), for the 1, 2, and 3d treatments, respectively. The amount of feed offered was adjusted based on refusal level, and DMI recovered during the following 1 to 3 d even during Trt phases. Milk yield and components were not affected by treatment ( $P > 0.37$ ). We conclude that abrupt changes in forage DM reduce daily feed intakes, but a change >3%-units in forage DM is necessary to affect milk yields and components for late lactation cows.

**Key words:** DM changes, silage, feeding

**T331 Effects of adding fibrolytic enzymes to diets containing bermudagrass silage harvested at two maturity stages on the performance of lactating Holstein cattle.** O. C. M. Queiroz<sup>\*1</sup>, A. T. Adesogan<sup>1</sup>, J. L. P. Daniel<sup>2</sup>, J. J. Romero<sup>1</sup>, J. H. Shin<sup>1</sup>, C. R. Staples<sup>1</sup>, and J. E. P. Santos<sup>1</sup>, <sup>1</sup>*University of Florida, Gainesville*, <sup>2</sup>*University of Sao Paulo, Piracicaba, Sao Paulo, Brazil*.

The objective was to examine effects of adding fibrolytic enzymes to diets containing bermudagrass ensiled after 4 or 8 weeks (4-wk or 8-wk) of regrowth on the performance of Holstein cows. Fifty-eight lactating cows (22 ± 4 DIM) were assigned to treatments arranged in a 2 by 2 factorial design. Treatments were diets containing 4- or 8-wk bermudagrass silage without (4-C and 8-C) or with exogenous enzymes (4-E and 8-E). The cellulase-xylanase enzyme was applied at 2.5 g/kg of TMR DM during ration mixing immediately before feeding. Milk production and DMI of individual cows were recorded daily. Milk and feed ingredients were sampled weekly and chemically characterized. The statistical model included treatment, time, parity, and all interactions of these terms. No enzyme by maturity interaction was detected. Dietary treatment did not affect milk yield (lsmean = 38.4 kg/d, SEM = 1.00) or FCM:DMI ratio (lsmean = 2.09 kg, SEM = 0.08). Feeding the 4-wk diet instead of the 8-wk diet tended ( $P < 0.07$ ) to increase DMI (22.6 vs. 21.4 kg/d; SEM = 0.7) and milk fat yield (1.83 vs. 1.71 kg/d, SEM = 0.06). Applying the enzyme increased ( $P = 0.02$ ) lactose concentration (4.84 vs. 4.73%; SEM = 0.04), but did not affect milk protein or fat concentrations (2.70 vs. 2.65%;  $P = 0.21$  and 4.41 vs. 4.49;  $P = 0.44$ , respectively) or milk protein yield ( $P = 0.27$ ). Feeding the enzyme did not improve the performance of the cows.

**Key words:** fibrolytic enzymes, cellulase, xylanase

**T332 Effects of *Bacillus subtilis natto* on intestinal morphology in pre and postweaning dairy calves.** Y. Sun, J. Q. Wang\*, P. Sun, D. P. Bu, G. C. Luan, and H. T. Zhang, *Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

This study investigated the effects of *Bacillus subtilis natto* on duodenal and jejunal morphology in pre and postweaning calves. Twenty 4 China Holstein calves were divided randomly into 3 groups: control group, fed milk and starter or basal diet only; 2 experimental groups, added *Bacillus subtilis natto* N1 and Na strains cultures respectively at a dose of  $1 \times 10^{10}$  cfu daily. Four calves selected randomly from each group were slaughtered and sampled at weaning, and the remaining calves were slaughtered 44 d after weaning. Results showed that *Bacillus subtilis natto* reduced calves diarrhea incidence. Supplementation of *Bacillus subtilis natto* N1 and Na strains in weaning calves increased villus height and villus height/crypt depth (V/C) in duodenum and jejunum ( $P < 0.05$ ), elevated muscle layer thickness in duodenum and anterior jejunum ( $P < 0.05$ ), but decreased crypt depth in duodenum, anterior jejunum and posterior jejunum ( $P < 0.05$ ). Villus height, V/C and muscle layer thickness in duodenum and jejunum of postweaning calves fed N1 and Na strains were higher ( $P < 0.05$ ) while the crypt depth was lower than control ( $P < 0.05$ ). In conclusion, *Bacillus subtilis natto* may have the potential to prevent diarrhea and improve duodenal and jejunal morphology in dairy calves.

**Key words:** *Bacillus subtilis natto*, dairy calves, intestinal morphology

**T333 Effect of dietary delivery product Force 6 on performances and antioxidant status of high-producing dairy cows.** D. Éclache, P. Etienne, and V. Noiro\*, *Phodé Laboratories, Terssac, France.*

High producing dairy cows are at risk of oxidative stress. Force 6 (Phodé Laboratories, France), a product containing curcumin and formulated to ensure product delivery and absorption in the gut, has been tested during 6 weeks on 2 groups of 17 Holstein dairy cows, matched in pairs according to the following criteria: parity, milking stage (DIM), dairy production (DP), milk solids content, live body weight and body condition score (BCS). The aim of this trial was to evaluate the effects of the product on dairy production parameters, as well as on the animal antioxidant status. At the beginning of the trial, the average DIM was 97 d and DP was 44.1 kg. The control group was fed non supplemented basal diet (corn silage based; 17% crude protein, 1530 kcal/kg), the treated group received the same basal diet supplemented with 2 g/animal/day of the tested product. Daily individual DP, weekly and daily milk solids contents and somatic cells counts (SCC), as well as body weight gain and BCS were measured. Blood samples were taken on the first day of the trial and then every fortnight, to assess plasma hydroperoxides content, an indicator of free radicals production (d-ROM kit, Dacron, expressed in U.CARR. - Carratelli units). Statistical analysis was performed using a linear model with treatment ( $n = 2$ ), matched pairs ( $n = 1$  to 17), week ( $n = 1$  to 6) and the interactions matched pair  $\times$  week and treatment  $\times$  week as factors. Dairy production parameters measured 2 weeks before the trial and d-ROM values measured on the first day of the trial were used as covariates. Milk solids contents, ADWG and BCS were not significantly different. The treatment, however, improved DP (44.9 kg/day vs. 43.8 kg/day for the control group,  $P < 0.05$ ), and decreased SSC (166,000 vs. 257,000 somatic cells/ml for the control group,  $P < 0.05$ ). Plasma hydroperoxides contents were significantly lower for the treated cows (137.4 U. CARR. vs. 162.6 U. CARR. for the control  $P < 0.05$ ). The increased

dairy production and reduction of SCC for high producing dairy cows could be linked to their improved antioxidant status.

**Key words:** antioxidant status, dairy cow, milk yield

**T334 Effects of abomasal infusion of linolenic acid on milk fat synthesis and composition in dairy cows.** U. Moallem\*<sup>1</sup>, D. Vyas<sup>2</sup>, B. B. Teter<sup>2</sup>, P. Delmonte<sup>3</sup>, and R. A. Erdman<sup>2</sup>, <sup>1</sup>*Agriculture Research Organization, Bet Dagan, Israel*, <sup>2</sup>*University of Maryland, College Park, FDA*.

In a recent study, feeding high rates of extruded flaxseed to dairy cows increased the milk C18:3n-3 by up to 2 percentage units (% of FA). However, enrichment of C18:3n-3 in milk fat was negatively correlated with milk fat percentage and yield, and C16:0 yields. We hypothesized that C18:3n-3 suppresses de novo synthesis of C16:0. Therefore, our objectives were to assess the transfer efficiency of abomasally infused C18:3n-3 into milk fat and the interaction with milk fat content and yield, and the proportion of C16:0 in milk fat. Three rumen fistulated multiparous mid-lactation Holstein cows were used in a 3x3 Latin square design, with 14 d experimental periods. Cows were milked twice daily and with treatments applied during last 7 d. Treatments consisted of twice daily (0600 and 1900h) abomasal infusion of: 1) Control - 110 mL water; 2) LFO - 110 mL/d flaxseed oil; and 3) HFO - 220 mL/d flaxseed oil, which provided 52 and 104 g/d C18:3n-3, respectively. Blood samples were collected twice weekly and milk samples were collected during the last 6 consecutive milkings of each period. No differences were observed in DMI, milk, and milk solids yields. However, milk fat and lactose percentages tended to be higher ( $P < 0.1$ ;  $P < 0.07$ , respectively) in LFO and HFO treatments than in the control. Plasma C18:3n-3 was 2.9 and 4.0 times higher in the LFO and HFO treatments. The C18:3n-3 in milk fat was 9 and 15 higher in the LFO and HFO treatments, (1.89 and 3.30 vs. 0.21 in the control), whereas the C18:3n-3 yields were 8.5 and 16.3 times greater than in the control (26.4 and 50.6 vs 3.1 g/d;  $P < 0.01$ ). The percentage of C16:0 decreased by 10% and 17% in the LFO and HFO compared with the control. There were no differences in C16:0 yields. The transfer efficiency of abomasally infused C18:3n-3 into milk fat averaged 45% for both groups. In summary, abomasal infusion of C18:3n-3 dramatically increased the C18:3n-3 concentration in plasma and milk fat with no effect on milk fat percentage. However, C16:0 percentage in milk fat was decreased in both flaxseed treatments which may indicate on inverse relationship of C16:0 and C18:3n-3 in milk fat.

**Key words:** flaxseed, milk fat, dairy cows

**T335 The time of access to temperate pasture influences rumen pH and NH<sub>3</sub>-N concentration in heifers.** A. Félix<sup>1</sup>, N. Hernández<sup>1</sup>, N. Figueredo<sup>2</sup>, M. Génova<sup>2</sup>, M. Ibarra<sup>2</sup>, A. Mendoza<sup>1</sup>, M. Aguerre<sup>1</sup>, A. Pérez-Ruchel<sup>2</sup>, J. L. Repetto<sup>1</sup>, and C. Cajarville\*<sup>2</sup>, <sup>1</sup>*Departamento de Bovinos, Facultad de Veterinaria, Udelar, Montevideo, Uruguay*, <sup>2</sup>*Departamento de Nutrición Animal, Facultad de Veterinaria, Udelar, Montevideo, Uruguay*.

Twenty-four Hereford  $\times$  Angus heifers (BW =  $153 \pm 18$  kg) were used in a randomized complete block design to determine the effect of time access to pasture (*Lolium multiflorum*, *Trifolium repens*; 19.1% CP, 48.2% NDF DM basis) on rumen pH and NH<sub>3</sub>-N concentration. Pasture was daily cut and offered ad libitum as sole feed for 4, 6, 8 or 24 h. After 15 d of adaptation, individual rumen fluid samples were collected through a ruminal cannula, every hour for 24 h ( $h_0 = 0800$ ) and pH and NH<sub>3</sub>-N concentration were determined. Results were

analyzed as repeated measures with a mixed linear model. pH was affected by treatment ( $P = 0.048$ ), hour ( $P < 0.001$ ) and treatment x hour ( $P < 0.001$ ). Mean pH values were 6.70, 6.64, 6.47, and 6.30 (SEM = 0.10) for treatments 4, 6, 8 and 24h respectively. The main difference observed was that restricted groups led to higher pH values during fasting periods (20 to 0 h), suggesting lower concentrations of volatile fatty acids or higher buffer availability in relation to OM in the rumen. While pH in treatment 24h reached a minimum of 5.83 at hour 10, in restricted-fed reached minimum values of 5.77, 5.62 and 5.78 between hour 5 and 6 for treatments 4, 6 and 8h respectively (SEM = 0.08), and then increased linearly after hour 13. Minimum pH values did not differ among treatments.  $\text{NH}_3\text{-N}$  concentrations were affected by treatment ( $P < 0.055$ ), hour ( $P < 0.001$ ) and treatment x hour ( $P < 0.001$ ). Mean  $\text{NH}_3\text{-N}$  concentrations were 26.8, 26.5, 28.8 and 30.7 mg/dL (SEM = 1.1) for treatment 4, 6, 8 and 24h respectively.  $\text{NH}_3\text{-N}$  concentrations increased after hour 0 and reached peak values between hour 6 and 7 of 66.0, 56.3 and 58.3 mg/dL (SEM = 2.8) for treatments 4, 6 and 8h respectively and then decreased linearly until hour 14, while in treatment 24h no variations were observed. Minimum  $\text{NH}_3\text{-N}$  concentrations differed among restricted treatments and treatment 24h ( $P < 0.001$ ), being 7.6, 7.9, 9.8 and 19.0 mg/dL for 4, 6, 8 and 24h respectively (SEM = 1.2). Restricting the time of access to pasture significantly influenced dynamics of rumen pH and  $\text{NH}_3\text{-N}$  concentrations, while unrestricted animals had a more stable ruminal environment.

**Key words:** feed restriction, rumen pH, rumen  $\text{NH}_3\text{-N}$

**T336 The time of access to temperate pasture influences intake and feeding behavior in heifers.** A. Félix<sup>1</sup>, N. Hernández<sup>1</sup>, N. Tortero<sup>1</sup>, S. Roja<sup>1</sup>, M. Aguerre<sup>1</sup>, A. Pérez-Ruchel<sup>2</sup>, J. L. Repetto<sup>1</sup>, and C. Cajarville\*<sup>2</sup>, <sup>1</sup>Departamento de Bovinos, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay, <sup>2</sup>Departamento de Nutrición Animal, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay.

Twenty-four Hereford x Angus heifers (BW = 153 ± 18 kg) were used in a randomized complete block design to determine the effect of number of hours with access to pasture (*Lolium multiflorum*, *Trifolium repens*; 19.1% CP, 48.2% NDF DM basis) on DM intake (DMI), feeding behavior and DMI rate. Pasture was daily cut and offered ad libitum as sole feed for 4, 6, 8 or 24 h from 0800 h (h0). Daily DMI was measured for 10d and DMI rate was registered by weighting the amount of pasture offered and refused every hour for 4 h. Feeding behavior (eating, ruminating, drinking, and others) were recorded every 5 min for 4 h by visual observation. Feeding behavior and DMI rate (analyzed as repeated measures) and DMI were analyzed with a mixed linear model. Mean DMI was 2.03, 2.69, 2.87 and 3.49 kg/day (SEM = 0.19) for treatments 4, 6, 8 and 24h respectively, representing 1.30, 1.78, 1.91 and 2.26% of BW (SEM = 0.12). DMI was lower in the more restricted animals (4 and 6h) than in 24h ( $P < 0.001$ ), but no differences were detected between treatments 6 and 8h, or 8 and 24h. Mean DMI rates were 0.51, 0.54, 0.52 and 0.37 kg/h (SEM = 0.04) for treatments 4, 6, 8 and 24h. During the first hour restricted animals ate more DM than those non restricted (0.90 vs. 0.63 ± 0.05,  $P \leq 0.012$ ), but no differences between treatments were detected from hours 2 to 4. No treatment x hour interaction was detected for behavior activities. Restricted heifers (4 and 6h) had a greater proportion of time eating than non restricted ones ( $P = 0.024$ ), but no differences were observed between restricted groups. Mean proportions for eating were 0.73, 0.76, 0.66 and 0.54 (SEM = 0.05) for treatments 4, 6, 8 and 24h respectively. Eating and ruminating activities were affected by time ( $P < 0.001$  and  $P = 0.014$ , respectively). The proportion of animals eating

decreased (0.93 vs. 0.46 ± 0.05,  $P < 0.001$ ) and ruminating increased (0 vs. 0.08 ± 0.02,  $P = 0.017$ ) from hour 1 to 4. DMI rate was affected by treatment ( $P = 0.001$ ), hour ( $P < 0.001$ ) and treatment x hour ( $P < 0.095$ ). It is concluded that time of access to pasture lower than 8 h led to changes in feeding behavior that were not enough to compensate the DMI drop.

**Key words:** feeding behavior, intake, intake rate

**T337 Effect of replacement of conventional corn silage with brown midrib corn silage on behavior and performance of lactating dairy cows.** K. W. Cotanch\*, H. M. Dann, C. Whitehouse, C. S. Ballard, and R. J. Grant, *William H. Miner Agricultural Research Institute, Chazy, NY.*

Feeding forages with high NDF digestibility to high-producing cows has the potential to increase feed intake and milk yield. However, highly digestible forage-based diets may negatively affect feeding behavior and ruminal fermentation. Fourteen multiparous Holstein cows (6 ruminally fistulated) averaging 196 d in milk were used in a crossover design study with 2-wk periods (10-d adaptation, 4-d collection) to determine the effect of NDF digestibility of corn silage on chewing behavior, ruminal fermentation, total tract digestibility, and lactational performance. Dietary treatments consisted of 1:1 replacement (DM basis) of conventional corn silage (CONV) with brown midrib corn silage (BMR). The total mixed ration (TMR) contained 43% corn silage, 15% grass silage, and 42% corn-soybean based grain mix (DM basis). The NDF content was 37.7 and 42.0%, the physically effective NDF (peNDF) was 35.8 and 39.6%, and 24-h NDF digestibility was 42.3 and 57.0% NDF for the conventional and brown midrib corn silages, respectively. Data were analyzed as a crossover design using the MIXED procedure of SAS. Cows had higher DMI but lower feed efficiency when fed the BMR diet. Diet did not affect milk yield, milk composition, time spent eating, or time spent ruminating. However, cows chewed less per unit of NDF and had a lower mean pH over a 24-h period when fed the BMR diet. Highly digestible forage does not stimulate chewing to the extent that would be predicted based on standard laboratory methods, such as peNDF. Measurement of peNDF may need to be adjusted based on forage NDF digestibility since chewing response is a function of forage particle size and NDF digestibility.

**Table 1.**

Item	CONV	BMR	SE	P-value
peNDF, % of TMR	17.5	18.3	-	-
DMI, kg/d	25.2	27.8	0.7	<0.01
Milk, kg/d	40.6	42.2	3.3	0.26
Milk fat, %	3.62	3.71	0.14	0.30
Milk true protein, %	3.12	3.15	0.10	0.46
Milk/DMI	1.60	1.50	0.10	0.03
Eating, min/d	228	222	10	0.38
Ruminating, min/d	516	498	17	0.12
Eating, min/kg NDF	31	26	1	<0.01
Ruminating, min/kg NDF	70	58	3	<0.01
Ruminal pH	6.08	5.95	0.05	<0.01
Total tract NDF digestibility, %	56.2	61.6	1.3	<0.01

**Key words:** dairy cow, corn silage, fiber digestibility

**T338 Evaluation of protein supplementation strategies for low-starch diets fed to lactating dairy cows.** K. W. Cotanch<sup>1</sup>, S. E. Boucher<sup>1</sup>, H. M. Dann<sup>1</sup>, C. S. Ballard<sup>1</sup>, R. J. Grant<sup>1</sup>, and K. Fujita<sup>2</sup>, <sup>1</sup>William H. Miner Agricultural Research Institute, Chazy, NY, <sup>2</sup>ZenNoh National Federation of Agricultural Cooperative Associations, Tokyo, Japan.

The objective of this study was to evaluate the effect of varying concentrations of rumen undegraded protein (RUP) and primary source of RUP [distillers dried grains with solubles (DDGS) or SoyPass (SP)] on ruminal and lactational responses of lactating Holstein dairy cows fed low-starch diets. Sixteen multiparous cows (4 ruminally fistulated) averaging 121 d in milk were fed one of 4 diets in a replicated 4 × 4 Latin square design with 3-wk periods (14 d adaptation and 7 d collection). Diets contained (% of DM) 20% starch, 21% physically effective neutral detergent fiber, and 35.6% RUP (% of crude protein; CP), 38.5% RUP with DDGS, 38.8% RUP with SP, or 41.9% RUP. The diets contained 16.9, 15.4, 17.0, or 16.5% CP with a metabolizable protein balance (g/d) calculated using CNCPS version 6.1 of -60.3, -217, 17.1, and 87.6 for the 35.6% RUP, 38.5% RUP with DDGS, 38.8% RUP with SP, and 41.9% RUP diets, respectively. The data were analyzed as a replicated Latin square design using Proc Mixed (SAS version 9.1) with model effects for diet, period, and replicate. Diet had no effect ( $P > 0.05$ ) on dry matter intake (DMI;  $28.2 \pm 0.4$  kg/d), body weight ( $732 \pm 14$  kg), or solids-corrected milk production ( $43.7 \pm 1.2$  kg/d). However, milk urea N was least ( $P < 0.01$ ) for cows fed the 38.5% RUP with DDGS diet compared with the 34% RUP, 38.8% RUP with SP, and 41.9% RUP diets (8.8, 12.3, 12.2, and 11.6, SEM = 0.33), whereas milk true protein/CP intake was greatest ( $P < 0.01$ ; 0.33, 0.30, 0.29, 0.30, SEM = 0.01) for the 38.8% RUP with DDGS diet. Ruminal pH ( $6.05 \pm 0.09$ ), total volatile fatty acid concentration ( $131 \pm 2.25$  mM), and microbial N ( $614 \pm 19$  g/d) were unaffected by diet ( $P > 0.05$ ). The acetate to propionate ratio was depressed for the 38.5% RUP with DDGS diet compared with the 34% RUP, 38.8% RUP with SP, and 41.9% RUP diets (2.57, 2.69, 2.67, 2.78, SEM = 0.04). Efficiency of N use was improved for cows fed DDGS as the primary source of RUP in these low-starch diets, although DMI and solids-corrected milk yield were unaffected by diet.

**Key words:** rumen undegraded protein, low-starch diets, dairy cattle

**T339 Effect of time of access to food on fermentation capacity of rumen fluid in heifers consuming temperate pastures.** N. Hernández<sup>1</sup>, A. Félix<sup>1</sup>, K. Saavedra<sup>1</sup>, K. Rosano<sup>1</sup>, A. Pérez-Ruchel<sup>2</sup>, M. Aguerre<sup>1</sup>, S. Brambillasca<sup>2</sup>, C. Cajaville<sup>2</sup>, and J. L. Repetto<sup>\*1</sup>, <sup>1</sup>Departamento de Bovinos, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay, <sup>2</sup>Departamento de Nutrición Animal, Facultad de Veterinaria, UdelaR, Montevideo, Uruguay.

The objective of this study was to evaluate if the time of access to forage affects the fermentation capacity of rumen fluid in heifers consuming temperate pastures, using the gas production technique. Twenty 4 cannulated heifers ( $153.1 \pm 18.1$  kg BW) in a randomized complete block design were housed in individual cages and assigned to one of 4 treatments according to the time of access to fresh forage: 4, 6 and 8h/d (restricted groups), or 24h/d (unrestricted group). Animals within each treatment had forage available (*Trifolium repens* - *Lolium multiflorum* mix) as sole feed. After 15 d of adaptation, ruminal fluid was taken from each animal 1h after the beginning of the meal and placed at 39°C in flasks with 0.5g of the pasture consumed by the heifers. Gas pressure was measured at 2, 4, 6, 8, 10, 12, 18, 24, 48, 72 and 96h. Cumulative gas production was analyzed by PROC MIXED

as repeated measures. Means between treatments were compared by Tukey test for each hour. There were differences between treatments ( $P < 0.001$ ) and hours ( $P < 0.001$ ) without significant interaction treatment × hour ( $P > 0.10$ ). Animals fed all day produced more gas than animals fed 4h until hour 18 ( $P \leq 0.04$ ), for example at hour 12 volumes of gas were 153.84 vs. 188.22 mL/gDM incubated for treatments 4h and 24h respectively ( $P < 0.007$ ). No differences were observed between 6h and 8h treatments ( $P > 0.10$ ). We concluded that unrestricted animals had higher fermentation capacity and suggests that the time of access to food affects the activity of microbial populations. Acknowledgements: ANII for scholarship of the first author.

**Key words:** in vitro gas production, time access, heifers

**T340 Frequency of feed delivery affects feeding behavior of limit-fed dairy heifers.** A. M. Greter<sup>1</sup>, T. F. Duffield<sup>2</sup>, B. W. McBride<sup>3</sup>, T. M. Widowski<sup>3</sup>, and T. J. DeVries<sup>\*1</sup>, <sup>1</sup>Dept. Animal and Poultry Science, University of Guelph, Kemptville Campus, Kemptville, ON, Canada, <sup>2</sup>Dept. Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada, <sup>3</sup>Dept. Animal and Poultry Science, University of Guelph, Guelph, ON, Canada.

Limit feeding may improve feed efficiency while reducing feed costs and nutrient excretion, but also poses health and welfare concerns. The objective of this study was to determine the effect of feeding frequency on the feeding and competitive behavior of limit-fed growing dairy heifers. Twenty-four Holstein dairy heifers ( $178.2 \pm 9.3$  d old) were divided into 6 groups of 4 and exposed to each of 3 treatments using a replicated 3 × 3 Latin square design with 28-d periods. The treatments were providing a high-concentrate ration (containing 16.9% corn silage, 22.1% haylage, 44.1% high moisture corn, and 16.9% protein supplement, DM basis) in a limited amount (1.93% of BW): 1) 1x/d (0800 h), 2) 2x/d (0800 and 1600 h), and 3) 4x/d (0800, 1200, 1600, and 2000 h). The rations were formulated to meet the nutrient requirements of a dairy heifer growing at 0.8 kg/d. There was sufficient bunk space (0.34 m/heifer) for all heifers to feed simultaneously. Feeding behavior was recorded for the last 14 d of each period. Competitive behavior was recorded on d 23, 25, and 27 of each period. Lying time was recorded for the last 7 d of each period. DMI was recorded daily and ADG was recorded weekly. Data were analyzed in a general linear mixed model. DMI was similar between treatments (4.9 kg/d;  $P = 0.5$ ). Daily feeding time was greatest when heifers were fed 1x/d (61.5 min/d, SE = 0.9;  $P = 0.01$ ), followed by when fed 4x/d (51.8 min/d) and then when fed 2x/d (44.5 min/d). When fed 1x/d heifers tended to displace each other more often (4.5 displacements/d, SE = 0.6;  $P = 0.08$ ) than heifers on the 2x or 4x treatments (1.9 and 2.8 displacements/d, respectively). Interestingly, heifers on the 1x/d treatment experienced higher ADG than heifers on the 2x or 4x treatments (0.9 vs. 0.7 kg/d, SE = 0.04;  $P < 0.005$ ). Lying time (802.5 min/d;  $P = 0.4$ ) and the number of lying bouts (11.9 bouts/d;  $P = 0.1$ ) were similar between treatments. These results suggest that although competition at the feed bunk may be greater, when given sufficient feeding space, it may be beneficial to feed limit-fed dairy heifers 1x/d as this treatment improved ADG and increased the amount of time spent feeding per day.

**Key words:** limit feeding, dairy heifer, feeding behavior

**T341 Effect of feeding brown midrib corn silage and dried distillers grains with solubles on bacterial diversity in rumen fluid of dairy cows using bacterial tag-encoded FLX amplicon pyro-**

**quencing.** H. A. Ramirez Ramirez\*<sup>1</sup>, L. O. Tedeschi<sup>2</sup>, T. R. Callaway<sup>3</sup>, S. E. Dowd<sup>4</sup>, K. Nestor<sup>5</sup>, and P. J. Kononoff<sup>1</sup>, <sup>1</sup>University of Nebraska-Lincoln, <sup>2</sup>Texas A&M University, College Station, <sup>3</sup>Food and Feed Safety Research Unit, USDA-ARS, College Station, TX, <sup>4</sup>Medical Biofilm Research Institute and Research Testing Laboratory, Lubbock, TX, <sup>5</sup>Dow AgroSciences LLC.

Four ruminally fistulated cows were used in a 4 × 4 Latin square with a 2 × 2 factorial arrangement of treatments to evaluate the bacterial diversity in rumen fluid (RF) of dairy cows fed dual purpose (DP) or brown midrib (bm3) corn silage, and the inclusion of dried distillers grains with solubles (DDGS). There were 4 28 d periods; in each period cows were assigned to one of 4 treatments: DP corn silage + 0% DDGS (CON); bm3 corn silage + 0% DDGS (BMR); DP corn silage + 30% DDGS (CONDG); or bm3 corn silage + 30% DDGS (BMRDG). On d 28 of each period RF samples were taken at 2 and 12 h post-feeding and were analyzed using 16s rDNA bacterial tag-encoded FLX amplicon pyrosequencing (bTEFAP). Two types of bacteria were of special interest and their populations were analyzed by grouping genera according to their known substrate affinity. *Butyrivibrio* sp, *Fibrobacter* sp, and *Ruminococcus* sp were grouped as cellulose digesters (CD); and *Butyrivibrio* sp and *Megasphaera* sp were grouped as bacteria involved in ruminal biohydrogenation of unsaturated fatty acids (BH). Population of CD was similar across treatments representing 8.4 ± 0.69% of the total DNA in the samples. When cows were fed bm3 corn silage, *Fibrobacter* sp tended ( $P = 0.15$ ) to represent a larger proportion of the total bacterial DNA (1.8 vs 2.3 ± 0.28% for DP and bm3). There was a significant forage × DDGS interaction ( $P = 0.05$ ) for *Ruminococcus* sp; DNA of these bacteria represented the largest proportion within the CD group at 5.26, 4.13, 3.34 and 5.03 ± 0.73% for CON, BMR, CONDG and CONBMR, respectively. The BH group was similar among treatments; on average it represented 2.0 ± 0.21% of the total DNA extracted. The ratio of Firmicutes:Bacteroidetes was reduced ( $P < 0.01$ ) by DDGS; the ratio was 0.56 for 0%DDGS and 0.39 ± 0.03 for 30%DDGS. Feeding bm3 corn silage tended to increase the population of the fiber digesting bacteria *Fibrobacter* sp while feeding DDGS decreased the ratio of Firmicutes:Bacteroidetes as determined by the bTEFAP technique.

**Key words:** bm3, fiber digestion, rumen microbiology

**T342 Optimization for isolating ruminal *trans*-11 18:1 hydrogenating bacteria from dairy cow in vitro.** D. Jin, J. Wang\*, S. Zhao, D. Li, D. Bu, and L. Zhou, *Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The biohydrogenation of ruminal bacteria has a significant effect on milk fatty acid profile, and *trans*-11 18:1 (TVA) is the major biohydrogenation intermediate. The process of biohydrogenation can be regulated by modulating the metabolism of hydrogenation related bacteria. So far, only partial ruminal hydrogenating bacteria was isolated because of harsh conditions for pure culture. This study was aimed to establish the optimal conditions for enrichment and isolation of ruminal TVA hydrogenating bacteria in vitro. TVA was added into anaerobic mediums with different final concentrations (0, 30, 40, 50, 60 µg/mL). Mixed ruminal microbes were inoculated into mediums for continuous cultivation, samples were collected every 4 h and used for detecting TVA concentration and OD value. In addition, TVA was added into the anaerobic medium to a final concentration of 50 µg/mL, then the cultures were transferred for 6 generations for enrichment. Changes of the bacterial composition during enrichment were

analyzed by DGGE profiling. The results showed that concentration of TVA in mediums was significantly decreased at 4 h during continuous incubation and then maintained constancy at 12 h. After incubation for 12 h, degradation rates of TVA were higher than others while initial TVA concentrations were 50 µg/mL and 60 µg/mL, and the final TVA concentrations are 16.1878 µg/mL and 15.0357 µg/mL respectively. Besides, the OD value of the culture initiate increased and reached the highest at 12 h and then decreased. The amounts and types of suspected TVA hydrogenated strains increased most significantly in the 4th generation. Sequencing results for the DGGE bands showed that most of them belonged to *Lactobacillus gasseri* and uncultured bacteria. In conclusion, the suitable TVA adding amount for isolating culture of ruminal TVA hydrogenating bacteria is 50 µg/mL, and the optimal transfer time and transfer generation for enrichment culture are 12h and the 4th generation respectively.

**Key words:** DGGE, isolation, TVA hydrogenating bacteria

**T343 Differential expression of the transcriptome in adipose tissue of first lactation dairy cattle.** J. P. McNamara<sup>1</sup>, J. M. Thomson\*<sup>2</sup>, and J. Looor<sup>3</sup>, <sup>1</sup>Washington State University, Pullman, <sup>2</sup>University of Alberta, Edmonton, Alberta, Canada, <sup>3</sup>University of Illinois, Urbana-Champaign.

Adipose tissue metabolism is an essential factor in establishment of a successful lactation. To continue our investigations into the control of adipose tissue metabolism, we conducted a transcriptomic analysis of adipose tissue of dairy cattle in late pregnancy and early lactation. Our objective was to determine the changes in gene expression in adipose tissue between 30 d prepartum and 14 DIM in first lactation animals, and to determine if changes in expression were related to practical production variables. Animals were Holstein heifers fed the same diet to NRC requirements, and adipose tissue was biopsied at 30 d prepartum and 14 DIM. Total RNA was extracted and used to determine gene expression on a bovine gene array. Genes that code for proteins controlling fatty acid transport were highly expressed including fatty acid binding proteins (FABP4 and FABP5) and lipoprotein lipase. Among those genes increasing in expression were those controlling lipolysis including the ADRB2 (52%) and LIPE (23%). Many genes coding for enzymes controlling lipogenesis decreased, including SREBP (-25%); TSHSP14 (-30.8%), LPL (-48.4%) and ACACA (-63.9%). Another novel finding on control of lipolysis is in the expression of the caveolar proteins, caveolin-1 and caveolin-2), which both decreased in early lactation ( $P < 0.02$ ). This gene expression array analysis in adipose tissue of lactating dairy cattle identifies several key genes that are components of the adaptation to lactation that can be incorporated into models of nutritional efficiency and may be amenable to genetic or dietary manipulation. Further functional analysis of differentially expressed genes revealed changes in synthesis, transport, and metabolism of fatty acids in adipose tissue. The expression values were related to milk production and body fat changes. Other functions revealed were in cell cycle control, immunity, and inflammation. These results confirm some key metabolic control points that can be targeted for further research to define the genotypic and phenotypic control of metabolic efficiency in dairy animals.

**Key words:** lactation, adipose, transcriptomics

**T344 The survival of *Bacillus subtilis natto* in rumen and duodenum of Holstein dairy cows.** S. H. Dong, J. Q. Wang\*, H. Peng, S. Peng, D. P. Bu, L. Y. Zhou, and H. Y. Kang, *State Key Laboratory*

Experiments in vitro and in vivo were conducted to evaluate the survival laws of *Bacillus subtilis* (BSN) in rumen and duodenum of Holstein dairy cows. In experiment 1: BSN spores were added at  $10^5$ /mL to strained rumen fluid or duodenum fluid taken from a healthy dairy cow and incubated in vitro at 39°C. Strained rumen fluid or duodenum fluid with no BSN inoculants served as controls. Changes of BSN spore counts and volatile fatty acid in rumen fluid were monitored at 0, 6, 12, 24, 48 and 72 h. Changes of BSN spore counts in duodenum fluid were monitored at 0, 1, 2, 3, 4, 5 and 6 h. The results of rumen fermentation showed that spores increased in the first 24 h, and then decreased. The survival rate of BSN was 191.3% and 157.1% at 24 h and 72 h, respectively. In addition, BSN increased the concentration of propionate and butyrate in rumen fluid ( $P < 0.05$ ), but reduced the concentration of acetic acid ( $P < 0.01$ ). The results of duodenum fermentation showed that spore counts tended to increase in the first 2 h, and then decreased gradually. The survival rate of BSN was 124.4%, 92.4% and 50.4% at 2, 4 and 5 h, respectively. In experiment 2: 7 cows were randomly assigned to 2 groups. Four cows were infused with  $10^{10}$  spores of BSN into rumen through rumen cannula, but the other 3 cows received no infusion. Rumen fluid, duodenum fluid and feces were collected at 0, 6, 12, 24, 48, 72 h after the infusion. Spore counts increased slightly in the first 6 h, and then decreased gradually in rumen fluid. They continued to decrease in duodenum as well as feces and almost cannot be detected at 48 h after infusion in all of the location. In conclusion, BSN spores have the ability to survive in rumen and alter rumen fermentation. Most of BSN spores are able to survive in duodenum fluid for 4 h. However, the spores cannot permanently colonize in the gastrointestinal tract of Holstein dairy cows.

**Key words:** *Bacillus subtilis natto*, rumen fluid, duodenum fluid

**T345 Milk fatty acid composition of lactating dairy cows fed short and medium chain fatty acids.** H. Cui, D. P. Bu, J. Q. Wang\*, X. W. Zhao, X. Y. Xu, Y. Sun, P. Sun, and L. Y. Zhou, *Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of this study was to evaluate the response of dietary short and medium chain fatty acids (SMCFA) (C6:0 to C14:0, plus 50% of C16:0) on milk fatty acid composition. Thirty-six Chinese lactating Holstein cows ( $150 \pm 30$  DIM) were used for 8 wks in the experiment. The cows were blocked based on DIM and milk yield ( $21.43 \pm 3.39$  kg/d) and randomly assigned to 3 treatments and fed TMR with 1 of 3 dietary fat supplements. The 3 treatments consisted of fat supplements containing increasing amounts of SMCFA replaced LCFA which was imitated to ideal with typical fatty acid in dairy cows milk: 1) LCFA (59% cocoa butter, 16% olive oil and 25% palm oil) (400 g/d), 2) butter fat(400 g/d), and 3) SMCFA (C6:0-6.0%, C8:0- 4.0%, C10:0-9.0%, C12:0- 10.0%, C14:0- 32% and C16:0- 39%) (400 g/d). Milk samples were collected every 2 wks for fatty acid analysis. Data were analyzed statistically by using PROC MIXED (SAS, 1999). Feeding SMCFA increased the proportion of C < 16:0, C16:0 and saturated fatty acid (SFA) in milk fat ( $P < 0.05$ ) in a linear fashion. Otherwise, dietary SMCFA resulted in concentration of C > 16:0 and MUFA in milk fat decreasing linearly ( $P < 0.05$ ). The concentration of PUFA in milk fat was no significant different between treatments (Table 1). In conclusion, increasing supplement SMCFA replaced LCFA caused the fatty acid composition in milk fat changed respectively.

**Table 1.** Effect of different type of lipids in milk fatty acid composition (% of total FA)

Lipids	LCFA (400 g/d)	Butter fat (400 g/d)	SMCFA (400g/d)	SEM	P-value
<16:0	25.20 <sup>b</sup>	26.76 <sup>b</sup>	30.17 <sup>a</sup>	0.52	0.0001
16:0	29.44 <sup>b</sup>	31.62 <sup>a</sup>	31.30 <sup>a</sup>	0.53	0.0291
>16:0	45.34 <sup>a</sup>	41.36 <sup>b</sup>	37.91 <sup>c</sup>	0.76	0.0001
SFA	65.69 <sup>b</sup>	68.88 <sup>a</sup>	70.83 <sup>a</sup>	0.84	0.0012
MUFA	26.66 <sup>a</sup>	22.99 <sup>b</sup>	21.98 <sup>b</sup>	0.78	0.0008
PUFA	7.17	7.63	6.76	0.26	0.0881

<sup>a-b</sup>Least squares means within a row with different superscripts differ.

**Key words:** cow, fatty acid profiles, short and medium chain fatty acids

**T346 Veal calves deposit nitrogen from solid feed as efficient as nitrogen from milk replacer.** H. Berends\*, J. J. G. C. Van den Borne<sup>1</sup>, C. G. Van Reenen<sup>2</sup>, and W. J. J. Gerrits<sup>1</sup>, <sup>1</sup>*Animal Nutrition Group, Wageningen University, Wageningen, the Netherlands*, <sup>2</sup>*Live-stock Research, Animal Sciences Group, Lelystad, the Netherlands.*

This study was designed to substantiate the contribution of increasing solid feed intake (SF) to protein and energy supply of veal calves. Due to potential interactions between milk replacer and solid feed, occurring either at the level of digestion or post-absorptive, this contribution may differ from that in ruminants exclusively fed on concentrates and roughage. To this end, 48 Holstein Friesian male calves (55 kg, SD: 2.1 kg) were divided over 16 groups of 3 calves each. Groups were assigned to one of 4 solid feed intake levels: 0, 9, 18, or 27 g DM of SF kg BW<sup>-0.75</sup> d<sup>-1</sup>. Solid feed consisted of 25% chopped wheat straw, 25% maize silage and 50% concentrates on a DM basis. All calves received 40.7 g DM milk replacer kg BW<sup>-0.75</sup> d<sup>-1</sup> during the experimental period. Groups were housed in respiration chambers during the 4-d experimental period, at an average BW of 164 kg (SD: 10.3 kg). Within chambers, calves were housed individually on metabolic cages to allow quantification of nitrogen balance. Data were analyzed using regression procedures with SF intake related parameters as independent variables. Preliminary results show that SF0 calves (exclusively milk replacer) retained 241 kJ kg BW<sup>-0.75</sup> d<sup>-1</sup> at an intake of 880 kJ kg BW<sup>-0.75</sup> d<sup>-1</sup>. The incremental efficiency with which energy from SF ingested was retained was 0.33 ( $P < 0.05$ ). The incremental efficiency with which digestible energy from SF was retained was 0.53 ( $P < 0.05$ ). SF0 calves retained 0.62 g N kg BW<sup>-0.75</sup> d<sup>-1</sup> at an intake of 1.38 g N kg BW<sup>-0.75</sup> d<sup>-1</sup>. The incremental efficiency with which N from SF ingested was retained was 0.74. Surprisingly, the efficiency of N retention (% of intake) increased with increasing N from SF by 0.35% per g N ( $P < 0.05$ ). With increasing SF intake, there was a substantial shift in N excretion from urine to feces ( $P < 0.05$ ). In conclusion, results show that in veal calves, efficiency of N utilization from SF (fed on top of a milk replacer diet) is markedly higher when compared with N utilization of milk replacer. Interactions between SF and milk replacer, such as an increased recycling of urea-N, may be involved.

**Key words:** calf, feed intake, protein and fat retention

**T347 Effect of B2M haplotype combinations on the expression of FcRn mRNA in mammary gland of dairy cows.** X. Hu, J. Wang\*, S. Zhao, J. Zhao, and D. Bu, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The Fc receptor (FcRn) is the specific transporter of IgG in mammary gland, which is encoded by FCGRT and B2M. The polymorphism of FcRn would influence the concentration and transportation of IgG in milk. We conducted this study to investigate the association of B2M haplotype combinations with FcRn mRNA expression by Real-time PCR, in hope of provide a basis for further study of the possible regulation mechanism of IgG transportation in mammary gland of dairy cows. The mammary gland samples were collected from 40 healthy Chinese Holstein cows immediately after slaughter (the animals were slaughtered in a permitted way in accordance with the policies of Chinese Academy of Agricultural Sciences) and preserved in liquid nitrogen. Total DNA was extracted from the frozen samples. Specific primers were designed to amplify B2M gene. The SNPs were identified after sequencing. Total RNA was purified from the tissues according to the haplotypes of B2M, and then transcribed reversely into cDNA. The level of FcRn mRNA expression was detected by Real-time PCR. The results showed that there were 3 SNPs in B2M gene. We found a transversion of G to T in SNP1, a transition of T to C in SNP3, and a 2-base deletion in SNP2 (the missing bases were A and T). The 3 SNPs assembled 4 haplotype combinations, which were named H1 (GG-deletion-TT), H2 (GG-AT-TC), H3 (GG-AT-TT), and H4 (GT-deletion-TT) respectively. The expression of FcRn mRNA in H4 was significantly higher than the others ( $P < 0.05$ ), but there were no significant differences ( $P > 0.05$ ) between H1, H2 and H3. We concluded that the haplotype combinations of B2M did produce an effect on the expression of FcRn mRNA.

**Key words:** B2M, dairy cows, real-time PCR

**T348 Effect of feeding *Bacillus subtilis natto* fermentation production on hindgut fermentation and microbiota of Holstein dairy cows.** H. Y. Kang, J. Q. Wang\*, D. P. Bu, L. Y. Zhou, P. Sun, H. Peng, X. I. Wang, and S. H. Dong, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The effects of *Bacillus subtilis natto* fermentation production on hindgut fermentation and microbiota of early lactation Holstein dairy cows were investigated in this study. Thirty-six early lactation Holstein dairy cows were randomly allotted to 3 treatments: no *Bacillus subtilis natto* (CON), 6 g *Bacillus subtilis natto* fermentation production/d (DFM1), 12 g *Bacillus subtilis natto* fermentation production/d (DFM2). All cows were treated with 3 treatments after adaption feeding period of 14 d, and the whole trail lasted for 63 d. Fecal samples were collected directly from the rectum of each animal at 0, 1, 2, 3, 4, 6, 8 wk, after the adaption feeding period. The pH,  $\text{NH}_3\text{-N}$  and VFA concentration were measured, and fecal total DNA was extracted and analyzed by DGGE. The results showed that *Bacillus subtilis natto* fermentation production tended to decrease fecal  $\text{NH}_3\text{-N}$  concentration ( $P < 0.1$ ), but had no effect on fecal pH and VFA. DGGE profile revealed that *Bacillus subtilis natto* fermentation production had some effects on fecal bacteria population. The diversity index of Shannon-Wiener in DFM1 decreased significantly ( $P < 0.05$ ) compared with CON. Fecal *Alistipes* sp., *Clostridium* sp., *Roseospira* sp., *Beta proteobacterium* decreased but *Bifidobacterium* increased after supplementation of *Bacillus subtilis natto* fermentation production. This study demonstrated that *Bacillus subtilis natto* fermentation production has potential to improve hindgut microbiota balance. More researches are needed to describe the mode of action to improve the efficiency of probiotic use.

**Key words:** *Bacillus subtilis natto* fermentation production, dairy cow, fecal microbiota

**T349 Effect of short- and medium-chain fatty acid on milk composition in lactating dairy cows.** X. W. Zhao, J. Q. Wang\*, D. P. Bu, H. Cui, X. Y. Xu, Y. Sun, L. Y. Zhou, and P. Sun, *Chinese Academy of Agricultural Sciences, Beijing, China.*

Short- and medium-chain fatty acids (SMCFA) (C6:0 to C14:0, plus 50% of C16:0), constitute about 45% of total milk fatty acid (FA) and originate from de novo FA synthesis in the mammary gland. The objective of this study was to investigate the effect of SMCFA on milk composition and its limitation to milk fat. The experiment was conducted for 8wks with 30 6 Chinese lactating Holstein dairy cows ( $150 \pm 30$  DIM). The cows were blocked based on DIM and milk yield and randomly assigned to 3 treatments. Cows fed corn silage based TMR were supplemented with 1 of 3 dietary lipids supplements (400 g/d). The 3 treatments consisted of lipids supplements containing mixtures of different ratio of long chain fatty acid (LCFA) and SMCFA: 1) LCFA (59% cocoa butter, 16% olive oil, and 25% palm oil), 2) butter fat (400 g/d), and 3) SMCFA (C6:0-6.0%, C8:0- 4.0%, C10:0- 9.0%, C12:0- 10.0%, C14:0- 32%, and C16:0- 39%). Dry matter intake (16.82, 16.82, and 16.90 kg/d;  $P > 0.05$ ), milk production (24.06, 23.94, and 24.45 kg/d;  $P > 0.05$ ), 4% fat-corrected milk (FCM) (23.94, 23.94, and 24.45 kg/d;  $P > 0.05$ ), milk protein percentage (3.34, 3.38, and 3.52%;  $P > 0.05$ ), milk protein yield (817.30, 783.82, and 815.23 g/d;  $P > 0.05$ ), and milk fat yield (954.33, 964.70, and 1030.62 g/d;  $P > 0.05$ ) were not different between treatments for LCFA, butter fat, and SMCFA, respectively. Whereas milk fat percentage (3.90, 4.16, and 4.45%;  $P < 0.05$ ) were increased in linear level when improved SMCFA content in the diet. Furthermore milk fat percentage reached the peak point coupled with SMCFA. In conclusion, SMCFA supplementation has positive effect in milk fat compared with LCFA, which means SMCFA may promote milk fat secretion in mammary gland in dairy cows.

**Key words:** Short- and medium-chain fatty acids, milk composition, dairy cows

**T350 Effect of feeding *Bacillus subtilis natto* fermentation production on milk production and composition, blood metabolites and rumen fermentation in early lactation dairy cows.** H. Peng<sup>1</sup>, J. Q. Wang\*<sup>1</sup>, H. Y. Kang<sup>1,2</sup>, S. H. Dong<sup>1,3</sup>, P. Sun<sup>1</sup>, D. P. Bu<sup>1</sup>, and L. Y. Zhou<sup>1</sup>, <sup>1</sup>*Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China*, <sup>2</sup>*College of Animal Science and technology, Southwest University, Chongqing, China*, <sup>3</sup>*Faculty of Animal Sciences and Technology, Gansu Agricultural University, Lanzhou, China.*

This experiment was conducted to determine the effect of *Bacillus subtilis natto* fermentation production supplementation on blood metabolites, rumen fermentation, milk production and composition in early lactation dairy cows. Thirty-six multiparous Holstein cows (DIM =  $29 \pm 6$  d, parity =  $2.8 \pm 1.1$ ) were blocked by DIM and parity and then randomly assigned to 3 treatments (12 per treatment) in a 9-wk trial. Cows in control, DFM1, DFM2 were fed TMR diets supplemented with 0, 6, 12 g of *B. subtilis natto* solid state fermentation production per day per cow separately. Six and 12 g of supplements contained about  $0.5 \times 10^{11}$  and  $1 \times 10^{11}$  spores of *B. subtilis natto* respectively. Plasma non-esterified fatty acids tended to be lower ( $P = 0.06$ ) in DFM1 and DFM2 compared with control cows (639, 633 vs. 685  $\mu\text{mol/L}$ ). Ruminal proportionate proportion of cows in DFM1 and DFM2 tended to be higher ( $P = 0.06$ ) than control cows (26.3 and 26.9 vs. 23.9 mol/100 mol). There were no significant differences among treatments for DMI, but milk yield was 3.1 kg/d and 3.2 kg/d higher for DFM1 and DFM2 than control cows on average across the 9-wk trial and significant differences

were observed during wk 5 to 9 of the trial, which resulted in 9.5% and 11.7% increases in feed efficiency (kg of milk per kg of DMI). No significant difference were observed in milk yield and feed efficiency between DFM1 and DFM2. Milk fat percentage, protein percentage and yield were not affected by treatment. Milk fat yield tended to be higher ( $P = 0.07$ ) and lactose percentage was significantly higher ( $P < 0.05$ ) for DFM1 and DFM2 (4.93 and 4.95%) compared with control cows (4.80%). The findings suggest that *B. subtilis natto* fermentation production has potential role to improve lactation performance of early lactation dairy cows by altering the rumen fermentation pattern without any negative effects on animal health.

**Key words:** *Bacillus subtilis natto* fermentation production, dairy cow, milk production

**T351 Fermentative and nutritional dynamics of bovine colostrum silage for dairy calves liquid feeding.** L. S. Ferreira<sup>1,2</sup>, M. C. Soares<sup>1</sup>, M. P. C. Gallo<sup>1</sup>, M. R. Paula<sup>1,2</sup>, and C. M. M. Bittar<sup>\*1,2</sup>, <sup>1</sup>University of São Paulo/ESALQ, Piracicaba, SP, Brazil, <sup>2</sup>Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brasília, DF, Brazil.

The objective of this study was to characterize the fermentative and nutritional dynamics of bovine colostrum fermented under anaerobic conditions 56 d during storage at ambient temperature. Colostrum from the second and third milking was collected, pooled, and stored in plastic bottles, which were filled and lightly pressed before its closure to remove all space with oxygen, thereby creating an anaerobic condition. Bottles were stored in a dark room at ambient temperature and 5 bottles were opened at d 0, 1, 2, 3, 4, 5, 6, 7, 14, 21, 28 and 56 after storage, to determine pH, titratable acidity and temperature values. Also, samples were collected for determination of total nitrogen, protein and non-protein fractions by the Kjeldahl method. The pH and the titratable acidity values showed great variation during the storage period, essential for the conservation of colostrum ( $P < 0.001$ ). However, although the pH and titratable acidity has shown great variations during the fermentation process, the colostrum temperature dynamics and values were close to ambient. The non-protein nitrogen fraction presented a high increase during storage ( $P < 0.001$ ) and the true protein values decreased ( $P < 0.001$ ), and presented with very low values after 56 d of storage. The fermentative dynamics observed suggests that colostrum silage has a potential for use as a milk replacer, however the nutritional quality of the resulting product, especially in relation to protein fraction, is inadequate for dairy calves. Strategies for reducing true protein conversion to non-protein nitrogen should be further investigated. Supported by CNPq.

**Table 1.** Composition and fermentative characteristics of colostrum silage

Item	Storage days						SE
	0	7	14	21	28	56	
pH	6.2	4.6	4.4	4.0	4.1	4.2	0.02
Titratable acidity, %							
of lactic acid	4.0	17.1	21.5	30.2	35.1	40.1	0.4
Temperature, oC	18.8	18.5	19.0	21.1	21.3	21.0	0.06
Total nitrogen, %	2.9	2.67	2.46	2.27	2.11	2.03	0.04
Non-protein nitrogen, % of total N	1.93	3.49	4.85	6.65	9.58	17.4	0.29
Casein nitrogen, % of total N	45.3	29.0	30.9	19.1	17.4	12.1	0.72
Crude protein, %	18.5	17.0	15.7	14.5	13.4	12.9	0.26
True protein, %	8.4	4.9	4.8	2.8	2.3	1.6	0.3

SE = standard error of means.

**Key words:** fermented colostrum, protein fractions, colostrum storage

**T352 Performance of dairy calves fed “colostrum silage” or milk replacer.** L. S. Ferreira<sup>1,2</sup>, J. T. Silva<sup>1</sup>, G. G. O. Nápoles<sup>1</sup>, C. E. Oltramari<sup>1</sup>, and C. M. M. Bittar<sup>\*1,2</sup>, <sup>1</sup>University of São Paulo/ESALQ, Piracicaba, SP, Brazil, <sup>2</sup>Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brasília, DF, Brazil.

The objective of this study was to evaluate the performance of male Holstein calves fed bovine colostrum fermented under anaerobic conditions as a replacement to traditional liquid diet. Following birth, 18 male Holstein calves were used in a completely randomized design and assigned to the following treatments: 1) Control: milk replacer (18.5% CP, 22.5% fat, 12.5% solids; Nattimilk, Auster Animal Nutrition) or 2) Anaerobically fermented colostrum (colostrum silage). The animals were housed in individual hutches, with free access to water, starter feed (18% CP; 72% TDN), and 4L of liquid diet (milk replacer or colostrum silage) until weaning which occurred abruptly at the eighth week of life. Colostrum from the second and third milking was collected, pooled, and stored in plastic bottles, which were filled and lightly pressed before its closure to remove all space with oxygen, thereby creating an anaerobic condition. After approximately 45 d of fermentation and at the time of calves feeding, bottles were opened and diluted in warm water in a 1:1 ratio, to ensure acceptance by the animals. The starter feed intake and fecal score were recorded daily and body weight measurements were taken weekly until the eighth week of age. Animals fed colostrum silage presented lower starter intake ( $P < 0.07$ ) during the experimental period, as compared with control animals (238 vs. 412 g/day). As expected, there was an age ( $P < 0.0001$ ) and treatment x age ( $P < 0.05$ ) effect for starter intake, with increasing values throughout the experimental period. However, no effects were observed for average daily gain (0.278 vs. 0.183 kg/day) or body weight (42.3 vs. 40.6 kg for the control treatment and fermented colostrum, respectively). The fecal score was affected by treatments during the wk 2 ( $P < 0.05$ ), with animals fed fermented colostrum showing abnormal and very dry feces (average fecal score = 1.65). Even though the anaerobic fermentation of colostrum may be a good alternative for its storage, feeding it as a liquid feed during all milk-feeding period does not result in adequate animal performance. Financial support provided by CNPq.

**Key words:** fermented colostrum, fecal score, liquid diet

**T353 In situ dry matter degradation kinetics of fennel forage in Holstein cow.** M. Chaji\*, T. Mohammadabadi, and H. Eghbali, *Khuzestan Ramin Agricultural and Natural Resources University, Molassani, Khuzestan, Iran.*

The objective of this experiment was determination of DM degradability of fennel forage. Dry matter degradability of the samples was measured by in situ technique using 2 fistulated Holstein steers (400 ± 12 kg, body weight). The animals fed a 40:60 concentrate: forage diet. The experimental samples were milled (2-mm screen) and weighed (5 g, DM) into bags (12x19 cm) made of polyester cloth with 52 µm pore size (8 replicates per each treatment). The bag were incubated in the rumen for 2, 4, 6, 8, 16, 24, 48, 72 and 96 h after being soaked in distilled water (38°C) for 10 min. Bags also were washed with cold tap water to estimate the wash-out at zero time. After each incubation time, the removal bags were hand-washed with cold tap water, and then dried in a forced-air oven (60°C, 48 h). The degradable parameters of DM were determined using the equation of  $P = a + b(1 - e^{-ct})$ . Data of degradable parameters and effective degradability of DM (out flow rate = 0.08 h<sup>-1</sup>) were analyzed using GLM of SAS in a completely randomized design ( $P < 0.05$ ). Results of the present experiment indicated that the rapidly degradable fraction (a), slowly degradable fraction (b) and fractional degradation rate (c) of DM of fennel forage was 0.29+0.035, 0.4+0.038 and 0.099+0.024, respectively. Potential of degradability and DM effective degradability of fennel forage was 0.68 and 0.61.

**Key words:** fennel forage, degradability, in situ

**T354 The effect of exogenous phytase on ruminal degradation of inositol phosphate in dairy cows.** J. Sehested\*<sup>1</sup>, D. N. Braks-Pedersen<sup>1</sup>, V. Glitsø<sup>2</sup>, L. K. Skov<sup>2</sup>, and P. Lund<sup>1</sup>, <sup>1</sup>*Department of Animal Health and Bioscience, Aarhus University, Tjele, Denmark,* <sup>2</sup>*Department of Feed Applications, Novozymes A/S, Bagsvaerd, Denmark.*

The effect of exogenous phytase on inositol phosphate degradation in the rumen of 4 lactating Danish Holstein dairy cows with ruminal, duodenal and ileal cannulas was investigated in a 4 × 4 Latin Square design with 4 dietary treatments (level of exogenous phytase) and 4 periods (21 d). The cows were offered a total mixed ration (TMR) with a total phosphorus (P) content of 3.8 g/kg dry matter (DM) and a high proportion of dietary P in inositol phosphate (1.7 g P/kg DM). The TMR was composed of (% of DM): Beet pulp (30), grass silage (26), rape seed cake (20), maize silage (17), cane molasses (5) and maize feed meal (2). The TMR was supplemented with one of 4 concentrations of exogenous phytase (phytase units/kg DM): CONTROL (0), LOW (2000), MEDIUM (4000), or HIGH (6000). Preliminary data show, that addition of exogenous phytase to the feed ration significantly increased ruminal degradability (%),  $P < 0.001$ , SEM = 1.82) and reduced duodenal flow (g/d,  $P < 0.001$ , SEM = 0.38) of myo-inositol hexakisphosphate (InsP6) compared with CONTROL (75%; 6.7 g/d), whereas there was no difference between LOW (92%; 2.1 g/d), MEDIUM (95%; 1.3 g/d) and HIGH (96%; 1.2 g/d). Ruminal pH, rumen degradability of NDF, and rumen NDF kinetics were not affected by treatment. The present study indicated that ruminal degradation of inositol phosphate was increased by adding exogenous phytase to the diet. The results indicated that max ruminal inositol phosphate degradation was obtained by adding 2000 phytase units/kg DM.

**Key words:** inositol phosphate, phytase, phosphorus availability