

## Ruminant Nutrition: Dairy Cattle

**W308 Protein balance alters expression of key genes for protein and lysine catabolism in liver of lactating dairy cattle.** H. A. Tucker<sup>\*1</sup>, S. L. Koser<sup>1</sup>, P. H. Doane<sup>2</sup>, and S. S. Donkin<sup>1</sup>, <sup>1</sup>*Purdue University, West Lafayette, IN*, <sup>2</sup>*Archer Daniels Midland Company, Decatur, IL*.

Lysine supply is often limiting for milk protein production in dairy cattle. The availability of lysine for mammary protein synthesis is a function of metabolizable lysine supply and hepatic lysine catabolism. The objective of this experiment was to examine the effect of protein balance in early lactating dairy cattle on expression of aminoadipate semialdehyde synthase (AASS), a committing step in lysine catabolism by liver, and ornithine transcarbamoylase (OTC), a general indicator of protein utilization and ureagenesis. Thirty multiparous early lactation Holstein cows were fed diets containing either 16.0 or 17.5% crude protein for an 84 d period. Liver samples were collected via percutaneous liver biopsy on d 42 and 84 of the experiment for mRNA analysis. Blood samples were collected on d 42 and 84 and analyzed for blood urea nitrogen. Protein balance was determined for the week preceding sample collection and used to classify cows as either positive or negative with respect to MP balance. AASS expression differed ( $P < 0.05$ ) for d 42 ( $0.37 \pm 0.2$  arbitrary units) and d 84 ( $0.88 \pm 0.2$  arbitrary units) of the experiment. OTC expression differed ( $P < 0.05$ ) between d 42 ( $1.43 \pm 0.2$  arbitrary units) and d 84 ( $2.62 \pm 0.2$  arbitrary units). Expression of AASS tended ( $P < 0.1$ ) to be lower in cows experiencing negative protein balance ( $0.39 \pm 0.2$  arbitrary units) and was elevated in cows in positive protein balance ( $0.85 \pm 0.2$  arbitrary units), while expression of OTC did not differ ( $P > 0.05$ ) between groups. There were no interactions between protein sufficiency and day of experiment for either transcript. Expression of OTC on d 42 was correlated ( $P > 0.05$ ) with metabolizable and rumen undegradable protein intake. Expression of AASS was correlated ( $P > 0.05$ ) with milk urea nitrogen in cows in negative protein balance. No significant correlations between gene expression and positive protein balance were observed. These data indicate that expression of lysine catabolism and ureagenic genes in the liver are responsive to protein balance in early lactating dairy cattle and suggest enhanced sensitivity when protein is limiting.

**Key words:** lysine, protein balance, gene

**W309 Effects of OmniGen-AF on performance and economics of a veal operation.** O. Bewley<sup>\*1</sup>, J. D. Chapman<sup>1</sup>, K. P. Zanzalari<sup>1</sup>, Y. Q. Wang<sup>2</sup>, and N. E. Forsberg<sup>2</sup>, <sup>1</sup>*Prince Agri Products, Quincy, IL*, <sup>2</sup>*OmniGen Research, Corvallis, OR*.

The goal of this study was to evaluate the effects of OmniGen-AF (Prince Agri Products, Quincy, IL) on veal calf performance, immune parameters and economics of production. Two hundred Holstein calves were received at a commercial Pennsylvania veal operation within 48–72 after birth and assigned to 2 treatments: control-fed ( $n = 50$ ) and OmniGen-AF-fed ( $n = 150$ ). At trial start, animals on the OmniGen-AF treatment received 10 g OmniGen-AF/head/day. This was added to a commercial milk replacer. The amount of OmniGen-AF was thereafter increased to maintain a dose of 0.09g/kg BW/d. Duration of the study was 137d. Starting weights and final weights were recorded and gain calculated. Whole blood was sampled 4 times during the study (Day 0 and monthly thereafter). Blood RNA was purified with Trizol and used for assay of 2 immune markers: L-selectin mRNA and interleukin-8 receptor (IL8R) mRNA using quantitative reverse transcriptase

PCR. Beta-actin mRNA concentration was also assessed to normalize expression of L-selectin and IL8R mRNAs. Treatments and treatment costs were also recorded and economic value of the supplementation program was calculated using on-farm medication costs. Data were analyzed with SAS using least squares means for unequal cell sizes. The Proc GLM procedure was used to compare means for main effects (ration). Mean final weights of control and OmniGen-AF-fed animals were 126.4 and 128.5 kg ( $P > 0.05$ ), respectively. OmniGen-AF reduced ( $P < 0.05$ ) treated calves ( $P < 0.05$ ) from 29 treated calves/50 calves to 18, respectively. Treatment costs were thereby reduced from \$2.58/calf to \$1.46/calf, respectively. Numbers of calves experiencing severe infections was reduced from 8 to 5.6 severe infections/50 calves by feeding OmniGen-AF. Effects of the additive on blood immune markers were similar to those reported previously (Wang et al., 2007, 2009). Feeding OmniGen-AF tended to increase ( $P > 0.05$ ) L-selectin mRNA and increased ( $P < 0.05$ ) IL8R mRNA during the third and fourth months of the study. Veal calves responded to OmniGen-AF as have most other animal models; including adult dairy cattle, beef cattle, sheep, swine and rodents.

**Key words:** veal calves, immunity, OmniGen-AF

**W310 Determining methionine bioavailability in commercial dairy herds.** D. Stucker<sup>1</sup>, J. R. Knapp<sup>\*2</sup>, and N. R. St-Pierre<sup>3</sup>, <sup>1</sup>*Venture Milling, Salisbury, MD*, <sup>2</sup>*Fox Hollow Consulting LLC, Columbus, OH*, <sup>3</sup>*The Ohio State University, Columbus*.

Our objective was to determine the relative bioavailability of methionine in rumen-protected supplements under field conditions using the selenomethionine dilution approach of Weiss and St-Pierre (2009). Three commercial methionine supplements were fed to 3 pens of approximately 250 cows each in a commercial dairy herd, and methionine bioavailability compared with an unsupplemented control in a truncated Latin square design. The selenium yeast and methionine supplements were fed to provide 0.3ppm selenium and 15g methionine per cow per day, respectively. The herd was milked 3x per day, and milk was sampled from each pen during 6 milkings distributed over the last 3 d in each 10-d period. Milk was sampled via an in-line sampling device, mixed extensively, and sub-sampled. Milk components, somatic cell counts, and milk urea nitrogen levels were determined by NIR (DHI Cooperative, Inc.). Milk nitrogen and selenium were determined by micro-Kjeldahl analysis and fluorometry, respectively. Data were analyzed using a mixed model with period and treatment (methionine supplement) as fixed effects and pen and related interaction terms as random effects. Supplementation with selenium yeast increased milk selenium from 19.8 to 36.6 ng/g milk, and is typical of the response observed in previous research. Methionine supplementation increased milk crude protein 0.049% units ( $P < 0.05$ ), decreased milk selenium 6.1 ng/g ( $P < 0.0001$ ), and decreased milk selenium:nitrogen ratio ( $P < 0.0001$ ). No differences were observed in these measurements among methionine supplements ( $P > 0.20$ ). These results confirm that the selenomethionine dilution approach provides an excellent method to determine methionine bioavailability to the mammary glands. However, refinement of the method is required to allow detection of differences between methionine supplements. In this experiment, within-pen variances were larger than expected from prior research conducted on individual animals, indicating that further research is needed to separate components of variances that contribute

to the large within-pen variances, including analytical, sampling, day-to-day, and animal variances.

**Key words:** amino acid availability, amino acid supplement, methionine

**W311 Effect of returned milk (Nutri-Gold) on performance of veal calves.** D. Vermeire\*, *Nouriche Nutrition Ltd., Lake St. Louis, MO.*

Calves were fed either control (CON) milk replacers (MR) produced with whey and whey protein concentrate or experimental (EXP) MR in which dried milk comprised 30% of the formula (w/w). CON and EXP MR were formulated to contain equal protein and fat concentrations. Dried milk (Nutri-Gold) was within-date returned milk from grocery stores, blended, and dried with drum dryers. Holstein calves (n = 196, 43.5 kg) were fed either CON or EXP pre-starter and starter MR (d 1–52), and either CON or EXP finisher MR (d 53–144) in a 2x2 factorial arrangement of treatments in a completely randomized experimental design. Calves were randomly assigned to individual stalls upon arrival. Calves in odd-numbered stalls were fed EXP while calves in even-numbered stalls were fed CON pre-starter and starter MR treatments, respectively. Calves in stalls 1 and 2, 5 and 6, 9 and 10, etc. were fed EXP while calves in stalls 3 and 4, 7 and 8, and 11 and 12, etc. were fed CON finisher treatments, respectively. All treatment combinations were represented in every 4 stalls throughout the room. Weight (WT) on day (d) 1 or d 52, and gain from d 1–52 were not different due to starter or finisher treatment. Gain from d 52–144 tended ( $P = 0.056$ ) to be greater, and gain from d 1–144 tended ( $P = 0.069$ ) to be greater for calves fed EXP vs CON starter MR. Carcass WT were heavier ( $P = 0.023$ , 120.9  $\pm$  1.16 vs 117.1  $\pm$  1.17 kg, respectively), and LD color was lighter ( $P = 0.031$ , 2.25  $\pm$  0.05 vs 2.40  $\pm$  0.05 VUSA score) for calves fed EXP vs CON starter MR, respectively. During the finishing phase, calves fed EXP were heavier on d 144 ( $P = 0.002$ , 201.0  $\pm$  1.85 vs 192.8  $\pm$  1.86 kg, respectively), had heavier carcass WT ( $P = 0.002$ , 121.5  $\pm$  1.14 vs 116.4  $\pm$  1.16 kg, respectively) and gained more WT from d 52–144 ( $P = 0.002$ , 126.7  $\pm$  1.60 vs 119.7  $\pm$  1.63 kg, respectively) than calves fed CON. LD color was not affected by finisher MR. Interaction of MR (CON vs EXP) and phase (starter vs finisher) was significant ( $P < 0.001$ ) for WT on d 144, carcass weight, and gain from d 52–144 indicating that feeding drum-dried returned milk in either starter or finisher phase increased carcass WT, WT on d 144, and WT gain from d 1–144.

**Key words:** veal, dried milk, calves

**W312 Antioxidant activity in milk of dairy cows fed diets containing propolis-based products.** S. M. Cottica<sup>1</sup>, S. C. de Aguiar<sup>1</sup>, E. M. de Paula<sup>1</sup>, R. B. Samensari<sup>1</sup>, L. P. P. de Moura<sup>1</sup>, S. L. Franco<sup>1</sup>, J. V. Visentainer<sup>1</sup>, G. T. dos Santos<sup>1</sup>, R. Kazama<sup>2</sup>, O. P. P. do Prado<sup>1</sup>, F. J. Maia<sup>1</sup>, and L. M. Zeoula\*<sup>1</sup>, <sup>1</sup>Universidade Estadual de Maringá, Maringá, Paraná, Brazil, <sup>2</sup>Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil.

The objective was to evaluate the effect of propolis-based products (PBP), which differ in the concentration of propolis, alcohol content, and concentration of flavonoids (PBP1, PBP2, PBP3) in the diets of dairy cows, to verify the antioxidant activity in the milk produced by these animals. Four Holstein cows, with 550 kg of body weight and 147 d of lactation were subjected to 2 daily milkings (0600h and 1500h) and randomly assigned to a 4x4 Latin Square. The diets were formulated with 60.27%:39.73% forage:concentrate to contain 16.9%

of CP, 1.49 mcal/kg of NEL, 10.2% RDP and 38.2% NDF, differing with the inclusion or not of PBP, which are: control (no additives), PBP1, PBP2 and PBP3 (with 30.63, 71.88 and 78.45 mg of quercetin equivalents (QE.g<sup>-1</sup>), respectively). 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. The PBP, a powder, were introduced into the rumen via ruminal cannula at the time of diets ministrations. Analyses of antioxidant activity of milk samples were performed using the ORAC method - Oxygen Radical Absorbance Capacity with fluoresceine (ORAC-FL), based in the capacity that the sample has to capture peroxy radicals generated by thermal decomposition of 2,2-azobis (2-amidinopropane) dihydrochloride (AAPH). The results were expressed as mM of Trolox Equivalent (mM TE) and differed significantly between treatments. It was observed that PBP increased ( $P = 0.000001$ ) the antioxidant activity of milk compared with control treatment. Milk samples resulting from treatments PBP2, PBP1 and PBP3 had antioxidant activity of 24.352, 23.640 and 16.075 mM TE, respectively, and the control treatment had antioxidant activity of 14.582 mM TE. It can be concluded that the PBP has antioxidant capacity and its addition in the diet of dairy cows can be positive, due to an increase transfer of antioxidant activity to the milk, preventing, therefore, their lipid oxidation, which will improve quality and lead benefits to consumer health.

**Key words:** antioxidant activity, milk, propolis ethanolic extracts

**W313 Ruminal fermentation of acidosis induced cows treated with monensin or polyclonal antibodies against target ruminal bacteria.** D. D. Millen\*<sup>2,3</sup>, R. D. L. Pacheco<sup>1</sup>, C. T. Marino<sup>4</sup>, J. P. S. T. Bastos<sup>4</sup>, T. A. Barros<sup>4</sup>, F. A. Ferreira<sup>4</sup>, C. L. Martins<sup>1</sup>, M. D. B. Arrigoni<sup>1</sup>, and P. H. M. Rodrigues<sup>4</sup>, <sup>1</sup>São Paulo State University (UNESP), Botucatu, São Paulo, Brazil, <sup>2</sup>São Paulo State University (UNESP), Dracena, São Paulo, Brazil, <sup>3</sup>Supported by FAPESP, São Paulo, São Paulo, Brazil, <sup>4</sup>University of São Paulo (USP), Pirassununga, São Paulo, Brazil.

This study was designed to evaluate the potential of a multivalent polyclonal antibody preparation (PAP) against target ruminal bacteria (*S. bovis*, *F. necrophorum* and *Lactobacillus* spp.) or monensin (MO) as acidosis preventative feed additive for cattle switched abruptly to high concentrate diets. Nine cannulated cows (677  $\pm$  98 kg of BW) were used in a completely randomized design in 2 periods of 20-d. Treatments were: control (CTL), PAP at a dose of 450 mg•kg<sup>-1</sup> of DM and MO at 30 mg•kg<sup>-1</sup> of DM. During first 5 d of each period, animals were fed a 100% forage diet (fresh chopped sugarcane). Ruminal acidosis was induced by abruptly introducing a 74% concentrate diet (based on high moisture corn) during 15-d. An interval of 15-d was considered between the 2 periods as ruminal washout. Ruminal acidosis evaluation parameters were: DMI, DMI fluctuations during the subsequent days after challenge, rumen pH, and VFA, lactate and NH<sub>3</sub>-N concentrations. There was no treatment main effect ( $P > 0.05$ ) for DMI. Higher pH was observed ( $P < 0.01$ ) for MO fed cows (6.06) compared with those on PAP (5.89) and CTL treatments (5.91). Ruminal lactate concentration remained low (0.23 mM) and unchanged ( $P > 0.05$ ) throughout the study. The NH<sub>3</sub>-N concentration of cows on CTL treatment (11.20 mg•dl<sup>-1</sup>) was lower ( $P < 0.01$ ) compared with cows fed MO (14.74 mg•dl<sup>-1</sup>) and PAP (13.64 mg•dl<sup>-1</sup>). A day x treatment interaction ( $P < 0.01$ ) for molar concentration of propionate was found, in which feeding MO increased propionate concentration during 4 d after challenge. Feeding MO also reduced ( $P < 0.01$ ) acetate:propionate ratio during 3 d after challenge. Molar proportion of butyrate was reduced ( $P < 0.01$ ) when cows were fed MO (15.42

mol•100mol<sup>-1</sup>) and PAP (16.35 mol•100mol<sup>-1</sup>) compared with cows on CTL treatment (18.43 mol•100mol<sup>-1</sup>). The type of ruminal acidosis generated in the present study was not lactic and possibly did not promote adequate conditions for PAP control ruminal lactate-producing bacteria. Nevertheless, MO was effective in increasing rumen pH and improving ruminal fermentation of cows induced to ruminal acidosis.

**Key words:** acidosis, monensin, PAP

**W314 Effect of a combined supplement of vitamin B12 and folic acid on vitamin B12 concentration in milk of dairy cows.** M. Duplessis<sup>\*1</sup>, D. Pellerin<sup>1</sup>, and C. L. Girard<sup>2</sup>, <sup>1</sup>Université Laval, Département des sciences animales, Québec, QC, Canada, <sup>2</sup>Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada.

Increasing folic acid supply could mask vitamin B12 deficiency until neurological damages are irreversible. Consequently, since folic acid fortification of flour became mandatory in many Western countries, there is a renewed interest for vitamin B12 status in human populations. The natural source of vitamin B12 in human diets comes from animal products, especially those from ruminants. Moreover, a recent study showed that vitamin B12 in cow's milk is absorbed more efficiently than its synthetic form. The objective of this work was to evaluate the effect of a combined supplement of vitamin B12 and folic acid on vitamin B12 concentration in milk of dairy cows. Commercial dairy herds were involved in this study (n = 15). Every 2 mo and within each herd, from February to July 2010, cows (n = 309) were randomly assigned, based on parity, predicted 305d milk yield, and calving interval to weekly intramuscular injections of 5 mL of 1) saline 0.9% NaCl (C) or 2) 10 mg of vitamin B12 + 320 mg of folic acid (V). The treatments began 3 wk before the expected calving date until 8 wk after parturition. Milk samples were taken on average at 28.1 ± 3.9 (T1) and 55.6 ± 3.9 (T2) DIM. Data were analyzed using the MIXED procedure of SAS with block, herd, parity, treatment and time as main effects. Vitamin supplements increased (P < 0.0001) average milk concentration of vitamin B12 from 3.1 to 5.2 ± 0.1 ng/g. For V and S, vitamin B12 concentrations were 5.5 and 5.0 ± 0.1 ng/g and 3.1 and 3.2 ± 0.1 ng/g at T1 and T2, respectively (treatment × time, P = 0.0005). Vitamin B12 concentration in milk was not affected by parity (P = 0.13) but it differed among herds (P < 0.05); there was no interaction treatment × herd (P = 0.23). Weekly intramuscular injections of vitamin B12 and folic acid increased by 68% milk concentration of vitamin B12 in commercial dairy herds. A glass (250 mL) of milk from supplemented cows provides 54% of the recommended daily allowance (2.4 µg) for adults and children over 13 years of age.

**Key words:** vitamin B12, folic acid, dairy cow

**W315 Effects of cornmeal or molasses supplemented with different protein sources on milk production and nitrogen utilization of organic dairy cows.** S. Ross<sup>\*1</sup>, A. F. Brito<sup>1</sup>, H. V. Petit<sup>2</sup>, and K. J. Soder<sup>3</sup>, <sup>1</sup>University of New Hampshire, Durham, <sup>2</sup>Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada, <sup>3</sup>USDA-Agricultural Research Service-Pasture Systems and Watershed Management Research Unit, University Park, PA.

Sixteen lactating organic Jersey cows were assigned to 4 replicated 4 × 4 Latin squares with a 2 × 2 factorial arrangement of treatments to compare the effects of feeding cornmeal (CM) or molasses (MOL) with either flaxseed meal (Flax) or a protein mix [(PM = 11% soybean meal (SB) + 5% sunflower meal (SM))] on milk yield and N utilization. Cows were fed (% diet DM) grass baleage (70%), mineral pre-mix

(2%), plus one of 4 concentrates (28% diet DM): 1) 12% CM plus 16% PM (CMP); 2) 12% CM plus 16% Flax (CMF); 3) 12% MOL plus 16% PM (MOLPM); or 4) 12% MOL plus 16% Flax (MOLF). Cows were fed twice a day with concentrates top-dressed on the baleage. Preplanned orthogonal contrasts were used to compare the main effects of: energy source (ES = CM vs. MOL) and protein source (PS = SB + SM vs. Flax), and the ES × PS interaction. A significant PS was observed for milk yield with cows fed Flax diets producing the lowest amounts. Cows fed MOL diets had the lowest (P = 0.01) feed efficiency while those fed PM diets the highest (P < 0.001). Significant PS effects were observed for yields and contents of milk fat and milk protein. A dilution effect possibly explains the reduced (P < 0.01) milk protein content in cows fed CMP and MOLP. A significant ES × PS interaction was found for MUN with cows fed CMF showing the highest and cows fed MOLF showing the lowest values, indicating enhanced N utilization in the latter diet. Cows fed MOL diets had the lowest PUN showing improved N utilization. Increased PUN with PM diets can be explained by their slightly greater CP compared with Flax diets. Overall, diets containing Flax reduced yields of milk and milk components while those containing MOL improved N utilization in organic cows.

**Table 1.** Performance and N utilization

	Diets					Contrasts		
	CMP	CMF	MOLP	MOLF	SED	ES	PS	ES × PS
DMI, kg/d	16.0	16.2	16.3	17.1	0.34	0.20	<0.001	NS
Milk yield, kg/d	14.0	13.0	14.0	12.3	0.34	NS	<0.001	NS
Milk: DMI	0.89	0.81	0.87	0.73	0.03	0.01	<0.001	0.10
Fat, %	4.58	4.43	4.56	4.29	0.11	NS	0.01	NS
Fat, kg/d	0.62	0.57	0.64	0.52	0.02	NS	<0.01	0.06
Protein, %	3.35	3.53	3.38	3.54	0.04	NS	<0.01	NS
Protein, kg/d	0.46	0.45	0.48	0.44	0.01	NS	0.01	0.09
MUN, mg/dL	15.7	17.4	15.6	14.9	0.44	<0.001	NS	<0.001
PUN, mg/dL	20.9	19.4	19.2	18.7	0.71	0.02	0.05	NS

SED=standard error of LSM difference; NS=not significant.

**Key words:** flaxseed meal, molasses, organic cows

**W317 Effects of essential oils, yeast and enzyme additive to milk replacer and starter on dairy calf performance.** A. D. Kmicikewycz<sup>\*1</sup>, H. T. Pervis<sup>2</sup>, J. Hill<sup>2</sup>, and N. B. Litherland<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>Ralco Nutrition Inc., Marshall, MN.

The objective of this study was to determine the effects of an essential oil blend, yeast cell wall extract, *B. subtilis*, and a source of digestible fiber in milk replacer (MRA) along with a digestible fiber, yeast cell wall extract, an essential oil blend, niacin and enzyme premix additive blend to starter (SA) on calf performance and health. Sixty multi-farm commingled male (n = 15) Holstein calves <7 d of age were randomly assigned to 1 of 4 treatments and balanced by initial body weight

(BW). The treatments (T) were as follows: T1) 20% CP:20% fat milk replacer (MR) and 18% CP texturized starter (control); T2) 20:20 MR with 10 g/d MRA and 18% CP starter; T3) 20:20 MR and SA; T4) 20:20 MR with 10 g/d MRA and SA. All MR was non-medicated, reconstituted to 12.5% solids and fed at 1.5% of arrival BW. Calves were weaned on d 42. Water and starter were provided ad libitum from d 1 to 56. Weekly weight and structural measurements and daily starter intake and fecal scores (FS) were recorded. Data were analyzed using Proc Mixed in SAS as a completely randomized design with repeated measures. Starter and total DM intake was not different among treatments. There was a tendency ( $P = 0.08$ ) for an increase in starter intake by week. Least squares means of starter intake (kg/d) from d 1 to 42 were 0.62 for T1, 0.59 for T2, 0.53 for T3, and 0.49 for T4. Average BW gain from d 1 to 42 (T1 = 15.4; T2 = 14.0; T3 = 13.0 and T4 = 10.7) was not different ( $P = 0.40$ ) or was BW gain from d 1 to 56 ( $P = 0.47$ ). Average daily gain (ADG) from d 1–56 was not different ( $P = 0.47$ ) averaging 0.43, 0.36, 0.34 and 0.36 kg/d for T1, T2, T3, and T4. There was no significant T or T  $\times$  wk interaction for hip width, hip height, wither height or heart girth. FS were not different ( $P = 0.95$ ) between treatments and averaged 2.2. Feeding a combination of essential oils, microbial and enzyme additives did not increase calf daily gain or performance over the 56 d.

**Key words:** calf, milk replacer, essential oils

**W318 Milk production responses of grazing cows to partial mixed rations.** M. J. Auld<sup>1</sup>\*, J. L. Jacobs, L. C. Marett, J. S. Greenwood, and W. J. Wales, *Department of Primary Industries, Ellinbank, Victoria, Australia.*

An experiment was conducted to measure milk production responses of grazing dairy cows in late lactation to supplements offered as partial mixed rations (PMR), or as grain in the dairy and forage in the paddock. Three groups of 72 multiparous spring-calving Holstein-Friesian cows had a common pasture intake of 8 kg DM/cow.d. Each group was randomly assigned to 1 of 3 rations to receive the balance of their nutrient intake. Rations were: (i) Control: barley grain in the dairy twice daily at milking times and pasture silage in the paddock. (ii). PMR1: a simple PMR of barley grain and pasture silage. (iii). PMR2: a PMR comprising maize silage, maize grain, barley grain and alfalfa hay. All rations were isoenergetic with grain:forage ratios of 75:25 (DM basis). Both PMRs were fed on a feed pad twice per day after milking. The 3 groups were further divided into 8 groups of 9 cows, and offered their supplements at one of 4 rates (6, 8, 10 or 12 kg DM supplement/cow.d) for 25 d. Milk yields measured daily and concentrations of fat and protein measured weekly were used to calculate yields of energy corrected milk (ECM). The ECM response to supplements between 6 and 12 kg DM/cow.d was linear ( $P < 0.05$ ) for PMR2, but not for Control or PMR1. There was no difference between ECM yield of any group except at the highest rate, when cows fed PMR2 produced 1.9 kg/cow.d more ( $P > 0.05$ ) than cows fed the Control and PMR1 diets. These data suggest that feeding grazing cows high rates of supplements as a PMR containing maize grain and maize silage may offer the opportunity to alleviate the diminishing or negative marginal response commonly observed when feeding high amounts of grain in the dairy.

**Table 1.** Yields of energy corrected milk (kg/cow.d) for cows offered different levels of supplements as a Control system or as one of two different partial mixed rations. Data are means for two groups of 9 cows offered each rate of each diet

Rate of feeding (kg DM/cow.d)	Control	PMR1	PMR2
6	17.5	15.8	16.5
8	19.6	18.1	19.5
10	21.4	20.3	21.0
12	20.1 <sup>a</sup>	19.8 <sup>a</sup>	22.0 <sup>b</sup>

<sup>a,b</sup>Within rates of feeding, means with different superscripts are significantly different. Overall standard error of the difference between means was 1.09.

**Key words:** pasture, milk response, supplements

**W319 Evaluation of a rumen protected carbohydrate supplement prototype feed with fresh lactation dairy cows.** J. P. Russi<sup>1</sup>\*, P. F. Russi<sup>1</sup>, J. M. Simondi<sup>2</sup>, G. M. Bonetto<sup>2</sup>, C. Nasser Marzo<sup>2</sup>, J. A. Di Rienzo<sup>3</sup>, and A. R. Castillo<sup>4</sup>, <sup>1</sup>Rusitec S.A., Buenos Aires, Argentina, <sup>2</sup>INTA, EEA Manfredi, Cordoba, Argentina, <sup>3</sup>University of Cordoba, School of Agriculture, Cordoba, Argentina, <sup>4</sup>University of California, Cooperative Extension, Merced, CA.

The objective of this trial was to feed a prototype rumen protected carbohydrate supplement to fresh lactation cows to determine if a patent pending manufacturing product is effective in protecting simple carbohydrates against ruminal degradation. Twenty 7 cows were group fed the same basal diet from -21 d of expecting calving date to parturition. From calving to 28 DIM cows were assigned to 3 treatments in a randomized complete block design and fed a diet of (% DM): 31.4% corn silage, 19.4% alfalfa hay, 22.8% corn grain, 7.4% soybean seeds, 4% extruded soybean meal, 4.3% minerals and vitamins; and 10.7% basal supplement (58.9% solvent soybean meal, 37.4% glucose and 3.7% urea). The 3 treatments consisted on replacing 0% (T0), 50% (T1) and 100% (T2) of the basal supplement with the rumen protected carbohydrate prototype feed. The prototype feed had the same ingredients of the basal supplement. Body weight, BCS, and blood samples were taken once a week. Weekly samples of TMR were taken for feed analysis. Milk yield and milk composition per cow was measured 2 times per week on non-consecutive days. Energy corrected milk (ECM) was calculated based on milk fat, protein, and lactose contents and milk yield/cow/d. DMI and ECM were not different for T0, T1 and T2, averaging 19.0, 20.2 and 21.1 Kg/d. and 28.2, 25.7, and 26.6 Mcal/cow/d. Milk fat, 4.08, 4.06, 4.15% and protein 3.36, 3.47, and 3.48% were similar among T0, T1 and T2. Milk lactose (%) was higher for T1 (4.96) and T2 (4.88), compared with T0 (4.70). Milk ketone bodies were not different averaging 0.73, 0.36 and 0.57 mg/dl for T0, T1 and T2. Blood glucose (mg/dl) was higher for T1 (45.3) and T2 (42.5) vs. T0 (38.8). Body weight loss (kg) during wk 3 was higher for cows in T0 (20.5) compared with T1 (7.3) and T2 (5.7). Based on milk lactose content, blood glucose, and body weight changes, it was concluded that the rumen protected carbohydrate supplement prototype was effectively protected against rumen microbial degradation

**Key words:** rumen protected carbohydrate, fresh cows' performance

**W320 Effects of balancing for methionine and lysine in a lactation diet containing high concentrations of wet corn gluten feed.** C. R. Mullins<sup>1</sup>\*, D. Weber<sup>2</sup>, E. Block<sup>2</sup>, J. F. Smith<sup>1</sup>, M. J. Brouk<sup>1</sup>, and B. J. Bradford<sup>1</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Arm & Hammer Animal Nutrition, Princeton, NJ.

Primiparous (n = 33) and multiparous (n = 63) lactating Holstein cows (186 ± 51 DIM) were used to evaluate the effects of balancing for metabolizable amino acids using lysine in a matrix of Ca salts of fatty acids (Megamine-L, Arm & Hammer Animal Nutrition) and the isopropyl ester of 2-hydroxy-4-methylthio butanoic acid (HMBi; MetaSmart, Adisseo Inc.) in diets with high concentrations of wet corn gluten feed. Cows were blocked by production, parity, and pregnancy status, then randomly assigned to 1 of 8 pens and allowed a 7 d adaptation period before receiving treatments. The study consisted of 2 28-d treatment phases, in which DMI and production were monitored daily and milk components analyzed 3 d/wk. Phase (P) 1 and 2 data were analyzed separately using mixed models with repeated measures. During P1, pens were offered 1 of 2 rations formulated to differ by amino acid content. The control diet had CPM-predicted values of 181 g/d of metabolizable lysine (6.05% of metabolizable protein [MP]) and 63 g/d of metabolizable methionine supply (2.11% of MP). The treatment diet was similar, with replacement of 190 g/cow per d of Ca salts of fatty acids (Megalac-R, Arm & Hammer Animal Nutrition) with the lysine product, and the addition of 14 g/cow per d of the HMBi product. This yielded CPM-predicted values of 197 g/d of metabolizable lysine (6.58% of MP) and 66 g/d of metabolizable methionine supply (2.20% of MP). No treatment effects were observed for any parameters in P1. For P2, cows remained in the same pens and dietary treatment groups; however, the treatment diet was modified to replace some wet corn gluten feed with corn silage, decrease dietary CP from 17.9% to 17.1% by removing expeller soybean meal, and further increase lysine and methionine supply. The resulting treatment diet had CPM-predicted values of 196 g/d of metabolizable lysine (7.10% of MP) and 69 g/d of metabolizable methionine supply (2.49% of MP). In P2, MUN was decreased in the treated group (10.8 vs. 12.5 ± 0.2 mg/dL,  $P < 0.001$ ) without affecting milk production ( $P = 0.51$ ). No differences were observed in any of the other parameters measured.

**Key words:** amino acid, dairy, by-product

**W321 Effects of subacute ruminal acidosis (SARA) challenges on bacteria in the digestive tract of dairy cows.** S. Li\*, J. C. Plaizier, E. Khafipour, and D. O. Krause, *University of Manitoba, Winnipeg, MB, Canada.*

Effects of SARA challenges on bacterial populations in the rumen and cecum were determined in 6 nonlactating Holstein dairy cows with cannula in the rumen and in the cecum. A replicated 3 × 3 Latin square was used. During the first 3 wk of the 4 wk experimental periods, cows received a control diet containing 70% forage (DM basis). During wk 4, cows received one of the 3 diets: the control diet, a grain-based SARA challenge (GBSC) diet containing 64% concentrate including 34% wheat-barley pellets, or an alfalfa-pellet SARA challenge (APSC) diet with 56% of forage including 37% alfalfa pellets. Digesta samples were taken at 6 h after feed delivery in wk 4. The starch content in cecal digesta was 2.8, 2.6, and 7.4% of DM for the control, APSC, and GPSC treatments, respectively. Relative qPCR quantification was used to determine the relative changes of bacterial groups during SARA challenges compared with control. Both GBSC and APSC increased *P. bryantii* and *S. ruminantium*, but decreased *S. bovis* in the rumen. Only GBSC increased *M. elsdenii* in the rumen. *E. coli* was undetectable in the rumen. In the cecum, both GBSC and APSC increased *P. ruminicola*, whereas only GBSC increased lactobacillus and *E. coli*, and decreased *S. bovis*. Across treatments, all selected bacteria groups, with the exception of *M. elsdenii*, *S. bovis* and lactobacillus were higher in the rumen than in the cecum. Results indicate that the balance between lactate producers and lactate utilizers and increased *E. coli*

numbers in the hindgut may play a role in the inflammatory response commonly associated with grain-based SARA.

**Table 1.** Relative change (log2) to control

	Rumen		Cecum	
	GBSC	APSC	GBSC	APSC
<i>Prevotella bryantii</i>	2.8*	1.6*	1.0	0.7
<i>Prevotella ruminicola</i>	0.2	-0.2	1.8*	1.9*
<i>Ruminobacter amylophilus</i>	1.8 <sup>a</sup>	-0.8 <sup>b</sup>	-0.1	2.5
<i>Fibrobacter succinogenes</i>	-0.02	1.0	2.0	2.2
<i>Selenomonas ruminantium</i>	2.5*	1.9*	0.1	0.8
<i>Lactobacillus</i>	0.7	0.2	2.1 <sup>*b</sup>	-0.2 <sup>a</sup>
<i>Streptococcus bovis</i>	-2.2*	-1.3*	-1.5 <sup>*a</sup>	0.03 <sup>b</sup>
<i>Megasphaera elsdenii</i>	3.1*	1.7	1.9	0.2
<i>Escherichia coli</i>	nd	nd	2.1*	1.6

Nd= not detected; <sup>a,b</sup>means within site differ ( $P < 0.05$ ); \*significant change ( $P < 0.05$ ).

**Key words:** SARA, bacteria, digestive tract

**W322 Interactions between mild protein imbalance and taste preference in young ruminants.** A. Bach\*<sup>1</sup>, J. J. Villalba<sup>2</sup>, and I. R. Ipharraguerre<sup>3</sup>, <sup>1</sup>ICREA and Ruminant Production-IRTA, Barcelona, Spain, <sup>2</sup>Utah State University, Logan, <sup>3</sup>Lucta, S.A., Barcelona, Spain.

Thirty-two crossbred lambs (BW = 31.2 ± 4.7 kg) distributed in individual pens were used to determine whether an imbalanced protein supply would alter preferences for feeds containing flavors designed to elicit either umami (U) or a mix (33.3:33.3:33.3%) of umami, sweet, and bitter (M) taste. Lambs were randomly allocated to either a low (LP; 10.9% CP) or a high (HP; 20.4% CP) protein diet for 21 d. Afterward, lambs were presented during 21 d with a choice of the same LP or HP diet unflavored (LPC or HPC) or flavored either with U (LPU or HPU) or M (LPM or HPM) at 0.1% as fed in a 2 × 2 factorial design with 8 replicates per treatment. Diets were offered ad libitum and intake was recorded daily. Blood samples were drawn on d 14 to assess blood urea N (BUN). Data were analyzed using a mixed-effects model for repeated measures accounting for random effect of animal within treatment and the fixed effects of treatment, time, and their interaction. During the first 21 d of study, feeding LP decreased ( $P < 0.05$ ) DMI, ADG, and feed efficiency compared with HP. The restricted intake of CP caused by LP was further evidenced by the lesser ( $P < 0.001$ ) BUN concentrations in LP lambs (7.63 ± 1.07 mg/dl) compared with HP lambs (18.81 ± 1.07 mg/dl). When offered a choice, all lambs showed a preference for the unflavored diet except for LP lambs which clearly ( $P < 0.001$ ) preferred LPU (72% of total DMI) over LPC. However, preference for LPU progressively decreased ( $P < 0.05$ ) as time of exposure to the choice increased. In summary, protein-restricted lambs were able to differentiate the umami-flavored feed and increase preference for and consumption of such feed probably in an attempt to fulfill their protein requirements. However, the increase in preference and consumption of the umami-flavored low-CP diet disappeared over time. This response was most likely a consequence of the overriding effects of metabolic control of intake elicited by the absence of a concomitant dietary supply of protein.

**Key words:** diet selection, sheep, flavor

**W323 Evaluation of RumeNext-D and monensin in early lactation diets for dairy cattle.** J. P. McNamara<sup>1</sup>, G. Duncan<sup>1</sup>, R. Bose<sup>1</sup>, S. Rocco<sup>1</sup>, J. Kay<sup>1</sup>, P. Doane<sup>2</sup>, and K. L. Perfield<sup>3</sup>, <sup>1</sup>Washington State University, Pullman, <sup>2</sup>ADM Research, Des Moines, IA, <sup>3</sup>Elanco Animal Health, Indianapolis, IN.

The plant botanicals eugenol and cinnamaldehyde (RumeNext-D), as well as the ionophore monensin, have been shown to positively affect performance of early lactation dairy cows. To test the effects of RumeNext-D (RND), monensin (MON) and the combination of the 2 (BOTH), on lactation performance of dairy cattle in early lactation as well as the relationship of productive responses and body compositional changes to estimate overall efficiency we used randomized complete block with parity (1 and 2) and genetic merit as blocks, with treatments (n = 15): 1) Control (CTL), 2) RND, 3) MON and, 4)BOTH. Alfalfa and triticale silage based diets with a corn, barley, peas and SBM based grain mix began at 21 DIM and continued to 111 DIM (d 13 through d 20 postpartum were used as a covariate). Monensin was mixed in the TMR at 14 g/ton (targeted 400 mg/d) and RND was included at 600 mg/d into the grain mix of the TMR. There was an effect of parity such that feed intake, milk yield and BW were all greater in 2nd parity animals. For most variables, there was a random effect of the covariate period. Dry matter intake (DMI) was 20.5, 21.0, 22.1 and 20.9 (SEM = 0.4) for the 4 treatments, respectively, 1.5 kg/d greater for the MON group versus CTL and 0.4 kg/d greater than control for RND or BOTH fed groups. However, with the covariate included, there was no significant effect of treatment on DMI. Milk yields were 34.2, 34.2, 36.5 and 34.9 kg/d (SEM = 1.1 kg/d) for the 4 treatments, respectively. Monensin increased ( $P < 0.04$ ) milk yield 2.3 kg/d over the 3 mo experimental period and MON significantly ( $P < 0.01$ ) increased milk protein yield by 0.15 kg/d over the CTL group. There was no effect of any treatment on milk fat or milk protein content or milk fat yield. Rumen pH (22 h after feeding) was approximately 6.2 and declined slightly as lactation progressed, there were no differences among treatments. Body weight and BCS did not change among treatments Monensin increased milk yield and milk protein yield, as previously demonstrated, however there did not appear to be an effect of the plant botanicals eugenol and cinnamaldehyde.

**Key words:** efficiency, monensin, plant botanicals

**W324 Comparing a 40-d dry period with a single close-up diet with a 60-d dry period with far-off and close-up diets on glucose, lactate, and calcium in the blood plasma of dairy cows.** H. Khazanehei\*, S. Li, D. O. Krause, M. L. Connor, L. Lippins, and J. C. Plaizier, *University of Manitoba, Winnipeg, MB, Canada.*

Effects of a 40-d dry period with a single close-up diet (40-d) with a 60-d dry period with far-off and close-up diets (60-d) on glucose, lactate, and calcium in blood plasma were compared. Twenty-six multiparous Holstein cows were paired based on the expected calving date and within pairs randomly assigned to 1 of 2 treatments. The 60-d dry period was divided into a 39-d far-off period and a 21-d close-up period. The far-off diet contained (DM basis) 1.29 Mcal/kg NEL, 12.0% CP, 38.7% NDF, and 0.79% Ca. The close-up diet contained 1.43 Mcal/kg NEL, 14.7% CP, 34.0% NDF, and 0.78% Ca. After calving, all cows received a diet containing 1.71 Mcal/kg, 17.6% CP, 29.7% NDF, and 0.97% Ca. Blood samples were taken weekly from wk 3 prepartum to wk 9 postpartum. Blood plasma was analyzed for glucose, lactate, and Ca. Data were analyzed as repeated measures under a randomized block design using the MIXED procedure of SAS. Cows on the 40-d treatment had higher blood glucose at 3 wk before calving, and at 1 wk

and 5 wk after calving. Cows on the 40-d treatment also had higher blood lactate at 1 wk after calving and higher blood calcium at 3 wk before and 2 wk after calving. The treatment differences at 3 wk before calving may be explained by the switch in diet that cows on the 60-d treatment, but not cows on the 40 d treatment made at that time. Treatment differences at wk 1 and 2 may have been due to the lower milk yields of the cows on the 40-d treatment.

**Table 1.** Concentrations of glucose, lactate, and calcium in the blood of dairy cows

Week	Glucose (mg/dL)			Lactate (mmol/L)			Calcium (mmol/L)		
	40-d	60-d	P-value	40-d	60-d	P-value	40-d	60-d	P-value
-3	86	71	0.03	2.51	2.06	0.28	1.06	0.97	0.04
-2	87	79	0.19	1.62	1.29	0.17	1.06	1.03	0.42
-1	82	80	0.76	1.55	1.38	0.7	1.04	1.03	0.63
1	77	59	<0.01	2.38	0.92	<0.01	1.07	1.02	0.12
2	71	65	0.17	1.13	1.18	0.54	1.12	1.05	0.04
3	73	66	0.21	1.82	1.25	0.41	1.08	1.05	0.33
5	77	67	0.05	1.29	1.35	0.73	1.07	1.06	0.72
7	74	72	0.71	1.05	1.00	0.73	1.03	1.05	0.66
9	74	73	0.71	1.85	1.23	0.36	1.06	1.08	0.79

**Key words:** dry period, nutrition, dairy cows

**W325 A meta-analysis on the effects of supplementing exogenous fibrolytic enzyme products in dairy diets on productive performance in early lactation.** J.-S. Eun<sup>1</sup>, C. M. Williams<sup>2</sup>, and A. J. Young<sup>1</sup>, <sup>1</sup>Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, <sup>2</sup>Department of Soil and Crop Sciences, Colorado State University, Fort Collins.

There have been several studies to examine the effects of exogenous fibrolytic enzyme (EFE) products on milk production of dairy cows. When viewed across all studies the variability in response is high, as a range of different enzyme products and experimental conditions were used. Thus, we performed a meta-analysis to assess production responses when EFE were supplemented in early lactation dairy diets. Supplementing EFE is likely to be more beneficial to early lactating cows than mid- to late lactating cows. Therefore, a database was developed from 10 studies recently published in the J. Dairy Sci. using early lactating dairy cows. In addition, the best responding treatment was chosen if an individual study tested various enzyme treatments, because efficacy of EFE depends on rate of dose, method of providing enzymes, and diet composition. A mixed model regression analysis with random study effect was used to evaluate relationships between supplementation of EFE and lactational performance parameters. Supplementing EFE increased DMI ( $P = 0.05$ ), milk yield ( $P < 0.01$ ), and ECM yield ( $P = 0.04$ ) by 0.5 (2.2% increase), 2.3 (6.6% increase), and 1.7 kg (4.7% increase) units, respectively, but did not affect milk fat ( $P = 0.27$ ) and protein ( $P = 0.82$ ) concentrations. While milk fat yield was not affected by EFE supplementation, milk protein yield increased by 0.06 kg unit (5.5% increase;  $P = 0.02$ ). Milk production efficiency (milk yield/DMI) was improved by 0.07 units (4.6% increase;  $P = 0.01$ ). Although the meta-analysis data set only included 10 studies, it is evident from the positive animal responses that EFE additives can be an effective means to improve productive performance of early lactating dairy cows. A better understanding of the factors affecting animal response to EFE supplementation will help ensure cost-effective use of these additives on-farm.

**Key words:** early lactating dairy cows, exogenous fibrolytic enzymes, meta-analysis

**W326 Evaluation of dietary fat from dried distillers grains in the diet Holstein heifers on growth and dry matter intake.** J. L. Anderson\*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

The objective of this study was to determine how increased dietary fat from dried distillers grains with solubles (DDGS) in diets of growing heifers affects DMI, ADG, and growth. Thirty-three Holstein heifers ( $133 \pm 18$  d old) were used in a 24-wk randomized complete block design. Treatments were: 1) control (C) containing ground corn (15.9% of DM) and soybean products (17.9%), 2) low-fat (LF) containing low-fat, high-protein DDGS (21.9%) and ground corn (11.9%), and 3) high-fat (HF) with traditional DDGS (33.8%). All diets contained 39.8% grass hay, 24.8% corn silage, and 1.5% vitamins and minerals. Diets were formulated for 16.3% CP (DM basis) 9.8% RDP and 6.5% RUP. The HF diet contained 4.8% fat compared with 2.8% in the C and LF diets, which were greater in NFC. Diets were 1.0 Mcal/kg of DM and limit-fed at 2.45% of BW. Heifers were weighed every 2 wk and rations adjusted accordingly. Every 2 wk, heart girth, hip height, wither height, body length, and BCS were recorded. No treatment  $\times$  time interactions were found. Dry matter intakes were similar, averaging 7.01, 7.01 and 6.89 kg/d (SEM = 0.26) for C, LF, and HF, respectively. Body weights were similar among treatments (248.4, 243.9, 244.2 kg, SEM = 8.06), as were ADG (0.92, 0.90, 0.91 kg/d, SEM = 0.07). Heart girth was similar among treatments (137.7, 138.2, 144.7 cm, SEM = 3.51). Hip height was less ( $P < 0.01$ ) for heifers fed HF (118.3 cm) compared with those fed C (119.7) and LF (119.3, SEM = 1.18). Wither height was greater ( $P = 0.02$ ) for heifers fed LF (115.3 cm) compared with HF (114.4), and tended ( $P = 0.09$ ) to be greater compared with heifers fed C (114.6), but C and HF were similar (SEM = 1.01). Body length was longest ( $P < 0.01$ ) for heifers fed C (105.0 cm), shortest for HF (102.6), with LF (103.7) in between (SEM = 1.47). Overall BCS were similar for heifers fed C and LF (3.05), but greater ( $P = 0.04$ ) for HF (3.09, SEM = 0.02). Despite similar BW, ADG, and DMI, feeding diets with additional fat from including DDGS compared with diets with low-fat DDGS or corn and soybean products to growing heifers may result in slightly greater BCS and slightly smaller body frame sizes.

**Key words:** distillers grains, heifers

**W327 Bee pollen and its polysaccharides, the new feed additives in milk replacer of preruminant calves.** Y. Tu\*, G.-F. Zhang, N.-F. Zhang, C.-G. Jiang, 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.*

The experiment investigated the influence of lotus bee pollen and polysaccharides extracted from lotus bee pollen on growth performance and nutrient digestibility in preruminant calves. Twenty-five neonatal Chinese Holstein female calves were randomly allotted to 5 groups, and each group was offered a milk replacer (MR) supplemented with 0 (control, C), 10 (10BP), 25 (25BP) or 50 g (50BP) lotus bee pollen/kg MR, or 5 g (5PS) polysaccharides/kg MR for 63 d. The MR, containing 20.41 MJ digestible energy/kg, 26.16% crude protein (CP) and 15.62% ether extract (EE), was fed at 11.0% of live weight of the calves, and a starter ration was offered ad libitum from 28 d thereafter. Average daily gain (ADG), average daily feed intake (ADFI) and feed/

gain ratio (F/G) were measured fortnightly. A 3-d digestion trial by total collection of feed refusals, feces, and urine was conducted from 26 to 28 d and from 47 to 49 d, respectively. The apparent digestibility of dry matter (DM), CP, EE, Ca and total P was calculated. Data were analyzed by GLM procedure of SAS<sup>®</sup> software. The results showed that, compared with group C, ADG was significantly higher in the calves from group 25BP or group 5PS (656.6 vs 808.7 or 797.5 g/d,  $P < 0.05$ ); F/G was decreased by 12.85% in the calves from group 25BP (1.79 vs 1.56,  $P < 0.05$ ); there was no significant differences in ADFI among the groups. The apparent digestibility of DM during 26 to 28 d was increased by 8.38% and 7.66% respectively in the calves from groups 25BP and 5PS (79.02% vs 85.64% and 85.07%,  $P < 0.05$ ); the apparent digestibility of CP was increased by 18.63% in the calves from group 25BP (66.35% vs 78.71%,  $P < 0.05$ ). No differences in the apparent digestibility of the nutrients were detected among the groups during 47 to 49 d ( $P > 0.05$ ). In conclusion, supplementation of bee pollen or its polysaccharides at 25 or 5 g/kg MR, respectively, improved ADG, F/G and apparent digestibility of DM and CP in preruminant calves.

**Key words:** bee pollen, calves, growth and apparent digestibility

**W328 Effect of lipopolysaccharides on immune parameters and nitrogen metabolism in preruminant calves.** N.-F. Zhang, H. Li, Y. Tu\*, C.-G. Jiang, and Q.-Y. Diao, *Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, P.R. China.*

This study investigated the effect of immunological stress on immune parameters and nitrogen metabolism in preruminant calves. Forty male Chinese Holstein calves of 24 d old were randomly divided into 2 groups with 20 calves each, and one group was injected intraperitoneally with 2.5  $\mu$ g *E. coli* lipopolysaccharides (LPS)/kg BW at 24, 26 and 28 d of age, and the other was injected with an equivalent volume of sterile saline. Rectal temperature was measured at 30, 90, 150 and 210 min after injection. A total collection of feces and urine was conducted between 25 and 27 d for analysis of nitrogen metabolism. Plasma samples were collected 60, 120 and 180 min after injection for analysis of urea nitrogen, interleukin-1 $\beta$  (IL-1 $\beta$ ), tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), complement C3, interleukin-2 (IL-2) and interleukin-4 (IL-4). The body temperature was elevated significantly 150 and 210 min after the challenge of LPS ( $P < 0.05$ ). The plasma concentration of IL-1 $\beta$  and TNF- $\alpha$  was increased significantly 120 and 180 min after the challenge of LPS ( $P < 0.05$ ), the plasma complement C3 was decreased significantly 120 min after the challenge of LPS ( $P < 0.05$ ), and the plasma IL-2 (Th1 type cytokine) ( $P < 0.05$ ), IL-4 (Th2 type cytokine) and the ratio of IL-2 to IL-4 were increased following the challenge of LPS. The plasma urea nitrogen was increased significantly 120 min postinjection of LPS ( $P < 0.05$ ). The urinary concentration of nitrogen was higher ( $P < 0.05$ ), but the nitrogen retention and apparently biological value of nitrogen were lower in the LPS-challenged calves than control. The results suggested that the immunological stress induced inflammatory responses, activated immune responses, and shifted immune responses from Th2 type to Th1 type, and then suppressed the nitrogen retention and decreased the utilization efficiency of nitrogen in the calves.

**Key words:** immunological stress, nitrogen metabolism, calves

**W329 Partially replacing barley grain with wheat factory sewage in the dairy cow diets did not affect digestion and milk production.** M. Khorvash<sup>1</sup>, S. Kargar<sup>1</sup>, G. R. Ghorbani<sup>1</sup>, M. Borou-

mand-Jari<sup>2</sup>, A. Ghaempour<sup>1</sup>, and W. Z. Yang<sup>\*3</sup>, <sup>1</sup>*Isfahan University of Technology, Isfahan, Iran*, <sup>2</sup>*Jahad-Agriculture Institute of Scientific-Applied Higher Education, Isfahan, Iran*, <sup>3</sup>*Agriculture and Agri-Food Canada, Research Centre, Lethbridge, Alberta, Canada*.

The objective of this study was to evaluate whether wheat factory sewage (WFS) could partially replace barley grain in the diet of dairy cows without adversely affecting DMI, rumen fermentation, digestibility, and milk production of dairy cows. Eight multiparous (60 ± 3 DIM) Holstein cows were used in a replicated 4 × 4 Latin square designed experiment with 4 21-d periods. The basal diet was formulated with 22% corn silage, 22% alfalfa hay and 56% barley grain-based concentrate (DM basis); barley grain was partially replaced with 0% WFS (WFS0), 4% (WFS26), 6% (WFS39) or 8% WFS (WFS52). Data were analyzed using the MIXED model procedure of SAS to account for diet as fixed effect and square, cows within square and period within square as random effect. DM content of diets linearly ( $P < 0.01$ ) decreased from 65, 59, and 57 to 54% with increasing the inclusion of WFS due to high water content of WFS (80%). DMI was quadratically changed ( $P < 0.04$ ) to be higher for WFS26 (23 kg/d) than for other 3 diets which were similar (21 kg/d). Rumen total VFA (100 to 103 mM), molar proportion of acetate (65 to 67%), propionate (24 to 25%), and ratio of acetate to propionate (2.68 to 2.89) were not affected with increasing the replacement of barley grain by WFS. Apparent total-tract digestibilities of DM (67%), CP (68%) and NDF (54%) were not different among treatments. Milk yield (averaged 40 kg/d) and milk composition were not affected by the diets. Results showed that partially replacing 26, 39 and 52% of barley grain with WFS in dairy cow diets decreased DM content but had no adverse effects on DMI, rumen fermentation, digestibility, and milk production responses. It suggests that WFS can be used as alternative to grain to feed dairy cattle.

**Key words:** barley grain, wheat factory sewage, dairy cow

**W330 Effects of dietary crude protein level on eating pattern and performance of Holstein calves.** G. Araujo<sup>1</sup>, M. Devant<sup>1</sup>, A. Mereu<sup>2,1</sup>, I. Ipharraguerre<sup>2</sup>, and A. Bach<sup>\*3,1</sup>, <sup>1</sup>*Department of Ruminant Production, Institut de Recerca i Tecnologia Agroalimentàries (IRTA), Barcelona, Spain*, <sup>2</sup>*Lucta, S.A., Barcelona, Spain*, <sup>3</sup>*Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain*.

The objective of this study was to evaluate changes in eating pattern and performance of calves fed 2 isoenergetic concentrates differing in CP concentration. Seventy 5 male Holstein calves (initial BW 246 ± 29 kg and 211 ± 24 d of age) were housed in 4 homogenized groups of 18 to 20 animals each according to ages and weights. One dietary treatment consisted on a concentrate containing 18% CP on DM basis (HP) and the other contained 16% CP on a DM basis (LP). In addition to concentrates, calves had ad libitum access to barley straw on a separate feeder. Animals were weighed on d 0, 14, and 28 of study and individual concentrate intake was monitored daily using an electronic feeding system. Data were analyzed with a mixed-effects model with pen as a random effect and treatment and day as fixed effects, with time entering the model as a repeated measure. Calves receiving HP spent more ( $P < 0.05$ ) time eating concentrate (42 ± 0.7 min/d) than those receiving LP (38 ± 0.7 min/d). However, the number of meals per day was similar for both treatments (9.0 meals/d for HP and 9.3 meals/d for LP) and average meal interval of HP calves (168.1 ± 2.8 min) was longer ( $P < 0.01$ ) than that of LP (161.5 ± 2.8 min). This was mainly due to the greater ( $P < 0.001$ ) meal length observed with HP (5.3 ± 0.1 min/meal) than with LP calves (4.5 ± 0.1 min/meal).

Meal size was also greater ( $P < 0.001$ ) in HP (845.4 ± 19.2 g/meal) than in LP (790 ± 19 g/meal) calves. Furthermore, eating rate of HP calves (163 ± 4 g/min) was slower ( $P < 0.001$ ) compared with calves consuming the LP concentrate (185 ± 4 g/min). Although concentrate intake did not differ between both treatments (6.7 kg/d), HP calves tended ( $P = 0.05$ ) to grow more (1.67 ± 0.02 kg/d) than LP (1.56 ± 0.02 kg/d) calves, and as a consequence HP calves were numerically ( $P = 0.35$ ) more efficient (26.6 ± 0.9%) than LP calves (24.9 ± 0.9%) converting consumed nutrients into gain. In conclusion, concentrates containing 18% CP tend to result in improved ADG compared with 16% CP levels due to increased CP supply and changes in eating pattern, mainly increased meal size and length and decreased eating rate, but not due to changes in DMI.

**Key words:** feeding behavior, intake regulation, efficiency

**W331 Feeding distiller's grains as an energy source to gestating and lactating heifers: Impact on calving and pre-weaning progeny performance.** P. J. Gunn<sup>\*1</sup>, J. P. Schoonmaker<sup>1</sup>, R. P. Lemenager<sup>1</sup>, and G. A. Bridges<sup>2</sup>, <sup>1</sup>*Purdue University, West Lafayette, IN*, <sup>2</sup>*University of Minnesota, Grand Rapids*.

Angus-cross beef heifers pregnant to a single sire (n = 80; BCS = 5.1 ± 0.03; BW = 518 ± 6 kg) were used to determine the effects of feeding dried distiller's grains with solubles (DDGS) as an energy source during the late gestation and early lactation on calving parameters and offspring growth through weaning. At 192 d in gestation, heifers were allotted by BW within BCS to receive either a control diet of corn silage and haylage (CON; 10% CP prepartum; 11.8% CP postpartum) or corn residue and DDGS, where DDGS were fed at 1.2% of BW per d (DG; 15.7% CP). Diets were formulated to be isocaloric (1.0 Mcal/kg NEg). Dietary treatments concluded and cattle were commingled 30 d after timed-AI (118 ± 0.1 d postpartum; DPP). Heifer BW and BCS (1–9) were assessed every 28 d. Calving score (1 = no assistance; 5 = C-section) and calf vigor at birth (1 = nursed on own; 4 = died after birth) was evaluated. Calf weights were taken at birth and at weaning (191 ± 0.6 d of age). Milk production was assessed via weigh-suckle-weigh procedure at 66 ± 0.6 DPP. Heifer BW never differed between treatments ( $P \geq 0.33$ ), but BCS was greater before calving (5.8 vs. 5.3;  $P < 0.01$ ) and at conclusion of dietary treatments (5.6 vs. 5.4;  $P < 0.01$ ) for CON than DG heifers, respectively. Gestation length was greater ( $P = 0.03$ ) for DG (278 ± 0.7 d) than CON (276 ± 0.6 d) heifers. Sex ratio and vigor of calves did not differ ( $P \geq 0.69$ ). Birth weight (36.7 ± 0.7 vs. 32.5 ± 0.7 kg) and rate of dystocia (59 vs. 24%) was greater ( $P < 0.01$ ) in DG than CON progeny, respectively. Although dam milk production did not differ between treatments ( $P = 0.86$ ), weaning weight was greater ( $P = 0.05$ ) for DG progeny (244 ± 3.6 kg) than CON (234 ± 3.7 kg). In summary, feeding DDGS at 1.2% of BW per d to gestating heifers resulted in greater birth weights, dystocia rates and weaning weights of the DG progeny without altering milk production, suggesting this dietary strategy induced developmental programming changes that increased progeny pre-weaning performance.

**Key words:** beef heifers, DDGS, developmental programming

**W332 Feeding distillers grains as an energy source to gestating and lactating heifers: Impact on milk production, composition, and fatty acid profile.** P. J. Gunn<sup>\*1</sup>, J. P. Schoonmaker<sup>1</sup>, R. P. Lemenager<sup>1</sup>, and G. A. Bridges<sup>2</sup>, <sup>1</sup>*Purdue University, West Lafayette, IN*, <sup>2</sup>*University of Minnesota, Grand Rapids*.

Angus-cross beef heifers pregnant to a single sire (n = 80; BCS = 5.1 ± 0.03; BW = 518 ± 6 kg) were used to determine the effects of feeding dried distillers grains with solubles (DDGS) as an energy source during late gestation and early lactation on milk production, composition, and fatty acid profile. At 192 d in gestation, heifers were allotted by BW within BCS to receive either a control diet of corn silage and haylage (CON; 10% CP prepartum; 11.8% CP postpartum) or corn residue and DDGS, where DDGS were fed at 1.2% of BW per d (DG; 15.7% CP). Diets were formulated to be isocaloric (1.0 Mcal/kg NEg). Dietary treatments concluded and cattle were commingled 30 d after timed-AI (118 ± 0.1 d postpartum; DPP). BW and BCS were assessed every 28 d during treatment and did not differ during milk data collection. At 65 ± 0.6 DPP, milk samples were collected to determine composition and fatty acid profile. The following day, milk production was assessed via 24 h weigh-suckle-weigh. Total milk production (8.8 ± 0.4 kg/d), milk protein, and lactose content did not differ ( $P \geq 0.38$ ). However, milk fat (223 ± 15 vs. 121 ± 14 g/d), total solids (1084 ± 44 vs. 951 ± 40 g/d), and energy corrected milk production (7.8 ± 0.4 vs. 6.5 ± 0.3 kg/d) was greater ( $P \leq 0.03$ ) in CON than DG, respectively. Milk urea N (MUN) was greater in DG (16.4 ± 0.5 mg/dL) than CON (7.1 ± 0.6 mg/dL;  $P < 0.01$ ). Short- (3.7 ± 0.2 vs. 2.3 ± 0.2 g/100 g) and medium-chain fatty acids, (17.3 ± 0.4 vs. 10.1 ± 0.4 g/100 g) and SFA (64.3 ± 1.1 vs. 47.5 ± 0.9 g/100 g) content was greater ( $P < 0.01$ ) in CON than DG, respectively. In contrast, long chain fatty acids (87.7 ± 0.5 vs. 79.0 ± 0.6 g/100 g), MUFA (44.7 ± 0.9 vs. 32.0 ± 1.0 g/100 g), PUFA (7.8 ± 0.2 vs. 3.6 ± 0.2 g/100 g), and CLA (3.4 ± 0.1 vs. 0.9 ± 0.1 g/100 g) content was greater ( $P < 0.01$ ) in DG than CON, respectively. In summary, feeding DDGS at 1.2% of BW per d to first-parity heifers resulted in decreased milk fat, milk solids, and energy corrected milk production, but greater MUN, long chain fatty acids, CLA, MUFA, and PUFA in the milk produced.

**Key words:** beef heifer, DDGS, milk

**W333 Effect of extruded flax products on dairy cow milk and steer tissue fatty acid composition.** D. A. Christensen\*, P. Yu, J. J. McKinnon, and A. Foth, *University of Saskatchewan, Saskatoon, SK, Canada.*

Several benefits have been attributed to omega-3 content of milk and ruminant products. The objective of this research was to determine the effect of extruded flax products on fatty acid content of milk, organs and meat. To determine effect on milk 6 early lactation Holstein cows were fed a barley silage, alfalfa hay, barley grain, canola meal, SBM based ration for 28 d, then 5.8% of DM of an extruded product (Oleet Processing, Regina SK) replacing concentrate for 28 d followed by a second control period of 28 d. The extruded product contained 54% flax, 38% pea grain, 8% alfalfa meal, vitamin E and ethoxyquin. Extrusion temperature was 143°C. Six large frame crossbred steers were fed a similar product as 18% of ration DM which contained 36% flax seed and 20% canola seed for 70 d before slaughter. Three additional steers were fed a control barley grain, barley silage finishing ration. Milk yield in the test feeding period averaged 46.6 kg and 3.36% fat. Milk C18:3n3 (ALA) increased from 0.49% of fatty acid methyl esters (FAME) to 0.83% ( $P < 0.01$ ) in the test period and declined to 0.46 in the second control period. C18:2 c9-t11 (CLA) increased from 0.30 to 0.60 ( $P = 0.07$ ) then declined to 0.32% of FAME in the second control period. EPA, DPA and DHA were 0.07% of FAME or less. Total milk omega-3 fatty acids increased from 0.59 to 1.04% then declined to 0.60% of FAME 28 d after the extruded product was withdrawn. In steer liver ALA increased from 0.71% to 2.28% ( $P < 0.01$ ). Liver EPA increased from 0.71 to 1.61% of FAME ( $P = 0.03$ ). The increase

in DHA from 1.74 to 2.04% of FAME was not significant ( $P = 0.29$ ). Total liver omega-3 increased from 7.36 to 12.9% of FAME. Ribeye (L. dorsi) ALA increased from 0.25% to 0.78% of FAME ( $P < 0.01$ ) with no other significant effects. Fatty acids in loin, shoulder and chuck meat samples showed a similar pattern to ribeye with the main effect being an increase in ALA. Substantial extruded product effects on ALA content of liver, milk, and meat samples were observed.

**Key words:** milk, meat and organ, fatty acids

**W334 Grain source and alfalfa hay particle size effects on fecal fermentability and particle size in midlactation Holsteins.** A. Nikkhah<sup>1</sup>, S. M. Nasrollahi<sup>2</sup>, M. Khorvash<sup>2</sup>, and G. R. 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 independent and interactive effects of alfalfa hay particle size and grain source on fecal fermentability and particle size. Eight Holstein cows (175 d in milk) in a replicated 4 × 4 Latin square design with four 21-d periods were fed 4 diets with either finer (FA) or coarser (CA) chopped alfalfa hay, with either ground barley (GB) or a 50:50 ratio of ground barley and corn grains (BC). Diets were offered ad libitum as mixed rations with forage to concentrate ratio of 40:60 (DM based). Geometric mean particle size was 4.33 and 3.43 mm for CA and FA, respectively; and 3.8, 3.6, 3.7, and 3.4 mm for CAGB, FAGB, CABC, and FABC, respectively. Feces were sampled for 5 d directly from rectum before morning feeding. Acid insoluble ash was used as an internal marker to estimate fecal outputs. Wet sieving was utilized to measure feces particle size. Feed and fecal potential fermentability was measured after 48 h of rumen incubation in situ through cannula. Data were analyzed using Mixed Procedures of SAS with linear models consisting of fixed period, grain source, hay particle size, and grain source × hay particle size effects, plus cow and residuals random effects. Feed potential fermentability was similar among CAGB (84.35%), FAGB (84.33%), CABS (84.35%), and FABC (84.46%). However, fecal fermentability was greater for BC vs. GB (67.8 vs. 64.4%,  $P < 0.01$ ). Fecal fermentable DM as % of DMI was similar among CAGB (33.9), FAGB (34.1), CABC (33.3), and FABC (32.0). Fecal fineness was not significantly different. Rumen pH was higher for CA vs. FA (6.45 vs. 6.27,  $P < 0.05$ ), while similar for GB vs. BC (6.36 vs. 6.37). Data suggest that greater amount of partially digested organic matter escaped the gastrointestinal tract digestion for BC vs. GB, that agrees with greater DMI for BC vs. GB (25.6 vs. 24.3 kg/d,  $P < 0.05$ ). Hay particle size and grain source interactions did not affect fecal properties. Results suggest that dietary grain source and not hay particle size can affect fecal fermentability in midlactation dairy cows.

**Key words:** fecal fermentability, grain source, alfalfa hay

**W335 Textured versus ground starter effects on Holstein calves chewing behavior.** A. Nikkhah<sup>1</sup>, S. M. Nasrollahi<sup>2</sup>, B. Raad<sup>2</sup>, S. Khorsandi<sup>2</sup>, M. Forootan<sup>2</sup>, and S. P. Emami Panaah<sup>2</sup>, <sup>1</sup>*University of Zanjan, Zanjan, Iran,* <sup>2</sup>*Foeka Agriculture and Dairy Corporation, Isfahan, Iran.*

The objective was to determine effect of calf starter physical form on chewing activity. Thirty-two Holstein calves (16 males and 16 females, 41 ± 2.8 kg body weight) were offered from 4-d of age until weaning an either textured (T) (with steam flaked grains plus pelleted non-grains) or fully ground (G) starter feed. Each treatment had 8 male and 8 female calves. Feed composition and calf management were

exactly the same for both groups. On d-60 of age, eating, ruminating and resting times were recorded visually every 5 min. Each activity was assumed to persist for the entire 5-min if occurred. Accordingly, meal size and eating rate per kg of dry mater intake and per minute of eating were calculated. Data were analyzed using Mixed Procedures of SAS as linear completely randomized models with fixed effect of starter physical form, and random effects of calf within treatment plus residuals. Daily starter intake (1.67 vs. 1.55 kg), duration of eating (126.7 vs. 117.0 min/d), ruminating (325.3 vs. 324.6 min/d), and resting (981.5 vs. 991.8 min/d), and per kg starter intake of eating (76.5 vs. 74.3 min) and ruminating (199 vs. 186 min) activities were not significantly different between T and G, respectively. Daily number of eating (24.3 vs. 24.4) and ruminating (15.3 vs. 13.7) bouts, mean eating bout size (68 vs. 64 g), and average bout length of eating (5.5 vs. 5.2 min) and ruminating (21.8 vs. 23.6 min) were also similar for T vs. G, respectively. In summary, results suggest that whether starter is textured or finely ground may not affect young calf eating and chewing behaviors.

**Key words:** calf chewing, physical form, starter

**W336 Changes in long-chain polyunsaturated fatty acid status of dairy cows during the periparturient period based on erythrocyte-membrane fatty acids.** C. L. Preseault<sup>1</sup>, H. M. Dann<sup>2</sup>, and A. L. Lock<sup>\*1</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>William H. Miner Agricultural Research Institute, Chazy, NY.

This study examined shifts in long-chain polyunsaturated fatty acid (LCPUFA) status of dairy cows during the periparturient period using erythrocyte membrane (EM) FA profiles. It was hypothesized that EM FA could be used to assess LCPUFA changes in dairy cows because they have been used previously in human studies to assess long-term FA status. Two groups of cows (11/treatment) were fed a low-energy, high-straw diet during a 40 d dry period, and then fed either a low-starch (22%) diet, or a high-starch (26%) diet for the first 91 DIM. Blood samples were collected at -14 d before projected calving date (DRY), at 21 DIM (EARLY), and at 90 DIM (MID). Data was analyzed as repeated measures using SAS proc mixed. There was no effect of dietary treatment at any time point on EM FA. Sampling time did not affect EM concentrations of total saturated or cis PUFA (47.6 and 22.6 g/100 g FA, respectively). Total cis MUFA concentration was 26.6, 27.7, and 24.9 g/100 g FA for DRY, EARLY and MID, respectively ( $P < 0.05$ ). The ratio of n-6/n-3 FA was 9.9, 9.1, and 11.2 for DRY, EARLY and MID, respectively ( $P < 0.01$ ). There was a trend for total n-6 FA to be lower in EARLY ( $P = 0.08$ ) whereas total n-3 FA were not different across time. EM concentrations of individual n-6 FA were consistently lower at EARLY, whereas individual n-3 FA were consistently lower at MID compared with the other times. Comparing EARLY to MID, the EM concentration of C18:2 n-6 was 11% lower ( $P < 0.1$ ), C20:2 n-6 31% lower ( $P < 0.001$ ), C20:3 n-6 37% lower ( $P < 0.001$ ), and C22:4 n-6 38% lower ( $P < 0.001$ ). Comparing MID to EARLY, the EM concentration of C18:3 n-3 was 11% lower ( $P < 0.05$ ), and C20:3 n-3 30% lower ( $P < 0.05$ ). Neither C20:5 n-3 nor C22:5 n-3 were different across time; 22:6 n-3 was not detected in cow EM. Total trans C18:1 was 19% higher in EARLY and MID compared with DRY ( $P < 0.001$ ). Results demonstrate potential differences in LCPUFA status of cows during the periparturient period. Whether EM FA profiles provide a robust measure of LCPUFA status and if these changes affect animal production and health remain to be determined.

**Key words:** erythrocyte membrane, long-chain PUFA, transition cows

**W337 A 40-d dry period with a single close-up diet and a 60-d dry period with far-off and close-up diets differ in their effects on lipolysis and liver triacylglycerol.** H. Khazanehei\*, S. Li, D. O. Krause, M. L. Connor, L. Lippins, and J. C. Plaizier, *University of Manitoba, Winnipeg, MB, Canada.*

Effects of a 40-d dry period with a single close-up diet (40-d) with a 60-d dry period with far-off and close-up diets (60-d) on  $\beta$ -hydroxybutyrate (BHBA) and nonesterified fatty acids (NEFA) in blood plasma and triacylglycerol (TAG) in liver samples were compared. Twenty 6 multiparous Holstein cows were paired based on their expected calving date. Cows within pairs randomly were assigned to 2 treatments. The 60-d dry period was divided into a 39-d far-off period and a 21-d close-up period. The far-off diet contained (DM basis) 1.29 Mcal/kg NEL, 12.0% CP, and 38.7% NDF. The close-up diet contained 1.43 Mcal/kg NEL, 14.7% CP, and 34.0% NDF. After calving, all cows received a diet containing 1.71 Mcal/kg, 17.6% CP, and 29.7% NDF. Blood samples were taken weekly from wk 3 prepartum to wk 9 postpartum, and were analyzed for BHBA and NEFA. Liver biopsies were obtained at wk 3 prepartum, and at wk 1 and wk 4 postpartum, and were analyzed for TAG. For both treatments TAG was low at 3 wk before calving, increased at 1 wk after calving, and remained high at 4 wk after calving. At 1 wk after calving cows on the 40-d treatment had higher TAG than cows on the 60-d treatment. NEFA were higher at 1 wk after calving than at 3 wk before calving. Cows on the 40-d treatment had higher NEFA at 1, 2, and 3 wk after calving than cows on the 60-d treatment. BHBA was not affected by treatments on any week before or after calving. The NEFA results mirrored the TAG results. Results suggest that during the 3 wk after calving, cows on the 40-d treatment had a deeper negative energy balance, which caused more intensive lipolysis and the accumulation of a greater amount of TAG in the liver. Results also suggest moderate fatty liver and high lipolysis in early lactation in cows on both treatments.

**Table 1.** Concentrations of liver TAG, and NEFA and BHBA in blood plasma

Week relative to calving	TAG (% wet weight)			NEFA (mmol/L)			BHBA (mg/dl)		
	60-d	P-value	40-d	60-d	P-value	40-d	40-d	60-d	P-value
-3	0.3	0.24	0.97	0.10	0.14	0.53	11.4	9.5	0.11
-2	ND	ND		0.18	0.18	0.94	10.6	11.0	0.91
-1	ND	ND		0.35	0.20	0.28	11.7	9.0	0.26
1	10.81	6.46	0.04	0.96	0.53	<0.01	19.0	18.4	0.98
2	ND	ND		0.62	0.29	0.05	20.1	15.8	0.98
3	ND	ND		0.42	0.28	0.05	23.8	16.1	0.45
4	9.36	9.22	0.88	ND	ND		ND	ND	
5	ND	ND		0.23	0.19	0.40	16.7	20.6	0.55
7	ND	ND		0.15	0.20	0.68	13.8	13.8	0.49
9	ND	ND		0.13	0.13	0.95	17.4	12.2	0.10

ND = not determined.

**Key words:** dry period, lipolysis, dairy cows

**W338 Reduced protein for late-lactation dairy cows.** A. B. D. Pereira<sup>\*1</sup>, L. K. Zeringue<sup>1</sup>, C. Leonardi<sup>2</sup>, M. E. McCormick<sup>1</sup>, and V. R. Moreira<sup>1</sup>, <sup>1</sup>Louisiana State University Agricultural Center, Baton Rouge, <sup>2</sup>Louisiana State University - Health Sciences Center, New Orleans.

Excess protein in dairy cattle diets unnecessarily increases the cost of production and may contribute to environmental pollution. The objective of this experiment was to determine the effect of feeding dairy cows with 2 levels of dietary protein on milk production and manure

characteristics. The experiment was carried out with 24 lactating dairy cows ( $334 \pm 43$  DIM and  $22.2 \pm 3.79$  kg milk yield). Cows were randomized to 4 pens in a free-stall barn equipped with Calan gates for individual TMR feeding. Control TMR (HP) was estimated to contain 16.5% CP with soybean meal as the main protein supplement. Treatment TMR (LP; 13.5% CP) was prepared using dry distillers grains plus solubles (DDGS) and rumen protected Lys (AminoShure-L, Balchem) and Met (Metaspart, Adisseo) to offset AA deficiencies in the diet. Rations contained nearly 55% forage as corn silage and Bermudagrass hay. Manure (feces and urine) samples were collected for the last 3 d of each sampling period, twice daily while cows were milked. The experiment was analyzed as a crossover design using the MIXED procedure of SAS with pen as the experimental unit. No significant difference was observed between treatments in DMI (21.0 kg/cow/d for HP and 20.4 kg/cow/d for LP;  $P = 0.46$ ), milk yield (20.7 kg/cow/d for HP and 20.5 kg/cow/d for LP;  $P = 0.91$ ), body weight gain (38.2 kg/cow/period for HP and 37.2 kg/cow/period for LP;  $P = 0.91$ ) and body condition score (0.14 units/period for HP and 0.10 units/period for LP;  $P = 0.91$ ). Water intake tended to be higher (5 L/cow/d;  $P = 0.09$ ) for HP. Percentages of milk components were 4.18 vs. 4.25 (HP vs. LP), 3.73 vs. 3.71, 4.53 vs. 4.55, and 9.18 vs. 9.12, respectively for fat, protein, lactose, and solids non-fat ( $P > 0.60$ ). Milk urea nitrogen decreased ( $P < 0.001$ ) from 17.2 mg/dL with HP to 9.93 mg/dL with LP. Manure pH was significantly higher for HP than LP (7.87 for HP and 7.53 for LP,  $P < 0.05$ ). Both, MUN and manure pH, are indicative of less nitrogen loss to the environment when cows were fed LP. This experiment suggests that performance of late-lactation dairy cows can be maintained with low-protein diets based on DDGS and supplemented with Lys and Met.

**Key words:** dairy cows, protein, amino acids

**W339 Comparison of in vivo and in vitro NDF digestibility data in dairy cows.** S. Colombini\*, G. Galassi, L. Rapetti, and G. M. Crovetto, *University of Milan, Department of Animal Science, Milano, Italy.*

Aim of the study was to determine, in dairy cows, the relationship between total tract in vivo NDF digestibility (NDFD) and the NDFD predicted by CNCPS model, using the  $k_d$  determined in vitro. Six lactating Italian Friesian cows were fed in a Latin square design 3 diets with a different silage basis: corn (CS), sorghum grain (SG) and sorghum forage (SF). Diets were formulated with the CNCPS model and balanced to have a content (% DM) of 11.0, 36.0 and 26.0 of metabolizable protein, NDF and starch, respectively. Due to the different fiber contents, forages were included in the diets in different proportions (41.5, 36.7 and 28.0% on DM for CS, SG and SF diet, respectively). Cows were housed in individual metabolic chambers to allow total collection of feces. TMRs were analyzed for NDF in vitro digestibility (Ankom Daisy Incubator) to predict the  $k_d$  according to Van Amburgh et al. (2003). Rumen NDF digestibility was predicted with the model of Waldo et al. (1972) with the  $k_p$  calculated according to Seo et al. (2006). According to CNCPS, intestinal NDF digestibility was supposed to be 20% of the NDF which enters the duodenum. The content of NDF was 39.5, 45.2 and 62.5 for corn, sorghum grain and sorghum forage silages. DMI (kg/d) was lower for SF (18.2) than CS and SG (20.0 for both diets) ( $P = 0.07$ ). Milk yield (kg/d) was higher for CS (25.4), intermediate for SG (24.6) and lower for SF (23.6) ( $P = 0.05$ ). In vivo NDFD was higher for SF than SG and SF (table). The predicted NDFD was slightly higher than the in vivo values but with the same rank. The relationship between in vivo and predicted NDFD was:  $y = 0.543x + 23.5$  ( $r^2 = 0.45$ ;  $n = 18$ ).

**Table 1.** In vivo and in vitro NDF digestibility of TMRs

Diet	CS	SG	SF	SE	P
NDFD 6h <sup>1</sup> , %	19.8	15.3	19.2	1.61	0.16
NDFD 24h <sup>2</sup> , %	43.0	37.8	44.7	2.25	0.14
$k_d^3$ , /h	0.035	0.032	0.042	0.004	0.21
NDFD vivo, %	51.4	48.6	54.1	0.94	0.01
NDFD predicted, %	53.4 <sup>b</sup>	51.8 <sup>b</sup>	57.4 <sup>a</sup>	1.78	0.15

<sup>1</sup>Rumen NDF digestibility after 6 h of incubation.

<sup>2</sup>Rumen NDF digestibility after 24 h of incubation.

<sup>3</sup>Rate of degradation determined from the in vitro NDFD values.

<sup>a,b</sup>LS means with different superscript are different ( $P = 0.05$ ).

**Key words:** NDF digestibility, CNCPS, sorghum silage

**W340 Effect of two different non-forage fiber sources on performance and feeding behavior of Holstein calves.** L. I. Castells\*<sup>1</sup>, A. Bach<sup>1,2</sup>, G. A. Pirisino<sup>1</sup>, and M. Terré<sup>1</sup>, <sup>1</sup>*Department of Ruminant Production, IRTA, Caldes de Montbui, Spain,* <sup>2</sup>*ICREA, Barcelona, Spain.*

The objective of this study was to evaluate the effect of 2 different non-forage fiber sources on performance and feeding behavior of Holstein calves. Fifty-nine male Holstein calves (initial BW =  $44.5 \pm 5.47$  kg) were randomly assigned to 1 of 3 different dietary treatments that consisted on a starter (21% CP, 15% NDF) without any other supplementation (CTR) or with an additional bucket with soybean hulls (SBH) or dehydrated citrus pulp (DCP). All calves were offered 2 L of milk replacer (MR) at 12.5% DM twice daily via a bottle until 50 d of age, and then only one daily dose of 2 L of MR at 12.5% DM during the week before weaning (57 d of age). Intakes of starter, MR, and fiber sources were recorded daily and BW was recorded weekly. Calves were individually housed and bedded with wood shavings. Performance data were analyzed with an ANOVA with repeated measures, and behavior data were analyzed with a Poisson regression analysis. There were no differences in ADG and gain-to-feed ratio among treatments. Animals in the CTR treatment consumed ( $830 \pm 44$  g/d) more ( $P < 0.01$ ) starter than those receiving SBH ( $610 \pm 44$  g/d) or DCP ( $450 \pm 44$  g/d). Calves tended ( $P = 0.08$ ) to consume more citrus pulp than soybean hulls (59 vs 25 g/d, respectively). Total DMI tended ( $P = 0.08$ ) to be greater in CTR and SBH than in DCP animals after weaning. Calves in DCP treatment were devoted 17% less ( $P < 0.01$ ) time to eat starter than CTR calves, and 5% less ( $P < 0.05$ ) time to eat non-forage fiber than those in SBH. Animals in the SBH treatment were 13.7 times more ( $P < 0.05$ ) likely to ruminate than those in CTR, and DCP calves were 11% less ( $P < 0.05$ ) likely to develop non-nutritive oral behaviors than CTR calves. In conclusion, providing a choice of a non-forage fiber source in the diet of young calves stimulates rumination and reduces non-nutritive oral behavior, but it reduces starter intake and tends to reduce DMI.

**Key words:** calves, non-forage fiber, performance

**W341 Morphology of the rumen of dairy cows fed high or low grain content diets before parturition.** T. S. Teófilo, J. C. Resende Júnior\*, S. F. Costa, M. B. Moreira, R. F. Lima, D. O. R. B. Santoro, G. P. Lenzi, P. P. Bueno, T. M. França, and T. A. Dell Vale, *Universidade Federal de Lavras.*

Dairy cows after parturition are fed diets rich in rapidly fermentable carbohydrates in reticulorumen leading to production of VFA at high speed which can to induce ruminal acidosis (RA). A high-energy diet

before parturition is able to induce the proliferation of ruminal epithelium, but some experiments have found conflicting results raising questions about the effectiveness of transition diet. The aim of this study was to examine whether transition diet given in the last weeks of gestation could contribute effectively to the control of RA in the postpartum of dairy cows. Six Holstein cows with cannula in the dorsal sac of the rumen, were allocated to 2 treatments in 3 blocks of 2 cows, defined by the date of the expected parturition. Six weeks before the expected calving, cows were fed a standard 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 rumen were collected by biopsy on days -42, -28, -14, -7, 2, 14, 28, 42 and 56 in relation to parturition. Cows that were fed HGC diet had higher ( $P < 0.01$ ) dry matter intake and higher ( $P < 0.01$ ) milk production. The HGC diet induced greater ( $P < 0.01$ ) extension of the rumen absorptive surface than LGC diet. This supports the hypothesis that transition diet improves the ruminal ability to absorb VFA. The extent of the absorptive surface before parturition was lower than after calving, probably reflecting the effect of the highly energetic lactation diet. The provision of HGC diet before parturition may be a good alternative for the RA control after calving of dairy cows. This practice induces further development of the absorptive surface of the rumen avoiding the accumulation of VFA in this compartment. The greater dry matter intake and the greater milk production associated to HGC diet appear to have been a reflection of better physiological conditions of the rumen of these animals.

**Key words:** acidosis, ruminant stomach, transition diet

**W343 Energy efficiency and performance of lactating dairy cows fed ethanol and acetic acid.** J. L. P. Daniel\*, L. G. Nussio, R. C. Amaral, A. Sá Neto, E. H. C. Garcia, A. W. Bispo, F. C. L. Oliveira, and I. F. Silva, *University of Sao Paulo, College of Agriculture "Luiz de Queiroz", Piracicaba, SP, Brazil.*

Ethanol and acetic acid are common end products from silages. The objective of this study was to determine whether ethanol and acetic acid affect performance and energy efficiency of high producing dairy cows. Heat of combustion from ethanol (kcal/g) is higher than either acetic acid or glucose, thus ethanol fed animals could be more efficient. Thirty lactating Holstein cows were grouped in 10 blocks and fed either: Control (33% Bermuda hay + 67% concentrates); Ethanol (control diet + 5% ethanol); or Acetic acid (control diet + 5% acetic acid, DM basis) diets, during 7 weeks. Ethanol and acetic acid were diluted in water (1:2) and sprayed onto total mixed ration twice daily before feeding. The same amount of solution was replaced with water in the control diet. During the 1st week the cows received half-dose of these chemical compounds. Dry matter intake (DMI) and milk yield were recorded every day and milk composition was determined once weekly. Data were analyzed as repeated measures using the MIXED procedure of SAS. Cows fed ethanol yielded more milk (37.9 kg/d) than those fed control (35.8 kg/d) or the acetic acid (35.3 kg/d) diets ( $P = 0.04$ ), due to the higher DMI (23.7, 22.2, 21.6 kg/d, respectively). The significant diet\*week interaction for DMI ( $P = 0.02$ ), mainly during the 2nd and 3rd weeks (when the 5% acetic acid achieved the full dose) was related to the decrease in DMI of the acetic acid diet. Milk fat yield, milk urea-nitrogen and somatic cells counts were unaffected by diets, however protein and lactose yields were higher for ethanol diet, which agrees with the higher milk yield. Energy efficiency showed diet\*week interaction ( $P = 0.06$ ) and again, during 2nd and 3rd weeks the acetic acid diet increased NEI milk/DMI ratio due to the lower DMI and body weight loss. Otherwise, energy efficiency was

similar across diets (1.1 Mcal NEI milk/kg DMI). Animal performance suggested similar energetic value from ethanol containing diet as compared with the other diets. Volatilization losses of ethanol at feed bunk and rumen conversion to acetate might be reasonable explanations to the deviation on the predicted energetic value.

**Key words:** volatile organic compounds, alcohol, intake

**W344 Effect of an essential oil compound based product on ruminal disappearance of proteins, fiber and starch and fermentation parameters in dairy cow.** D. Éclache, P. Etienne, and V. Noirot\*, *Phodé Laboratories, Terssac, France.*

An in vivo study was carried out to evaluate the effect of Oleobiotec (Phodé Laboratories, France) containing carvacrol on ruminal disappearance of crude proteins-CP (soybean meal), starch (corn meal), fiber (alfalfa hay) and rumen fermentation parameters. Four non lactating dairy cows with ruminal cannulas were assigned to a  $2 \times 2$  factorial arrangement in a  $4 \times 4$  Latin square design. The product was given orally (0 or 1g/cow/day) and tested on 2 types of diet: one concentrated in fiber (F diet: 42% NDF, 20% starch) and the other in starch (S diet: 42% starch, 27% NDF). The ruminal disappearance of starch, CP and fiber was measured by the nylon bag method, after 4, 8 and 24 h, respectively. Each experimental period lasted 35 d with 15 d for adaptation, 12 d for the treatment and measures and 8 d without additive. A mixed linear model was used for statistical treatment (SPSS). Oleobiotec increased ADF disappearance with the S diet (+6.1 pts,  $P < 0.05$ ) and decreased CP disappearance when associated with F diet (-6.0 pts,  $P < 0.05$ ). There was no significant effect on starch disappearance and total volatile fatty acids concentration on either diet. The proportion of acetate increased with the S diet ( $P < 0.05$ ) and that of propionate tended to increase with the F diet and to decrease with the S diet ( $P < 0.10$ ). N-NH<sub>3</sub> concentration decreased with the S diet ( $P < 0.05$ ). Oleobiotec seems to improve fiber utilization with high starch diet and lower CP rumen utilization with high fiber diet.

**Table 1.**

	F		S		SEM
	Control	Oleobiotec	Control	Oleobiotec	
Disappearance, %					
ADF	28.2 <sup>c</sup>	28.0 <sup>c</sup>	19.3 <sup>a</sup>	25.4 <sup>b</sup>	1.6
CP	40.1 <sup>c</sup>	34.1 <sup>a</sup>	36.1 <sup>b</sup>	37.3 <sup>b</sup>	2.2
Starch	50.7	50.5	51.1	51.2	2.3
Fermentation parameters					
Total VFA, mmol	80.2 <sup>a</sup>	82.2 <sup>a</sup>	97.5 <sup>b</sup>	100.8 <sup>b</sup>	2.4
Acetate, %	70.2 <sup>c</sup>	70.2 <sup>c</sup>	63.9 <sup>a</sup>	65.7 <sup>b</sup>	0.5
Propionate, %	15.9 <sup>x</sup>	16.5 <sup>y</sup>	17.8 <sup>z</sup>	16.9 <sup>y</sup>	0.3
N-NH <sub>3</sub> , mg/L	166.1 <sup>a</sup>	160.1 <sup>a</sup>	272.7 <sup>c</sup>	223.0 <sup>b</sup>	16.7

<sup>a-c</sup>Within a row means without a common superscript letter differ,  $P < 0.05$ ; <sup>x-z</sup> $P < 0.10$ .

**Key words:** essential oil, dairy cow, rumen

**W345 Milk fatty acid profile from dairy cows fed tropical forage-based TMR containing increasing levels of sunflower oil.** M. A. S. Gama\*<sup>1</sup>, C. G. S. Ribeiro<sup>4</sup>, F. C. F. Lopes<sup>1</sup>, M. M. Almeida<sup>2</sup>, E. F. Motta<sup>1</sup>, M. T. Ribeiro<sup>1</sup>, and J. M. Griinari<sup>3</sup>, <sup>1</sup>Brazilian Agricultural Research Corporation, Juiz de Fora, Minas Gerais, Brazil, <sup>2</sup>The Uni-

versity of Juiz de Fora, Juiz de Fora, Minas Gerais, Brazil, <sup>3</sup>Swedish University of Agricultural Sciences, Uppsala, Sweden, <sup>4</sup>The University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

Due to health concerns associated with milk fat intakes, efforts have been made to decrease medium chain saturated fatty acids (C12 to C16) and increase oleic acid (cis-9 C18:1) as well as CLA (cis-9 trans-11 C18:2) in milk fat. Supplementation of the dairy cow diet with plant oils is a practical way to achieve this goal. Most studies published, thus far, have used temperate grasses or corn silage as forage. In this study, we evaluated the effects of increasing levels of sunflower oil (SO) on milk fatty acid profile in cows fed fresh Elephant grass (*Pennisetum purpureum*) - a tropical forage. Twelve primiparous Holstein cows (95 ± 25 DIM) were assigned to the following dietary treatments (level of SO inclusion, % of diet DM): Control (CTL): 0%; T1: 1.5%, T2: 3.0% and T3: 4.5%. The experimental design was a 4 × 4 Latin Square with 15 d treatment periods (last 5 d for data collection). Diet was fed as a TMR and it was composed of chopped Elephant grass and a concentrate mixture (65:35, DM basis) containing the SO. Milk yield, milk composition and DM intake were unaffected by the treatments. SO supplementation reduced the relative proportion of C12:0 to C16:0 fatty acids from 42.2% to 38.8, 27.8 and 26.8% for CTL, T1, T2 and T3, respectively ( $P < 0.05$ ). C18:0 increased from 9.9% to 14.3, 15.7 and 16.7% ( $P = 0.006$ ), cis-9 C18:1 increased from 21.7% to 24.8, 26.7 and 27.3% ( $P = 0.0315$ ) and cis-9 trans-11 CLA increased from 0.88% to 1.26, 1.62 and 2.14% ( $P < 0.0001$ ) for CTL, T1, T2 and T3, respectively. Interestingly, there was a linear decrease ( $P < 0.05$ ) in desaturase indexes (14:1/14:0, 16:1/16:0, 18:1/18:0 and CLA/trans-11 C18:1) as the level of dietary SO increased. Concentration of C18:0 in milk fat was inversely associated with C18:1/C18:0 and CLA/trans-11 C18:1 ( $r = -0.85$ ,  $P < 0.0001$ ), and with C14:1/C14:0 ( $r = -0.69$ ,  $P < 0.0001$ ). These results suggest that extensive biohydrogenation of dietary PUFA has occurred in the rumen, leading to high levels of C18:0 in milk fat. High level of C18:0 in the preformed fatty acid supply to the mammary gland may have contributed to the observed reduction in desaturase indexes.

**Key words:** desaturase, milk fat, cows

**W346 Effects of grinding or steam rolling of starter grains on nutrient digestibility of Holstein suckling calves.** N. Jalali-Farahani, M. Dehghan-Banadaky\*, K. Rezayazdi, and M. Ganjkanlou, *Animal Science Department, Campus of Agriculture and Natural Resources, University of Tehran, Karaj, Tehran, Iran.*

This study conducted to evaluate the effects of grains processing (grinding versus steam rolling) in calf starter diet on nutrient digestibility of Holstein suckling calves. In present experiment, 60 Holstein calves (28 male and 32 female) with average 44 ± 5 kg birth weight were used from 3 until 120 d old. Calves randomly divided to 4 treatments included: 1) ground barley and corn, 2) steam rolled barley and ground corn, 3) ground barley and steam rolled corn, 4) steam rolled barley and corn. Calves were housed in individual hutch and had free access to water and starter diet. Calves weaned at 90 d old. In this experiment a complete blocks randomized design used with 4 treatment (diets) and 15 replicates (calves) and 2 blocks (sex). Feed and fecal were sampled at 90 and 120 d. Acid insoluble ash used as internal markers for nutrients digestibility study. Manure screening was done every other week for evaluation of grain digestion. In diet 1, undigested grain in fecal was significantly different from others treatments ( $P < 0.05$ ). Apparent digestibility of dry matter, crude protein, neutral detergent fiber, organic matter, and ether extract between diets had not

significant discrepancy. But apparent digestibility of non fibrous carbohydrates (NFC) was significantly different between treatments ( $P < 0.05$ ). The results indicated that the treatment with grinding corn and grinding barley did the best performance for starter diet in Holstein calves.

**Key words:** calf starter, grinding, steam rolling

**W347 Investigation of grinding or steam rolling of starter grains on growth performance of Holstein suckling calves.** N. Jalali-Farahani, M. Dehghan-Banadaky\*, K. Rezayazdi, and M. Ganjkanlou, *Animal Science Department, Campus of Agriculture and Natural Resources, University of Tehran, Karaj, Tehran, Iran.*

This study conducted to evaluate the effects of grains processing (grinding versus steam rolling) in starter diet on growth performance of Holstein suckling calves. In present experiment, 60 Holstein calves (28 male and 32 female) with average 44 ± 5 kg birth weight were used from 3 until 120 d old. Calves randomly divided to 4 treatments include: 1) ground barley and corn, 2) steam rolled barley and ground corn, 3) ground barley and steam rolled corn, 4) steam rolled barley and corn. Calves were housed in individual hutch and had free access to water and starter diet. Calves weaned at 90 d old. In this experiment a block completely randomized design used with 4 treatment (diets) and 15 replicates (calves) and 2 blocks (sex). Measurements of shoulder height, hip width and hip height were recorded every 15 d. In diet 1, hip height and shoulder height were significantly more than other treatments ( $P < 0.05$ ). Width hip between diets did not show any significant difference but hip width was a significant difference between sexes, female calves had wide hip. Results indicate that the type of grain processing incorporated into calf starter can influence structural growth in suckling calves.

**Table 1.** Least squares means for structural growth measurements of Holstein calves fed for diet 1-4

	Diets				SEM	Sex		P-value	
	1	2	3	4		male	female	sex	treatment
Shoulder Height (cm)	89.9	86.1	88.3	87.8	1.16	88.5	87.6	NS	NS
Hip Height (cm)	92.8 <sup>a</sup>	90.6 <sup>ab</sup>	91.1 <sup>ab</sup>	89.3 <sup>b</sup>	1.01	90.4	90.0	NS	0.03
Hip Width (cm)	13.4	13.2	14.8	13.6	0.56	13.0 <sup>b</sup>	14.5 <sup>a</sup>	0.01	NS

Diets 1-4 included: 1) ground barley and corn, 2) steam rolled barley and ground corn, 3) ground barley and steam rolled corn, 4) steam rolled barley and corn.

**Key words:** grinding, steam rolling, calf starter

**W348 Investigation of chewing activity in cows fed diet with different ratios of alfalfa hay and corn silage.** A. Akbaj, A. Zali, M. Ganjkanlou, and M. Dehghan-Banadaky\*, *Animal Science Department, Campus of Agriculture and Natural Resources, University of Tehran, Karaj, Tehran, Iran.*

In present study, chewing activity in cows fed total mixed ration based on alfalfa hay and corn silage evaluated. Fifteen Holstein cows (37 ± 10 DIM) were used in a completely randomized design with 3 treatments and 5 replicates during 9 weeks. Treatments included 3 levels of

hay and corn silage included: 1) 10% alfalfa–30% silage corn (CS), 2) 20% alfalfa–20% silage corn (CSAH) and 3) 30% alfalfa–10% silage corn (AH). The ratio of forage: concentrate was 40:60 in all treatments. Cows were fed the total mixed rations (TMR) twice daily. Individual dry matter intake and ort were measured daily. Chewing activity was recorded visual every 5 min during 24 h in 2 periods at 4 and 8 weeks. Eating and ruminating activities were monitored by 2 alternating individuals once every 5 min under the assumption that each activity would persist for the entire 5 min. Total time spent chewing was calculated as the time spent eating plus the time spent ruminating. Dry matter intake was higher when cows were fed CSAH (23.20 kg per day) compared with CS (22.95 kg per day) and AH (18.64 kg per day). Eating time (min/day) and (min/ kg DM, NDF intake) increased in CSAH group. Ruminating time (min/day) and (min/ kg DM, NDF intake) were not affected by treatment. Also, the total chewing time (min/day) decreased with increase alfalfa ratio. Resting time in AH group was more than CS and CSAH. Total pledges during the day and during each meal, ruminate and chewing activity did not significant difference between treatments.

**Key words:** alfalfa hay, corn silage, Holstein cows

**W349 A non activated charcoal reduced diarrhea of calves subject to *Escherichia coli* compared to a conventional treatment after 9 days of treatment.** C. Ionescu\*<sup>1</sup>, P. Ferretti<sup>2</sup>, and D. M. Bravo<sup>1</sup>, <sup>1</sup>*Pancosma, Geneva, Switzerland*, <sup>2</sup>*NanoAgro, Buenos Aires, Argentina*.

Calves post-weaning diarrhea is common in several areas. One of the diarrhea causes is the prevalence of *E. coli*. To treat diarrhea, veterinarian use conventional treatments including antibiotics (ANTIB). The objective of this trial was to check if a non activated charcoal (NAC: CARBOVET) could be used as an alternative, in case of *E. coli* diarrhea in calves. Twelve calves (34.9 ± 3.5 kg) were selected based on diarrhea diagnostic. *E. coli* presence was confirmed by microbiology counts in their feces. Calves were introduced in 2 groups for 20 d as following: NAC calves were given orally 20 g NAC per head per d for 6 d and 10 g NAC per head per d for the remaining 14 d; ANTIB calves were given: orally 30 mL Estreptocarboftiazol (ftalisulfatiazol, dihydrostreptomycin sulfate, coffee charcoal extract and dimethylpolyxyloxan) and 40 mL Brebaje (streptomycin sulfate, sodium sulfadimethylpyrimidine and gallotanic acid) for 3 d and injected 5 mL of Diafin (benzetimide hydrochloride and enrofloxacin), 6 mL of Terramycin (oxytetracyclin). Fecal score (FS) and average daily feed intake (ADFI) were measured daily; BW was measured on d 1/2, 5 and 20. Fecal scores were noted on a 5 points scale: 1 being normal to 5 being watery. Two calves died during the trial due to virosis. Data were analyzed using GLM procedure. ADFI was higher in NAC than in ANTIB during the first 4 d (25 vs. 0 g/d,  $P \leq 0.05$ , respectively). From d 5 to 20, no more differences in ADFI were observed. No differences in BWG were measured between groups. The FS for d 1 to 8 period was numerically higher in NAC than in ANTIB calves (3.47 vs. 2.77,  $P = 0.20$ ) indicating a higher diarrhea intensity in NAC. For d 9 to 20 period, FS was lower in NAC group compared with ANTIB (1.04 vs. 1.63,  $P \leq 0.05$ , respectively). The percentage of calves relapsed in diarrhea (with FS values over 4) after 6 d where higher in ANTIB than in NAC (83.3% vs. 33.3%,  $P = 0.09$ , respectively). These results indicate that NAC could be beneficial for calves experiencing diarrhea caused by *E. coli*.

**Key words:** *E. coli*, charcoal, calves

**W350 A new method for individually feeding a supplement to dairy cows in a free stall.** E. M. Ramsing\*<sup>1</sup>, C. M. Shriver-Munsch<sup>1</sup>, J. R. Males<sup>1</sup>, W. K. Sanchez<sup>2</sup>, I. Yoon<sup>2</sup>, and G. Bobe<sup>1</sup>, <sup>1</sup>*Department of Animal Science, Oregon State University, Corvallis*, <sup>2</sup>*Diamond V Mills, Cedar Rapids, IA*.

Previously, nutrition research on commercial farms was limited to treatments applied across entire pens or utilization of forced-intake techniques such as bolusing. Our hypothesis was to develop a reproducible, non-invasive procedure for individually feeding supplements to dairy cows on commercial dairy farms. Multiparous Holstein cows, housed in free-stall barns, received *Saccharomyces cerevisiae* fermentation product (Diamond V Original XP) as a top dressing during the morning feeding lock-up period. The supplement consisted of 0, 56, or 112 g of Original XP mixed with 84 g of molasses and 168, 112, or 56 g of corn meal, respectively. After creating an indentation (25 to 30 cm deep and 10 cm diameter) in front of each cow in the newly delivered TMR, the supplement was placed in the indentation so adjacent cows could not consume it. Intake of the supplement and other feed was monitored and given a score on a 5-point scale (0 = no supplement consumption, 1 to 4 = partial consumption, 5 = complete consumption). To prevent supplement consumption by other cows, leftovers of the supplements were removed after 15 min from the feed bunk. Cows accepted the new feeding method within 3 d. The greatest differences in feed consumption between cows were observed at calving (no supplement consumption: 25 cows; partial consumption: 5 cows; complete consumption: 66 cows). Using PROC GLM, complete supplement consumption on the day of calving was associated with lower serum  $\beta$ -hydroxybutyrate concentrations the following day ( $P = 0.02$ ). The impact of the differing supplements on intake behavior is reported in companion abstracts presented at this meeting. In conclusion, the newly developed method is non-invasive to cows, requires minimal investment and no modification to existing facilities, and enables 3 technicians to feed and monitor up to 50 cows during a 30-min lockup period.

**Key words:** dairy, individual feeding, supplement

**W351 Effect of quantity and frequency of colostrum feeding on passive transfer, health, and performance of pre-weaned and post-weaned dairy calves.** B. Ozer\*<sup>1</sup>, M. Chahine<sup>1</sup>, C. M. Matuk<sup>1</sup>, and M. E. de Haro Marti<sup>2</sup>, <sup>1</sup>*University of Idaho, Twin Falls*, <sup>2</sup>*University of Idaho, Gooding*.

The objective of this study was to determine the effect of quantity and frequency of colostrum feeding on serum IgG concentration, health parameters, and growth in Holstein calves. Two hundred 16 Holstein female calves raised on a commercial facility in southern Idaho were randomly assigned to one of 2 treatments which consisted of maternal colostrum (MC, n = 107) or maternal colostrum+milk (MCM, n = 106). The first feeding of colostrum (3.2 L) was administered to MC and MCM calves using an esophageal tube within 1 h of birth. A second feeding of colostrum (2 L) was administered 12 h following the first feeding to MC calves while MCM calves received 2 L of milk. Blood samples were collected at 24 ± 3 h of age and tested for total serum protein (TSP) and serum IgG concentration. Rectal body temperature was measured twice a week during the first 3 weeks of age. Health evaluations were conducted daily until calves were 3 mo of age. Fecal (FC), dehydration (DH) and respiratory (RS) scores were recorded during the first 4 weeks of age. Average daily gain was measured at 28 ± 1 d of age and at weaning (52 ± 3 d). Data were analyzed using a mixed model in SAS. TSP and IgG concentrations were significantly

greater ( $P < 0.0001$ ) in calves fed MC (TSP =  $5.74 \pm 0.05$  g/dL; IgG =  $21.06 \pm 0.53$  g/L) compared with calves fed MCM (TSP =  $5.17 \pm 0.05$  g/dL; IgG =  $17.40 \pm 0.53$  g/L). Rectal body temperature did not differ between MC and MCM and averaged  $38.8^\circ\text{C} \pm 0.01$ . No differences were detected in pneumonia or diarrhea incidence which averaged 70.4% and 10.3% respectively. MCM calves had a greater ( $P < 0.05$ ) incidence of abnormal FC (75.0%) and DH (30.0%) compared with MC calves (30.3% and 12.1% respectively). MC calves had a greater ( $P < 0.0001$ ) incidence of abnormal RS (69.7%) compared with MCM (20.0%). Average daily gain did not differ between MC and MCM and averaged  $0.60 \pm 0.01$  kg. Results suggest that feeding Holstein calves 2 separate feedings of colostrum will improve passive transfer and might lead to some health benefits. The effect of colostrum feeding quantity and frequency on RS needs to be investigated further.

**Key words:** colostrum, immunoglobulin, calves

**W352 Odd- and branched-chain fatty acid (OBCFA) composition of plasma in response to N underfeeding and energy source in dairy cows and their distribution among plasma lipid classes.** R. Gervais<sup>\*1</sup>, B. Vlaeminck<sup>2</sup>, A. Fanchone<sup>3</sup>, P. Nozière<sup>4</sup>, M. Doreau<sup>4</sup>, and V. Fievez<sup>2</sup>, <sup>1</sup>Département des sciences animales, Université Laval, Québec, Québec, Canada, <sup>2</sup>Lanupro, Ghent University, Melle, Belgium, <sup>3</sup>Unité de Recherches Zootechniques, INRA, Petit Bourg, Guadeloupe, France, <sup>4</sup>Unité de Recherche sur les Herbivores, INRA, Theix, St-Genès-Champagnelle, France.

The objective of the current study was to evaluate the consequences of a strong decrease in dietary N supply in dairy cows and its interaction with the nature of energy on the OBCFA composition of plasma total lipids and to assess the distribution of these fatty acids (FA) among plasma lipid classes. Four Holstein cows ( $662 \pm 62$  kg;  $71 \pm 10$  d in lactation), fitted with rumen, proximal duodenum, and terminal ileal cannulas, were used in a  $4 \times 4$  Latin square design, with 28-d periods. Treatments were 2 N levels (low and high) combined with 2 energy sources rich in starch (barley, corn, and wheat) or fiber (soybean hulls and dehydrated beet pulp). The high level of N met 110% of N requirements expressed in the French protein digestible in the intestine (PDI) system from INRA, with an adequate supply in rumen degradable N, whereas the low level covered 80% of N requirements with a shortage in rumen degradable N. The 4 diets had a forage:concentrate ratio of 60:40 (DM basis) and were isoenergetic. A decrease in dietary N supplementation had no effect on total plasma concentration of iso, anteiso, and linear odd-chain FA. The total plasma concentration of iso FA was decreased when cows received starch compared with fiber-rich diets ( $1.07$  vs.  $1.25$  g/100g FA;  $P < 0.05$ ), whereas energy source had no effect on plasma concentrations of anteiso and linear odd-chain FA. No interaction between level of N supply and energy source on OBCFA plasma composition was observed. Regardless of treatments, proportions of iso and anteiso FA were higher ( $P < 0.01$ ) in cholesterol esters (28.4 and 33.1 g/100g OBCFA, respectively) and triacylglycerols (28.0 and 31.7) compared with phospholipids (23.5 and 27.4) and free fatty acids (23.0 and 26.9). Phospholipids (49.2 g/100 g OBCFA) and free fatty acids (50.1) presented higher ( $P < 0.01$ ) concentrations of linear-odd chain FA compared with cholesterol esters (38.5) and triacylglycerols (40.4). Results from the current study suggest the selective incorporation of OBCFA in different plasma lipid classes.

**Key words:** lipid class, OBCFA, plasma fatty acids

**W353 Effect of dietary escape microbial protein (DEMP) and degradable protein level on fermentation, digestion, and N flow in rumen-simulating fermenters.** G. A. Harrison<sup>\*</sup>, M. D. Meyer, and K. A. Dawson, *Alltech Biotechnology, Nicholasville, KY.*

Dietary escape microbial protein (DEMP) is a yeast-derived protein source with a moderate ruminal degradation rate allowing supplementation of high quality protein similar to ruminally synthesized microbial protein. Effects of DEMP in diets differing in calculated ruminally degradable protein (RDP) were examined in single-flow rumen-simulating fermenter cultures. Twelve cultures were used in a  $2 \times 2$  factorial design with 4 treatments and 3 replications per treatment. Cultures were fed 25 g twice daily for 6 d. Factors were DEMP at 0 or 2.64% (600 g/d equivalent at 22.7 kg DM intake) and RDP at 9.9 and 11.4% in diets balanced at 16.5% CP (DM basis). Fermentation samples were collected from cultures before morning feeding during the last 3 d of experiment. Composite effluent samples from each fermenter were used for DM and NDF disappearance and volatile fatty acid analyses. Nitrogen flow measures were estimated by using purine to N ratios for effluent and bacteria. Data were analyzed for treatment effects using GLM procedure of SAS with factor effects determined by orthogonal contrasts. Culture fed higher RDP diets had higher molar proportions of acetate and isoacids (isobutyrate + isovalerate + valerate) and lower molar proportion of propionate ( $P < 0.05$ ). Ammonia concentration was higher in cultures fed more RDP ( $P < 0.01$ ). Bacterial N yield was 10.3% greater in cultures fed higher RDP and efficiency of bacterial N production based on DM truly digested or fermentable carbohydrate greater ( $P < 0.05$ ). Efficiency of bacterial N production based on DM truly digested tended to be higher in DEMP-fed cultures ( $P < 0.10$ ). Bacterial N yield was numerically greater (+6.6%) in cultures fed DEMP ( $P = 0.13$ ). Cultures fed DEMP and higher RDP degraded more protein and had a greater proportion of effluent N from bacteria but not when DEMP was fed with lower RDP (interaction;  $P < 0.05$ ). DEMP fed at the equivalent of 600 g/d had no impact on fermentation. Interactions suggest that DEMP may have a more positive effect when fed in higher RDP diets.

**Key words:** dietary escape microbial protein, degradable protein, ruminal metabolism

**W354 Effect of level of dietary escape microbial protein (DEMP) on fermentation, digestion, and N flow in rumen-simulating fermenters.** G. A. Harrison<sup>\*</sup>, M. D. Meyer, and K. A. Dawson, *Alltech Biotechnology, Nicholasville, KY.*

Dietary escape microbial protein (DEMP) is a yeast-derived protein source with a moderate ruminal degradation rate allowing supplementation of high quality protein similar to ruminally synthesized microbial protein. DEMP has a recommended feeding rate of 600 g/d for lactating dairy cows but effects of DEMP fed at higher levels on ruminal metabolism have not been evaluated. Diets were formulated at 16% CP with inclusion rates of DEMP at 0, 1.76, 2.64, 3.96, 5.95, and 8.92% DM or 0, 400, 600, 900, 1350, and 2025 g equivalent for 22.7 kg DM intake. DEMP primarily replaced soybean meal. Twelve single-flow rumen-simulating fermenter cultures were used in a completely randomized design with 6 dietary treatments, 2 replications per treatment, and 2 experimental runs. Cultures were fed 25 g twice daily for 6 d. Fermentation samples were collected from cultures before morning feeding during the last 3 d of experiment. Composite effluent samples from each fermenter were used for DM and NDF disappearance and volatile fatty acid (VFA) analyses. Nitrogen flow measures were estimated by using purine to N ratios for effluent and bacteria. Data were

analyzed for effects of treatment using GLM procedure of SAS. Culture diet did not affect fermentation pattern or extent of digestion ( $P > 0.10$ ). Bacterial purine content was altered by diet. Bacteria isolated from cultures fed the 0 g DEMP diet had a higher purine concentration than those from all other treatments except the 400 g DEMP treatment. Bacteria from cultures fed the 900 g DEMP diet had a lower purine concentration than those from cultures fed 0, 400, and 2025 g DEMP diets ( $P < 0.05$ ). Bacterial N yield and efficiencies of bacterial N yield production were not significantly affected by culture diet ( $P > 0.10$ ). Numerical increases in bacterial N yield in cultures fed 600 to 2025 g DEMP compared with the 0 g DEMP diet (+6.1 to 8.2%) are in agreement with previous work with fermenter cultures. Inclusion of dietary escape microbial protein (DEMP) at equivalent feed rates of 400 to 2025 g/d did not affect ruminal fermentation.

**Key words:** dietary escape microbial protein, ruminal metabolism

**W355 Effects of abomasal infusion of fish oil, sterculia foetida oil and conjugated linoleic acids on milk yield and composition, and mammary mRNA expression of stearoyl CoA desaturase in dairy cows.** M.-P. Dallaire<sup>\*1,2</sup>, L. Ma<sup>3</sup>, B. A. Corl<sup>3</sup>, R. Gervais<sup>1</sup>, Y. Lebeuf<sup>1</sup>, F. J. Richard<sup>1</sup>, and P. Y. Chouinard<sup>1,2</sup>, <sup>1</sup>Département des sciences animales, Université Laval, Québec, QC, G1V 0A6 Canada, <sup>2</sup>Institute of Nutraceuticals and Functional Foods (INAF), Québec, QC, Canada, <sup>3</sup>Department of Dairy Science, Virginia Tech, Blacksburg.

Sterculic acid and t10c12 conjugated linoleic acid (CLA) are both inhibitors of stearoyl CoA desaturase (SCD). This enzyme is active in mammary gland of lactating cows where it plays a key role in the regulation of milk fat composition. The purpose of this study was to determine the effects of sterculic acid, CLA and fish oil (FO) on milk yield and composition and on the mammary expression of 2 isoforms of SCD (1 and 5). Eight multiparous Holstein cows (mean BW 635 ± 34 kg; mean DIM 69 ± 13 d) were used in a double 4 × 4 Latin square design with 28-d periods. For the first 14 d, cows received abomasal infusion of CTL) 406 g of saturated fatty acids (Energy Booster (EB); control); SFO) 7 g of sterculia foetida oil + 399 g of EB; CLA) 36 g of CLA (42% t10c12 CLA) + 370 g of EB; and FO) 406 g of fish oil. Contrasts were used to compare individual effects of SFO, CLA, and FO with CTL. On d 14 of infusion, mammary gland biopsies were harvested and analyzed for RNA transcripts of SCD1 and SCD5. Compared with CTL, SFO decreased milk yield from 38.0 to 33.0 kg/d, and increased milk fat and protein content from 3.79 to 4.45% and 3.30 to 3.63%, respectively ( $P < 0.01$ ). Milk fat content was also decreased ( $P < 0.01$ ) by CLA (2.23%) and FO (3.34%). Milk fat yield was not affected by SFO (1475 g/d) when compared with CTL (1431 g/d), but was decreased ( $P < 0.01$ ) by CLA (774 g/d) and FO (1186 g/d). Compared with CTL, expression of SCD1 was increased ( $P = 0.04$ ) by SFO (30%) and decreased ( $P = 0.02$ ) by CLA (24%), while FO had no effect. The mRNA abundance of SCD5 was not affected by treatments. Results from the current study support the concept that SCD1 and SCD5 present differences in their regulation by dietary FA.

**Key words:** conjugated linoleic acids, stearoyl-CoA desaturase, sterculic acid

**W356 Effect of corn silage inoculation with Sil-All and dietary protein on fermentation, digestion, and N flow in rumen-simulating fermenters.** G. A. Harrison\*, M. D. Meyer, M. S. Taylor, and K. A. Dawson, *Alltech Biotechnology, Nicholasville, KY.*

Effects of feeding corn silage treated with inoculant (Sil-All) on ruminal metabolism were evaluated in rumen-simulating fermenter cultures. Whole corn plants (CF 738; Caverndale Farms, Danville, KY) were harvested at 6 stages of maturity (90, 94, 98, 105, 108, and 111 d) and ensiled in 125 L black plastic bags. At each harvest date, 5 kg of wet forage was ensiled without treatment (control) and with Sil-All at 200,000 cfu/g (SA). After 35 d, silages were dried at 55°C and ground through a 4 mm screen. Twelve single-flow rumen-simulating fermenter cultures were used in a 2 X 2 factorial design with 4 treatments, 2 replications per treatment, and 6 experimental runs. For each run, diets were formulated at 15 or 18% CP (DM basis) with control or SA corn silage from a single maturity date. Diets consisted of 75–85% silage with soybean meal used to meet protein targets. Cultures were fed 20 g twice daily for 6 d. Fermentation samples were collected from cultures before morning feeding during the last 3 d. Composite effluent samples from each fermenter were used for DM and NDF disappearance and volatile fatty acid (VFA) analyses. Nitrogen flow measures were estimated by using purine to N ratios for effluent and bacteria. Data were analyzed for effects of treatment using GLM procedure of SAS with factor effects determined by orthogonal contrasts. Culture pH was higher when either higher CP diets or SA corn silage were fed (6.40 vs. 6.46,  $P < 0.05$ ). Higher protein diets resulted in higher molar proportions of isoacids (isobutyrate + isovalerate + valerate) and greater culture ammonia ( $P < 0.0001$ ). Digestion of OM and NDF were increased when cultures were fed more protein ( $P < 0.05$ ). Bacterial N yield tended to be greater with higher protein diets (+3.4%,  $P < 0.10$ ). Cultures fed SA silage produced 3.7% more bacterial N than cultures fed control silage ( $P < 0.05$ ). Both higher protein and SA silage increased efficiency of bacterial N yield based on DM truly digested ( $P < 0.05$ ). Diets based on Sil-All treated corn silage resulted in increased bacterial N production in fermenter cultures.

**Key words:** corn silage inoculation, ruminal metabolism

**W357 Enhancing antioxidant properties of milk using a programmed, nutritional approach.** G. A. Harrison\*, M. S. Taylor, M. D. Meyer, and K. A. Dawson, *Alltech Biotechnology, Nicholasville, KY.*

The potential to enhance antioxidant capacity in milk was examined in a series of field trials. This programmed approach involved feeding a low inclusion rate pack of bundled, proprietary Alltech technology formulated to meet trace mineral and vitamin needs of lactating dairy cows. Six field trials were conducted using herds in SW Kentucky. Herds were selected on the basis of ability to follow trial protocols including replacement of current trace mineral and vitamin supplementation with an Alltech-Inside Dairy Pack (ATI) for 2–3 weeks and collection of individual milk samples from 12 cows before and during and ATI supplementation period. Bulk tank milk samples were also taken on collection days and approximately 3.5 L of milk was used in the production of mozzarella cheese. Herd was used as the experimental unit and response to ATI supplementation was evaluated using the GLM procedure of SAS. Milk and cheese samples were analyzed for selenium via hydride generation fluorescence (Millennium Excalibur 10.055, PS Analytical). Total antioxidant capacity was estimated by ferric reducing antioxidant power and radical scavenging ability by the DPPH assay (2,2-diphenyl-1-picrylhydrazyl). Se content of individual milk samples was 33% greater when cows were fed ATI Dairy Pack (32 vs. 42 ppb;  $P < 0.05$ ). Total antioxidant capacity of individual milk samples was 9% greater when cows were fed ATI Dairy Pack (934 vs. 1021 μM Trolox equivalent;  $P < 0.05$ ). Radical scavenging ability in milk from individual cows was similar comparing the 2 col-

lection periods (96 vs. 107  $\mu\text{M}$  Trolox equivalent  $P > 0.10$ ). Bulk milk samples collected during the ATI period had higher Se content (33 vs. 39 ppb;  $P < 0.05$ ) and more radical scavenging ability (110 vs. 127  $\mu\text{M}$  Trolox equivalent  $P < 0.05$ ), but did not differ in total antioxidant capacity (1013 vs. 1099  $\mu\text{M}$  Trolox equivalent  $P > 0.10$ ). For mozzarella cheese, feeding the ATI pack resulted in higher Se content (178 vs. 294 ppb;  $P < 0.05$ ) but did not alter in total antioxidant capacity and radical scavenging ability ( $P > 0.10$ ). Antioxidant properties of milk can be enhanced through a programmed, nutritional approach.

**Key words:** milk, antioxidant capacity, selenium

**W358 Mineral metabolism in pregnant dairy goats.** C. J. Härter<sup>\*1</sup>, I. A. M. A. Teixeira<sup>1</sup>, L. D. Lima<sup>1</sup>, H. G. O. Silva<sup>1</sup>, A. R. Rivera<sup>1</sup>, D. S. Castagnino<sup>1</sup>, K. T. Resende<sup>1</sup>, and N. R. St-Pierre<sup>2</sup>, <sup>1</sup>Universidade Estadual Paulista, Jaboticabal, SP, Brasil, <sup>2</sup>Department of Animal Sciences, The Ohio State University, Columbus.

Although mineral requirements are important to animal nutrition especially during pregnancy there are few studies on mineral metabolism of pregnant goats. Therefore the aim of this study was to determine calcium (Ca) and phosphorus (P) metabolism during pregnancy of dairy goats. After pregnancy confirmation, 32 female goats were distributed into treatments according to a block design in a  $2 \times 2 \times 3$  factorial as follows: 2 breeds (Oberhasli and Saanen), 2 types of pregnancy (single and twin) and 3 levels of feed restriction (0, 20 and 40% feed restriction). Blood samples were collected at 1, 35, 50, 65, 80, 95, 110, 125 and 140 d of gestation and serum samples were taken after centrifugation at 4°C for 20 min. at 1370  $\times$  g. Serum concentration of Ca, P, magnesium (Mg) and alkaline phosphatase (AP) activity were determined in these samples. Statistical analysis was performed in PROC MIXED using compound symmetry covariance structure. It was observed a significant decrease ( $P < 0.05$ ) in serum concentration of Ca, P and AP activity after 80 d of pregnancy. Regardless the number of fetuses and the level of feed restriction Saanen goats presented higher levels of serum concentration of Ca and P and lower AP activity ( $P < 0.01$ ). The serum concentration of Ca, P and AP activity decreased, and Mg raised as feed restriction increased ( $P < 0.01$ ). Twin pregnant goats were found to have higher serum Ca ( $P < 0.05$ ) than goats pregnant with one fetus. On the other hand, serum P concentration and AP activity ( $P < 0.05$ ) were lower in twin pregnant goats. These results show that the mineral demand increases as pregnancy advances, especially in twin pregnancy, and the higher mineral demand is met by calcium mobilization through bone resorption. Under feed restriction the animals might have attempted to meet Ca demand also by increasing intestinal absorption which is related to high ATPase activity and consequently higher Mg serum concentration (ATPase co-factor). (Fapesp project number 2009/10125-0).

**Key words:** dairy breeds, days of gestation, feed restriction

**W359 Effect of various dosages of *Saccharomyces cerevisiae* fermentation product on milk production of multiparous dairy cows.** E. M. Ramsing<sup>\*1</sup>, C. M. Shriver-Munsch<sup>1</sup>, J. R. Males<sup>1</sup>, W. K. Sanchez<sup>2</sup>, I. Yoon<sup>2</sup>, and G. Bobe<sup>1</sup>, <sup>1</sup>Department of Animal Science, Oregon State University, Corvallis, <sup>2</sup>Diamond V, Cedar Rapids, IA.

Feeding 56 g/d of *Saccharomyces cerevisiae* fermentation product (Diamond V Original XP) to transition dairy cows increased milk production in most studies. Doubling feeding rates of Original XP was suggested during times of increased stress such as around parturition, which is an especially challenging time period for older cows. The

objective of the current study was to evaluate whether greater dosages of Original XP than 56 g/d are beneficial during the transition period. Multiparous Holstein cows housed in the same pen were given a supplement containing either 0 (control;  $n = 32$ ), 56 ( $n = 33$ ); or 112 g ( $n = 31$ ) of Original XP daily during morning lock-up as a top dressing to their TMR. The supplement consisted of 0, 56, or 112 g of Original XP mixed with 84 g of molasses and 168, 112, or 56 g of corn meal, respectively. Supplement feeding started 28 d before predicted calving date (at least 14 d prepartum) and ended 28 d postpartum. The study was conducted on a commercial dairy. Milk weights and samples were collected twice weekly from the afternoon milking on non-consecutive d and analyzed for milk fat, protein, lactose, and somatic cell counts. Overall, supplementation with Original XP did not significantly increase milk production, however, in second lactation Holstein cows ( $n = 25$ ; 8 or 9 cows per group), Original XP supplementation, regardless of dosage, increased milk production by 5.5 kg/d ( $P = 0.05$ ). Doubling feeding rates of Original XP (112 g/d) additionally benefited milk production in the last supplementation wk in fourth or higher lactation Holstein cows ( $n = 27$ ; 8 to 10 cows per group; +10.6 kg/d versus control,  $P = 0.08$ , and +9.8 kg/d versus 56 g Original XP;  $P = 0.10$ ). Although there were several potential confounding factors that could not be controlled on the commercial dairy, our results support the original hypothesis that greater dosages of Original XP than 56 g/d may be required to support increased nutritional demands and milk production during time periods of increased stress.

**Key words:** dairy, milk, yeast culture

**W360 Prediction of enteric methane output from milk fatty acid composition, intake and rumen fermentation parameters.** R. Mohammed<sup>\*</sup>, S. M. McGinn, and K. A. Beauchemin, AAFC, Lethbridge Research Centre, Lethbridge, AB, Canada.

Milk fatty acid (FA) composition has been suggested as a means of predicting enteric methane ( $\text{CH}_4$ ) output in lactating dairy cattle. The objectives of this study were to: i) predict  $\text{CH}_4$  from milk FA composition, intake and rumen fermentation parameters and ii) test the reliability of  $\text{CH}_4$  prediction equations reported in previous studies. Sixteen lactating Holstein cows were used in a cross over design with four 28-d periods. All diets contained steam-rolled barley, a pelleted supplement and 45% barley silage and were supplemented with crushed oilseeds from sunflower, flax, canola and calcium salts of long chain FA to provide 3.3% added fat on dry matter basis. Methane (g/d) was measured in chambers (2 animals/chamber) on 3 consecutive days (d21–23). Total dry matter intake (DMI, kg/d; d21–23), forage DMI (kg/d; d21–23), milk FA composition (% total FA methyl esters; d18–21), volatile FA (mol/100 mol; d19–21) and protozoal counts (d19–21) were averaged by chamber before including in the model. Forage DMI ( $r = 0.52$ ;  $n = 32$ ), DMI ( $r = 0.52$ ;  $n = 32$ ) and rumen acetate:propionate ( $r = 0.66$ ;  $n = 16$ ) were positively related ( $P < 0.01$ ) to  $\text{CH}_4$  (g/d) whereas rumen propionate ( $r = 0.63$ ;  $n = 16$ ), milk c9–17:1 ( $r = 0.64$ ;  $n = 32$ ) and c11–18:1 ( $r = 0.64$ ;  $n = 32$ ) were negatively related ( $P < 0.01$ ) to  $\text{CH}_4$ . The best regression equation was ( $P < 0.001$ ;  $R^2 = 0.90$ ;  $n = 16$ ):  $\text{CH}_4$  (g/d) =  $-910.8 (\pm 156.7) \times \text{milk c9-17:1} + 331.2 (\pm 88.8) \times \text{milk 16:0 iso} + 0.0001 (\pm 0.00) \times \text{total entodinomorphs} + 242.5 (\pm 39.7)$ . Removing rumen parameters from the model also resulted in a reasonably good estimate ( $P < 0.001$ ;  $R^2 = 0.83$ ;  $n = 32$ ) of  $\text{CH}_4$ . Step-wise regression analysis within diets resulted in greater  $R^2$  and lower standard error values. Methane predicted using equations from previous studies resulted in a mean over-estimation ranging from 19 – 61% across studies. Thus, milk FA composition and intakes (DMI) can be used to estimate enteric  $\text{CH}_4$  under field conditions. However, more accurate

predictions require equations specific to each diet. More studies are required to test the reliability of CH<sub>4</sub> prediction equations under varied feeding conditions.

**Key words:** methane, milk fatty acid composition, prediction equations

**W361 Effect of dietary starch content in early lactation on the lactational performance of dairy cows.** B. H. Nelson<sup>1,2</sup>, K. W. Cotanch<sup>1</sup>, M. P. Carter<sup>1</sup>, H. M. Gauthier<sup>1</sup>, R. E. Clark<sup>1</sup>, P. D. Krawczel<sup>1</sup>, R. J. Grant<sup>1</sup>, K. Yagi<sup>3</sup>, K. Fujita<sup>3</sup>, and H. M. Dann<sup>1</sup>, <sup>1</sup>William H. Miner Agricultural Research Institute, Chazy, NY, <sup>2</sup>Department of Animal Science, The University of Vermont, Burlington, <sup>3</sup>ZenNoh National Federation of Agricultural Cooperative Associations, Tokyo, Japan.

Multiparous Holstein cows (n = 78) were used to evaluate the effect of dietary starch content in corn silage-based diets fed in early lactation on performance and blood metabolites. Dietary treatments were 1) a low-starch diet (L; 21.0%; 1.65 Mcal NE<sub>L</sub>/kg) for the first 91 d in milk (DIM; LL), 2) a medium-starch diet (M; 23.2%; 1.67 Mcal NE<sub>L</sub>/kg) for first 21 DIM and a high-starch diet (H; 25.5%; 1.68 Mcal NE<sub>L</sub>/kg) for the next 70 DIM (MH), and 3) a high-starch diet (H; 25.5%; 1.68 Mcal NE<sub>L</sub>/kg) for the first 91 DIM (HH). Corn meal was replaced partially with soyhulls and wheat middlings in the L and M diets. Cows were housed in sand bedded freestalls, fed in a Calan Broadbent feeding system and milked 3 × daily. Dry matter intake (DMI) and milk yield were measured daily. Milk composition was measured weekly starting at wk 2. Serum was collected every other day (1 to 21 DIM) and was analyzed for nonesterified fatty acids (NEFA) and β-hydroxybutyrate (BHBA). Data were analyzed as a completely randomized design by ANOVA with the MIXED procedure of SAS using treatment and time as fixed factors and cow within treatment as a random factor. Through the first 21 DIM (n = 78 cows), there was no treatment effect ( $P > 0.10$ ) for DMI (20.3 ± 0.6 kg/d), milk yield (40.9 ± 1.6 kg/d), milk fat (4.34 ± 0.11%), milk protein (3.39 ± 0.05%), and serum BHBA (8.8 ± 1.1 mg/dL). Serum NEFA (μEq/L) was higher ( $P = 0.02$ ; SEM = 39) for MH (578) than HH (437); LL was intermediate (452). Through the first 91 DIM (n = 72 cows; Table 1) treatment affected milk yield and milk urea nitrogen (MUN) and tended to affect DMI and milk fat. Diets containing ≤23% starch can be fed successfully to cows in early lactation when corn meal is partially replaced with nonforage fiber sources as long as energy density of the diet is maintained.

**Table 1.**

Item	LL	MH	HH	SE
DMI, kg/d	25.2 <sup>x</sup>	24.9 <sup>xy</sup>	23.7 <sup>y</sup>	0.5
Milk, kg/d	47.9 <sup>ab</sup>	49.9 <sup>a</sup>	44.2 <sup>b</sup>	1.6
3.5% FCM, kg/d	51.9	52.2	47.4	1.7
Fat, %	3.88 <sup>x</sup>	3.64 <sup>y</sup>	3.79 <sup>xy</sup>	0.08
True protein, %	2.90	2.92	2.97	0.04
MUN, mg/dL	15.2 <sup>a</sup>	12.7 <sup>b</sup>	11.9 <sup>b</sup>	0.31
FCM/DMI	2.04	2.07	1.97	0.06
Body weight, kg	681	682	682	12
Body condition score	3.13	3.04	3.16	0.07

<sup>ab</sup>  $P \leq 0.05$ ; <sup>xy</sup>  $P \leq 0.10$ .

**Key words:** lactation, starch, transition cow

**W362 A fibrolytic enzyme additive for lactating dairy cow diets: ruminal fermentation, pH, bacterial populations and enteric methane emissions.** Y.-H. Chung<sup>\*1</sup>, L. Holtshausen<sup>1</sup>, T. W. Alexander<sup>2</sup>, M. Oba<sup>3</sup>, and K. A. Beauchemin<sup>1</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada, <sup>2</sup>Department of Animal Science, University of Vermont, Burlington, <sup>3</sup>Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada.

The objective was to determine if supplementing a dairy cow diet with a fibrolytic enzyme product (Econase RDE; AB Vista, Marlborough, Wiltshire, UK) alters ruminal fermentation, pH, bacterial populations, the risk of ruminal acidosis or enteric methane (CH<sub>4</sub>) emissions. In a companion study this enzyme product improved ( $P < 0.05$ ) efficiency of fat-corrected milk production for early-lactation dairy cows in a dose-dependent manner up to 11.3%. Nine ruminally cannulated, lactating Holstein cows were used in a replicated 3 × 3 Latin Square design with 21-d periods. Dietary treatments were 0 (control), 0.5 (low) and 1.0 (high) mL enzyme/kg TMR DM. Rumen contents were collected on 2 d, ruminal pH was measured continuously for 6 d, and enteric CH<sub>4</sub> emissions were measured for 3 d. The enzyme additive did not alter volatile fatty acids or ruminal pH profiles. However population densities of certain bacteria, calculated as copy number of specific 16S rRNA genes, were affected by enzyme treatment. The ruminal fibrolytic bacterium, *Fibrobacter succinogenes* ( $P = 0.11$ ), and non-fibrolytic bacteria, *Ruminobacter amylophilus* ( $P = 0.04$ ) and *Selenomonas ruminantium* ( $P = 0.03$ ), increased linearly with increasing levels of enzyme in the diet. Increasing the level of enzyme supplement in the diet also increased enteric CH<sub>4</sub> production, even when adjusted for feed intake or milk production (19.3, 20.8 and 21.7 g CH<sub>4</sub>/kg DMI or 12.9, 13.6 and 15.1 g CH<sub>4</sub>/kg milk for the control, low and high enzyme diet, respectively;  $P \leq 0.05$ ). The improvement in feed conversion efficiency of fat-corrected milk production with this enzyme product was related to a shift in ruminal bacterial communities associated with improved fiber digestion, which resulted in an increase in enteric CH<sub>4</sub> emissions without a change in volatile fatty acids or pH profile of the rumen fluid.

**Key words:** fibrolytic enzyme, ruminal bacteria, enteric methane emission

**W363 Nutritional and seasonal factors causes milk fat concentration variability in dairy cows.** A. S. Atzori<sup>\*1</sup>, P. Carta<sup>2</sup>, G. Gaspa<sup>1</sup>, and A. Cannas<sup>1</sup>, <sup>1</sup>Dipartimento di Scienze Zootecniche, Università di Sassari, Sassari 07100, Italy, <sup>2</sup>Associazione Regionale Allevatori della Sardegna, Nuraxinieddu, OR, Italy.

Many animal and dietary factors might affect milk fat concentration (MF) of dairy cows. In this work several of them were studied in cows kept in Mediterranean climatic conditions. From December 2009 to July 2010, 54 samples of different total mixed rations (TMR) and bulk milk were collected from 26 dairy Sardinian farms (Italy). Daily herd DMI intake and milk yield (MY) were also recorded at the day of sampling. TMR were analyzed for chemical composition and sieved with the Penn State Particle Separator (PSPS) to estimate their physical effectiveness (peNDF). In the studied farms MY was 27.3±2.8 kg/cow per d (mean±s.d.; range 20.0-33.3), MF was 3.79±0.26% (range 2.88-4.29), dietary NDF was 37±2.6% of DM (range 32.2-43.9), while peNDF was 31.1±3.0% of DM (range 24.8-38.4). Despite this large variability, no significant associations between MF and NDF, peNDF or DM in the PSPS sieves were found. MF was negatively associated with the DM of TMR ( $r = -0.55$ ;  $P < 0.001$ ) and positively associated

with the concentration of silage in the ration ( $r = 0.30$ ;  $P < 0.05$ ). MF was lower in hot than in cold seasons ( $P = 0.03$ ). A multivariate factor analysis, which excluded MF, was applied to the dataset and 6 factors were extracted. They indicated: F1) diet energy content (linked to TDNm, NEL3m, apparent digestibility, ADL, lipids in diet), F2) forage to concentrate ratio (linked to starch, NFC, NDF, ADF), F3) silage effects (linked to middle and lower PSPS fractions, silage in diet, DM of TMR), F4) cow performances (linked to MY, DMI, upper PSPS fraction), F5) diet protein balance (related to CP and bottom pan of the PSPS) and F6) season effects (linked to cold and hot season). Silage and season effects were the only factors significantly correlated with MF ( $r = 0.40$ ,  $P < 0.01$  and  $-0.33$ ,  $P < 0.05$ , for F3 and F6 respectively). F3 was positively related to MF, with a similar trend both in hot and cold seasons, highlighting the positive effects of silages in the nutritional supply. The results showed that in many instances other factors than peNDF affect MF of dairy cows.

**Key words:** factor analysis, PSPS, silage

**W364 Replacing soybean meal with Upland cottonseed, Pima cottonseed or extruded Pima cottonseed cake on production of lactating dairy cows.** G. A. Broderick<sup>\*1</sup>, T. M. Kerkman<sup>2</sup>, H. M. Sullivan<sup>2</sup>, M. K. Dowd<sup>3</sup>, and P. A. Funk<sup>4</sup>, <sup>1</sup>U.S. Dairy Forage Research Center, Madison, WI, <sup>2</sup>EcoSol, Tucson, AZ, <sup>3</sup>USDA-ARS, New Orleans, LA, <sup>4</sup>USDA-ARS, Mesilla Park, NM.

Pima cotton production is growing in the US Pima cottonseed contains more gossypol, a toxic compound, than Upland cottonseed; heating cottonseed reduces gossypol absorption. Forty lactating Holstein cows were blocked by DIM into 5 squares in an incomplete 8x8 Latin square. Diets were formulated to (DM basis) 30% alfalfa silage, 30% corn silage, 21–25% corn, 16% CP and fed as TMR for ad libitum intake. Dietary protein was from: 1) solvent soybean meal (SSBM) or SSBM plus equal CP from 2) Upland cottonseed (UCS), 3) cracked Pima cottonseed (PCS), 4) Pima cottonseed cake (PCSC; prepared using experimental extrusion), 5) UCS plus PCS, 6) UCS plus PCSC; or expeller soybean meal (ESBM) plus equal CP from 7) PCS, or 8) PCSC. Periods were 4-wk (total 16 wk); data were from the last 2 wk. Blood plasma was collected on d-28. Data were analyzed using Proc Mixed in SAS. LS-means are in the table. Diet affected DMI ( $P = 0.05$ ), with greatest intake on diet 6 and lowest intake on diet 1. MUN ( $P = 0.05$ ) was lowest on diets 3, 7 and 8. No other production trait was affected. Milk fat ranged from 3.78 to 4.25%, suggesting cottonseed oil had no adverse effects. Plasma gossypol was higher ( $P < 0.001$ ) on PCS, and lower on PCSC, than on corresponding diets with UCS, indicating extrusion reduced gossypol absorption. Performance on all diets supplemented with cottonseed was comparable to that on SSBM.

**Table 1.** Results

Item	Diet no.								P > F
	1	2	3	4	5	6	7	8	
	SSBM	SSBM + UCS	SSBM + PCS	SSBM + PCSC	SSBM + UCS + PCS	SSBM + UCS + PCSC	ESBM + PCS	ESBM + PCSC	
DMI, kg/d	25.7 <sup>c</sup>	26.1 <sup>bc</sup>	25.9 <sup>c</sup>	26.9 <sup>a</sup>	26.0 <sup>bc</sup>	26.9 <sup>a</sup>	26.3 <sup>abc</sup>	26.9 <sup>a</sup>	0.05
Milk, kg/d	43.7	44.3	43.6	44.2	44.0	45.3	45.0	45.3	0.73
Fat, kg/d	1.61	1.70	1.74	1.67	1.72	1.73	1.64	1.83	0.13
Protein, kg/d	1.24	1.25	1.24	1.28	1.22	1.27	1.26	1.30	0.56
MUN, mg/dl	9.2 <sup>ab</sup>	9.2 <sup>ab</sup>	8.6 <sup>b</sup>	9.4 <sup>a</sup>	9.2 <sup>ab</sup>	9.5 <sup>a</sup>	8.9 <sup>b</sup>	8.9 <sup>b</sup>	0.05
Plasma (-)gossypol, µg/ml	0.3 <sup>c</sup>	0.9 <sup>c</sup>	2.2 <sup>a</sup>	0.5 <sup>d</sup>	1.6 <sup>b</sup>	0.8 <sup>c</sup>	1.9 <sup>b</sup>	0.5 <sup>d</sup>	<0.01
Total gossypol, µg/ml	0.5 <sup>c</sup>	1.4 <sup>c</sup>	3.3 <sup>a</sup>	0.8 <sup>d</sup>	2.5 <sup>b</sup>	1.3 <sup>c</sup>	2.8 <sup>b</sup>	0.7 <sup>d</sup>	<0.01

a-e ( $P < 0.05$ ).

**Key words:** upland cottonseed, pima cottonseed, milk production

**W365 The effects of feeding high-fiber byproduct feedstuff on productivity of dairy cows in early lactation.** Y. Q. Sun<sup>\*</sup> and M. Oba, University of Alberta, Edmonton, Alberta, Canada.

The objective of this study was to evaluate effects of a partial substitution of dietary grain with wheat DDGS on DMI, sorting activity, milk production and plasma metabolites of early-lactating dairy cows. Sixty-one Holstein cows were blocked by parity (22 primiparous and 39 multiparous cows) and assigned to one of 2 experimental diets immediately after calving until 12 weeks in lactation. Experimental diets contained 43.1% barley silage, 21.6% rolled corn grain, and either steam-rolled barley grain (Control) or wheat DDGS (DDGS) at 17% of dietary DM. Both diets were formulated to contain 19.5% CP, 22.6% forage NDF, and 5.4% fat on a DM basis, but dietary NFC contents were 38.1% and 32.3% for Control and DDGS diet, respectively. Because excess fermentation in the rumen often decreases energy intake of ruminants, we hypothesized that reducing dietary NFC content by replacement of barley grain with DDGS would increase DMI and milk production. Cows fed DDGS diet sorted to a greater extent for long (104 vs. 102%,  $P = 0.08$ ) and medium (94.7 vs. 91.4%,  $P = 0.004$ ) particles, which retained on 19- and 8-mm screens of Penn State Particle Separator, respectively, compared with animals fed the control diet. Treatment did not affect body weight, BCS, or plasma concentrations of glucose, NEFA, BHBA, and plasma urea N. We observed parity-by-treatment interactions for DMI ( $P = 0.08$ ), milk yield ( $P = 0.05$ ), and milk protein concentration ( $P = 0.05$ ). Feeding DDGS diet increased DMI (16.5 vs. 15.0 kg/d), milk yield (31.4 vs. 28.7 kg/d) but decreased milk protein concentration (2.71 vs. 2.78%) for primiparous cows. For multiparous cows, feeding DDGS decreased DMI (20.2 vs. 21.2 kg/d) and milk yield (39.1 vs. 41.8 kg/d) but increased milk protein concentration (2.85 vs. 2.77%). In conclusion, wheat DDGS can be used as a substitute for barley grain in the diets of dairy cows in early lactation, but the causes for different production responses between multiparous and primiparous cows warrant further investigation.

**Key words:** early-lactating cow, DDGS, barley grain