Ruminant Nutrition Platform Session I: Rumen Function and Health

219 Effects of prepartum dietary cation-anion difference intake on dairy cows: A meta-analysis. J. J. Lean1,2, J. E. P. Santos1, E. Block4, and H. M. Golder1,2, Scibor, Camden, NSW, Australia, 2Dairy Science Group, School of Life and Environmental Sciences, Faculty of Science, The University of Sydney, Camden, NSW, Australia, 3Department of Animal Sciences, University of Florida, Gainesville, FL, 4Arm & Hammer Animal Nutrition, Princeton, NJ.

Effects of prepartum intake of DCAD equivalents (Eq/d) on concentrations of blood minerals and metabolites, production and health, were evaluated using classical meta-analytical methods. We hypothesized that reducing DCAD intake would reduce the risk of milk fever, hypocalcemia and increase production. There was a maximum of 58 comparisons from 31 experiments and 1,476 cows. Intakes of DCAD were 2.28 Eq/d and ~0.64 Eq/d for control and treated groups. Diets with lower DCAD reduced urine pH (SMD = 1.90; −1.23 pH; P < 0.001), decreased prepartum DMI (SMD = 0.23; 0.29 kg/d; P < 0.001), increased postpartum DMI (SMD = 0.40; 0.63 kg/d; P < 0.001), and increased milk production (SMD = 0.172; P < 0.001). However, treatment significantly increased milk in parous cows (SMD = 0.29; 1.1 kg/d; P = 0.002) but treated nulliparous (NP) cows produced 1.28 kg/d (SMD = −0.2; P > 0.1) less than controls. The FCM yield increased with treatment (SMD = 0.12; 0.56 kg/d; P = 0.03); but treatment tended to increase (P = 0.06) FCM in parous cows and decrease in NP cows compared with controls. Milk fat percentage, fat yield, and protein percentages were not affected by treatment, but protein yield tended to increase (SMD = 0.21; 0.02 kg/d; P = 0.07). Treatment increased blood Ca and P on the day of calving, (SMD = 0.53; 0.13 mM; P < 0.001) and (SMD = 0.40; 0.13 mM; P < 0.001), respectively, and Ca postpartum (SMD = 0.36; 0.06 mM; P = 0.003). Blood BHB was decreased in treated cows before calving (SMD = −0.39; −0.04 mM; P = 0.007). No other blood metabolite changes occurred. Cows fed lower DCAD diets (Eq/d) had less risk of milk fever by 68%, retained placenta (69%), metritis (219%), and morbidity (64%). There was no effect on risk of abomasal displacement or mastitis. There was no effect of differences in Ca intake g/d on outcomes evaluated. Increased Mg intake g/d between groups increased milk fat production and reduced risk of retained placenta. The DMI increased in cows of both parity and milk increased in parous cows. Health was improved for both parity groups, hence this study supports a positive effect of acidogenic diets on dairy cows. More studies are needed on dietary strategies for NP transition cows.

Key Words: DCAD, hypocalcemia, calcium

221 Timing of initiation and duration of feeding ruminally protected choline (RPC) affects performance of lactating Holstein cows. J. M. Bollati1, M. G. Zenobi1, N. A. Artuso1, G. F. Alfaro1, A. M. Lopez1, B. A. Barton2, J. E. P. Santos1, and C. R. Staples1, 1Department of Animal Sciences, University of Florida, Gainesville, FL, 2Balchem Corp., New Hampton, NY.

The objective was to evaluate the timing of initiation and duration of feeding ruminally protected choline (RPC; ReaShure, Balchem Corp., New Hampton, NY) on dairy cow performance. The experiment was divided into the following 2 periods of time: −21 to 21 DIM and 22 to 105 DIM with data from periods analyzed separately using repeated measures within the MIXED procedure of SAS. From −21 to 21 DIM, multiparous Holstein cows (n = 99) were top-dressed with 0 or 60 g/d of RPC (12.9 g/d choline ion). Starting at 22 DIM, cows were switched to the alternate diet (control to RPC or RPC to control) or maintained on the same diet (control to control or RPC to RPC) resulting in a 2 by 2 factorial arrangement of treatments. Methionine (Perdue Ag Solutions LLC, Salisbury, MD) was formulated to 2.9% of metabolizable protein (MP) in the prepartum diets and to 2.4% of MP in the postpartum (PP) diets. Feeding RPC did not affect prepartum DMI, BW, or BCS (means of 11.7 kg/d, 774 kg, and 3.46, respectively). During the first 21 d PP, RPC did not affect DMI (16.2 vs. 16.4 kg/d; P = 0.72) or milk yield (35.1 vs. 36.8 kg/d; P = 0.13) of control and RPC-fed cows, respectively. Milk fat % was greater for cows fed RPC (4.41 vs. 4.60%; P = 0.05). As a result, cows fed RPC produced more energy-corrected milk (ECM; 39.0 vs. 42.0 kg/d; P = 0.04) and feed efficiency (FE; ECM/DMI) was greater (2.44 vs. 2.64, P = 0.01). Extent of BW loss was greater for cows fed RPC (24.4 vs. 37.7 kg, P = 0.01). Between 22 and 105 DIM, yield of milk tended to be greater (44.6 vs. 46.9 kg/d; P = 0.06) and yield of ECM was greater (43.2 vs. 45.6 kg/d; P = 0.05) for cows fed RPC in transition (control-control + control-RPC) vs. (RPC-control +

220 Blood metabolites as indicators of susceptibility to subacute ruminal acidosis in mid-lactation Holstein cows. S. M. Nasrollahizadeh1,2, A. Zali1, G. R. Ghorbani1, and W. Z. Yang3, 1University of Tehran, Tehran, Iran, 2Isfahan University of Technology, Isfahan, Iran, 3Lethbridge Research and Development Centre, Lethbridge, AB, Canada.

The objective of the study was to evaluate blood metabolites as indicators of susceptibility to subacute ruminal acidosis (SARA) in mid-lactation Holstein cows. Seventy-eight lactating dairy cows (DIM = 103 ± 27; BW = 630 ± 77 kg) were fed a high-concentrate diet (65% of DM) during a 24-d study. Cows were classified according to rumenocentesis pH, measured 4 h after the morning feeding on the last day of the study, as tolerant (pH ≥6.0; n = 26), marginal (5.8 ≤ pH < 6; n = 21), and susceptible (pH < 5.8; n = 31). Cows were also classified accord-
inducing and LPS dosing started at d 8. Ruminal digestibility, VFA, and NH₃-N samples were analyzed in this study. Ruminal pH was measured every hour before SARA induced and every 30 min once ruminal pH went below 5.6. The ruminal pH of WBD was lower than LPSD and CON (P = 0.05), and WBD was able to keep ruminal pH below 5.6 for 240 min every sampling day, successfully inducing SARA. Ruminal pH of LPSD was not different from CON, and both were above 6 for the entire experimental period. Ruminal NDF (P = 0.10), ADF (P = 0.09) and CP (P = 0.06) digestibility of LPSD tended to be lower than that of CON, but not different from WBD. There were no differences on total VFA concentration, molar proportion of propionate, isobutyrate, valerate, and isovalerate among treatments. WBD had the lowest acetate and the highest butyrate and lactate concentrations; however, there were no differences between LPSD and CON. The dynamic patterns of VFA of LPSD stated to be similar to WBD at 6 h after LPS dosing. The WBD had the lowest concentration of NH₃-N while the highest dietary N; however, no differences were observed between LPSD and CON. In conclusion, grain induced SARA model was successfully set up in dual-flow continuous culture system; ruminal LPS dosing tended to decrease ruminal fiber and CP digestion but have no effects on ruminal pH and fermentation in a dual-flow continuous culture system.

Key Words: in vitro, SARA, pH

224 Effect of *Saccharomyces cerevisiae* fermentation product and clay sequestering agents on rumen fermentation and bacterial community of lactating dairy cows challenged with dietary aflatoxin B₁, Y. Jiang*1, I. M. Ogunade2, A. A. Pech-Cervantes1, P. Fan1, X. Li3, D. H. Kim1, K. G. Arriola1, M. B. Poin dexter1, M. C. M. Goncalves4, K. C. Jeong1, D. Vyas1, and A. T. Adesogan1, 1Department of Animal Sciences, University of Florida, Gainesville, FL, 2Division of Food and Animal Science, Kentucky State University, Frankfort, KY, 3Department of Animal Sciences, China Agricultural University, Beijing, China, 4Institute of Agriculture and Environmental Sciences, Federal University of Mato Grosso, Sinop, MT, Brazil.

This study was conducted to examine the effects of clay (CL) and *Saccharomyces cerevisiae* fermentation product (SCFP) sequestering agents on the ruminal bacterial community of Holstein dairy cows challenged with aflatoxin B₁ (AFB₁). Eight lactating cows stratified by milk yield and parity were randomly assigned to 1 of 4 treatments in a 4 × 4 Latin square with 2 replicate squares, 4 33-d periods and 5-d washout between periods. Treatments were (1) Control (basal diet); (2) T (Control + 63.4 µg/kg AFB₁); (3) CL (T + 200 g/head/d sodium bentonite clay, top-dressed); (4) CL+SCFP (CL +19 g Diamond V NutriTek + 16 g MetaShield, top-dressed). During each period, cows were adapted to the basal diet (36.1% corn silage, 8.3% alfalfa hay and 55.6% concentrate; DM basis) from d 1 to 25 (pre-dosing period), orally dosed with AFB₁ from d 26 to 30 (dosing period), followed by toxin withdrawal from d 31 to 33 (withdrawal period). Data were analyzed using GLIMMIX procedure of SAS. During the pre-dosing period, feeding CL+SCFP increased the relative abundance of *Prevotella* compared with the Control (43.6 vs. 40.0%; P = 0.02). During the dosing period, feeding T had no effects on the ruminal bacterial community (P > 0.10) but CL+SCFP increased the abundance of *Fibrobacter* compared with T and Control (1.45 vs. 0.97 and 1.05%; P = 0.04 and 0.10, respectively). Ruminal fermentation parameters did not differ across treatments. Feed efficiency was positively correlated (r >0.30, P < 0.05) with relative abundance of *Treponema*, and *Coprococcus*. Yields of milk and milk components correlated positively (r >0.42; P < 0.01) with relative abundance of unclassified *Succinivibrionaceae*, or *Coprococcus*, suggesting they play an important role in increasing milk production. The ruminal microbial
community was not affected by T or CL but CL+SCFP increased the abundances of *Prevotella* and *Fibrobacter* in the predosing and toxin-dosing periods, perhaps resulting in the increased milk yield observed in our companion study.

**Key Words:** aflatoxin, microbiome, sequestering agents

### 225 Effect of *Saccharomyces cerevisiae* fermentation products on performance, diarrhea outbreaks, and plasma glucose and NEFA concentration in bottle-fed calves

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The use of microbial additives in rations has become a common practice in ruminant’s nutrition. The main purpose on their use is to increase cattle performance and production from early stages. One of these additives are yeast cultures like *Saccharomyces cerevisiae* fermentation products (SCFP). The objectives of this study were to evaluate the effect of SCFP on BW, DMI, diarrhea outbreaks, and plasma glucose and NEFA concentration in bottle fed calves. Eighty newborn calves (n = 40 per treatment) were involved in this experiment. They were randomly assigned to a control (C) treatment or SCFP supplemented treatment (SC). Calves received a total of 6 L of colostrum at birth and 3 L of milk twice daily. They were offered ad-libitum access to a solid feed. Body weight was recorded at birth and on d 14, 30, and 60. Dry matter offered was measured daily and refusals twice a week to obtain an average DMI. Blood was sampled on d 7 and 14 to evaluate plasma glucose and NEFA concentration. Fecal scores were collected for measurements on d 30. Fecal samples were collected for measurements on d 7 and 14, respectively. The results showed that the acute phase response is mediated by cytokines and that NTH can reduce this increase in LTA. The interactions between the effects of SARA and treatment were tested for significance. LTA was not detected in rumen fluid, but that may have been due to compounds that interfered with the assay. The interactions between the effects of SARA and SCFP on LTA and IL-6 in blood plasma were significant (P < 0.05). SARA increased this concentration from 0.66 to 0.71 ng/mL (P < 0.05) only in the cows on the control, XPC, and NTL treatments. SARA only increased (P < 0.05) the concentration of IL-6 in cows on the NTH treatment (380 vs. 569 ng/mL). Results show that grain-induced SARA increases LTA moderately, without increasing IL-6 in blood, and that NTH can reduce this increase in LTA. This increase in LTA is likely due to increased translocation of this endotoxin, and can be attenuated by LTH. The acute phase response resulting from SARA does not appear to be mediated by IL-6.

### 226 Effect of subacute ruminal acidosis (SARA) and *Saccharomyces cerevisiae* fermentation products on endotoxins and interleukin-6 in blood plasma

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Grain-induced SARA has been associated with an acute phase response and translocation of endotoxins from the digestive tract. It is assumed that the acute phase response is mediated by cytokines and that *Saccharomyces cerevisiae* fermentation products (SCFP) attenuate the effects of SARA. This study tested if grain-induced SARA increases the translocation of lipopolysaccharide (LTA), an endotoxin of gram-positive bacteria, and raises interleukin (IL)-6 cytokine. A total of 32 lactating Holstein dairy cows were assigned to 4 treatments in a complete randomized block design. Cows received a base TMR ration, containing 34% DM NDF and 18.6% DM starch. Treatments included control (base TMR and 140 g/d of ground corn), and 3 SCFP treatments: XPC (base TMR with 14 g/d of Diamond V Original XPC mixed in 126 g of ground corn), NTL (base TMR with 19 g/d of Diamond V NutriTek mixed in 121 g of ground corn), and NTH (base TMR with 38 g/d of Diamond V NutriTek mixed in 102 g/d of ground corn). Diets were fed from 4 wk before to 12 wk after calving. During wk 5 and 7 of lactation, SARA was induced by replacing 20% of DM of the base TMR with pellets containing 50% wheat and 50% barley. The SARA diet contained 28.2% DM NDF and 27.9% DM starch. Blood and rumen fluid samples were collected twice weekly during wk 4 (baseline), 5 (SARA 1), and 7 (SARA 2). The interaction between the effects of SARA and treatment were tested for significance. LTA was not detected in rumen fluid, but that may have been due to compounds that interfered with the assay. The interactions between the effects of SARA and SCFP on LTA and IL-6 in blood plasma were significant (P < 0.05). SARA increased this concentration from 0.66 to 0.71 ng/mL (P < 0.05) only in the cows on the control, XPC, and NTL treatments. SARA only increased (P < 0.05) the concentration of IL-6 in cows on the NTH treatment (380 vs. 569 ng/mL). Results show that grain-induced SARA increases LTA moderately, without increasing IL-6 in blood, and that NTH can reduce this increase in LTA. This increase in LTA is likely due to increased translocation of this endotoxin, and can be attenuated by LTH. The acute phase response resulting from SARA does not appear to be mediated by IL-6.
The importance of the ruminal epithelial barrier for a healthy and productive cow. J. R. Aschenbach*1, G. Greco1, G. B. Penner2, Q. Zebeli3, and S. Amasheh1, 1Institute of Veterinary Physiology, Freie Universität Berlin, Berlin, Germany, 2Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, 3Institute of Animal Nutrition and Functional Plant Compounds, University of Veterinary Medicine Vienna, Vienna, Austria.

The squamous ruminal epithelium (RE) is crucial for the performance of dairy cows because it is the main site for absorption of key nutrients (e.g., short-chain fatty acids, SCFA) and electrolytes (e.g., Na+ and Mg2+). The absorptive function has to be highly selective to prevent simultaneous entry of microbes and toxins from the ruminal content into the blood. As such, absorption is primarily via the transcellular route; whereas, the paracellular pathway is tightly sealed. The latter is accomplished by a network of tight junction (TJ) proteins (claudin-1, claudin-4, and occludin) and TJ-associated proteins (ZO-1); the network being most intense in the stratum granulosum where the decisive permeation barrier is located. When microbial fermentation activity is high, the integrity of absorbing cells and their connecting TJ is often challenged by acidity, high osmolarity, toxins, and by immune mediators released during inflammation of the RE. The epithelial damage induced by acidity has been studied most frequently. In contrast to the transient opening of the paracellular space induced by high luminal osmolarity, acidity-induced opening of the RE barrier is not immediately reversible and it even aggravates upon return to physiological pH values. A recent key finding has been that the RE can withstand low luminal pH values rather well in the absence of elevated concentrations of SCFA. It is essentially the combination of luminal acidity and high luminal SCFA concentration that determines the degree of RE damage during an acidotic incidence, with SCFA dose being more relevant than SCFA species. The initial insults set by luminal acidity and the increasing concentrations of microbe-derived toxins such as lipopolysaccharide during acidosis are among the key factors that trigger ruminal and systemic inflammation. Recent studies suggest that thiamine can ameliorate the local inflammation. Butyrate has also been claimed to reduce inflammation in recent studies; however, other studies support promotion of parakeratosis and epithelial injury by butyrate. Further research is needed to enhance the understanding of the various factors that make the barrier tight during epithelial adaptation to changing diets.

Key Words: rumen epithelial barrier, ruminal acidosis, tight junctions