Ruminant Nutrition VI: Early Lactation and Inflammation

495 Impacts of short-term sodium salicylate administration and infrequent milking on early lactation cow energetics and milk yield through mid-lactation. M. Garcia*, C. Ylioja, L. K. Mamedova, and B. J. Bradford, Kansas State University, Manhattan, KS.

We hypothesized that at the onset of lactation, inflammation may contribute to an adaptive temporary insulin resistance to protect against hypoglycemia, but infrequent milking may reduce nutrient demands to the extent that this adaptation is unnecessary. Thirty-three multiparous Holstein cows were used to evaluate whether sodium salicylate (SS) and milking frequency (MF) alter energy status and milk yield. Cows were randomly assigned to frequent (3 × /d) or infrequent milking (1 × /d), and SS (2.3 g/L in drinking water) or control treatments in a 2 × 2 factorial design for 5 d, beginning ~24 h postpartum. Cows were fed a standard TMR to meet nutrient requirements. For measures of digestibility, TMR, refusals, and fecal samples were collected from 3 to 5 DIM. All variables, except digestibility, were analyzed as repeated measures. SS did not interact with MF for any of the variables measured (P > 0.10). MF did not alter water or DM intakes, total-tract NDF or DM digestibilities during treatment (P > 0.10). One × /d-cows produced less milk (25.0 vs. 33.1 ± 1.3 kg/d, P < 0.01) and energy corrected milk (ECM, 35.0 vs. 40.4 ± 1.6 kg/d, P = 0.02). Fat content was greater in 1 × /d-cows (5.3 vs. 4.2 ± 0.3%, P = 0.01) but protein and lactose content did not differ (P > 0.10). Three × /d-cows were in a more negative energy balance (−13.0 vs. −8.6 ± 1.2 Mcal/d of NE₃, P < 0.01), produced more ECM per unit of DM intake (2.9 vs. 2.4 ± 0.1, P < 0.01), and had lesser milk urea N concentrations (7.8 vs. 10.1 ± 0.7 mg/dL, P = 0.04). When 1 × /d-cows were switched to 3 × /d at d 6, their milk yield rapidly returned to that of 3 × /d-cows and yields were similar from wk 2 to 17 of lactation (55.8 vs. 56.8 ± 1.3 kg/d for 1 × and 3 × /d, respectively, P = 0.59). SS-treated cows produced more milk on wk 9 (62.0 vs. 55.1 ± 1, P = 0.03) but the average 17-weeks milk yield did not differ (P = 0.59). No other impacts of SS on these outcomes were observed. Although milking frequency had expected impacts on energetics, we found no evidence that SS influences this response.

Key Words: hepatic mitochondrial function, pasture vs. TMR, cryopreservation

496 Mitochondrial function of cryopreserved liver biopsies during early and late lactation of dairy cows. M. Garcia-Roche1,2, A. Casarí, M. Carriquiry3, C. Quijano4, and A. Cassina4, 1Centro de Investigaciones Biomédicas - Departamento de Bioquímica, Facultad de Medicina, Montevideo, Montevideo, Uruguay, 2Departamento de Producción Animal y Pasturas, Facultad de Agronomía, Montevideo, Montevideo, Uruguay.

Early lactation is an energy demanding period for dairy cows that threatens both animal health and milk yield. Metabolic changes occur in this period, affecting the liver, a key organ in gluconeogenesis and lipoprotein metabolism. We studied the impact of early lactation on hepatic mitochondrial function of dairy cows. Twenty-four Holstein-Friesian multiparous cows (664 ± 65 kg BW, 3.0 ± 0.4 BCS, spring calving) were assigned in a randomized block design to either (G0) total mixed ration (TMR) fed ad libitum (70% forage: 30% concentrate) or (G1) grazing plus supplementation from 0 to 180 d postpartum (DPP). The G1 cows grazed on Festuca arundinacea or Medicago sativa in one (6h) or 2 sessions (18h) depending on heat stress conditions 20–30 kgDM/cow day and were offered TMR (15 kgDM/cow/day) or supplemented with 5.4 kgDM of a commercial concentrate, respectively. From 180 to 250 DPP, all cows grazed Festuca arundinacea (10th; 30 kgDM/cow/day) and were offered TMR (16 kgDM/cow/day). Liver biopsies were collected at 35 and 250 DPP and cryopreserved using sequential freezing in modified UW medium using 10% DMSO. Mitochondrial function was assessed measuring oxygen consumption rates using complex I and II substrates. Mitochondrial content was determined measuring citrate synthase (CS) activity. Data were analyzed as repeated measures in a mixed model including feeding strategy, DPP and their interaction. Maximum respiratory rate and oligomycin-sensitive respiration were unchanged in G0 (6.7 ± 1 vs. 7.0 ± 1, P = 0.6; 2.9 ± 0.7 vs. 2.5 ± 0.7 pmolO₂/min/mg, P = 0.5) during both early and late lactation and were lower in early lactation in G1 (2.8 ± 1 vs. 7.5 ± 1, P < 0.0001; 1.2 ± 0.7 vs. 2.7 ± 0.7 pmolO₂/min/mg, P = 0.03). However, no differences between groups were observed in CS activity (47 ± 4 vs. 43 ± 3, P = 0.5; and 43 ± 5 vs. 48 ± 3 mU/mg, P = 0.3; for G0 and G1 respectively suggesting that mitochondrial content did not vary. Our results indicate that mitochondrial function is impaired during early lactation in cows in the grazing system and not in the TMR system, which could be related to differences in plane of nutrition.

Key Words: hepatic mitochondrial function, pasture vs. TMR, cryopreservation

497 Independent effects of metabolizable protein and heat stress affected milk production and plasma free fatty acid and insulin concentrations in dairy cows. J. D. Kaufman*, H. R. Bailey, and A. G. Rius, University of Tennessee, Knoxville, TN.

Environmental and nutritional factors influence productivity of dairy cows during lactation, possibly via similar physiological mechanisms. The objective of this study was to test the effects of heat stress (HS) and metabolizable protein (MP) on milk production and plasma metabolites. Thirty-six multiparous Holstein cows (219 ± 27 kg milk) were assigned to a factorial arrangement of treatments in a completely randomized design. Treatments were imposed for 21 d and consisted of HS or cooling with fans and sprinklers (CO) and high or low MP diets [17.9% (HMP) or 14.2% (LMP) crude protein on a DM basis]. Cows were exposed to prevailing weather of July and August in Tennessee. By design, CO cows were fed restricted to match intake of HS cows receiving the LMP treatment. Body temperature was monitored, and milk and blood samples were collected and analyzed. Treatment effects were tested using the Mixed procedure in SAS (LSM ± SEM). No interactions were detected, thus main effect differences are reported hereafter. Compared with CO, HS increased (P ≤ 0.03) rectal (38.4 vs. 39.0 ± 0.09°C) and vaginal temperatures (38.6 vs. 39.3 ± 0.09°C) and respiration rate (48.6 vs. 76.2 ± 2.2 breaths/min). Relative to CO, HS decreased (P < 0.01) yields of energy-corrected milk (37.5 vs. 33.9 ± 0.8 kg/d), protein (0.99 vs. 0.93 ± 0.02 kg/d), and fat (1.47 vs. 1.30 ± 0.04 kg/d) but did not affect circulating insulin (21.4 vs. 21.7 ± 3.0 µU/mL). Metabolizable protein did not affect energy-corrected milk yield. Low MP increased (P ≤ 0.05) milk fat yield (1.36 vs. 1.41 ± 0.04 kg/d) and plasma free fatty acid concentrations (159 vs. 204 ± 21.6 µEq/L) but decreased (P < 0.01) circulating insulin (28.3 vs. 14.9 ± 3.0 µU/mL). In summary, HS did not affect circulating insulin and reduced synthesis of protein, fat, and energy-corrected milk. Low MP reduced circulating insulin, increased circulating free fatty acids, and did not affect energy-corrected milk.

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yield. Hormonal and metabolite adaptations in LMP cows may have promoted the use of nutrients to support milk synthesis.

**Key Words:** crude protein, heat stress, milk production

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**498 Oxidative stress in periparturient dairy cows and its relationship with negative energy balance markers.** E. Mariani\(^1\), G. Invernizzi\(^1\), G. Savoini\(^2\), A. Baldi\(^1\), and I. Politis\(^3\), \(^1\)Department of Health, Animal Science and Food Safety, Università degli Studi di Milano, Milan, Italy; \(^2\)Department of Animal Science and Aquaculture, Agricultural University of Athens, Athens, Greece.

Living organism’s defensive systems are very sensitive and complex mechanisms. Endogenous production of reactive oxygen species (ROS) is one of the main ways these systems can achieve their goals. On the other side, ROS can be dangerous also for the living cells and the right balance between pro-oxidant and antioxidant is essential to avoid oxidative stress. Peripartum is typically a very stressful period of life in producing animals and dairy cows can experience a negative redox status at this time. The aim of the trial was to study the relationship between negative energy balance markers such as NEFA and BHBA and oxidative stress in transition dairy cows. Thirty Holstein Friesian dairy cows over 2 commercial farms located in Milan area were involved in the trial. Blood samples were collected at dry-off, at calving and at 30 DIM. ROS and serum antioxidant capacity (SAC) were measured on samples and the Oxidative Stress index (OSi) was calculated. On the same samples NEFA, BHBA and α-tocopherol concentrations were determined. Statistical analysis was performed with MIXED and CORR procedures of SAS. NEFA and BHBA increased around parturition compared with dry-off levels (P < 0.05). At 30 DIM, NEFA decreased to concentrations similar to pre-partum, BHBA concentration instead remained high. α-tocopherol blood levels decreased at calving and increased at 30 DIM at higher values than dry-off (3.12 vs. 3.59 μg/mL, P < 0.05). ROS results were not significant over the time and SAC values showed a tendency (P = 0.05) to have lower concentration at calving compared with dry-off. OSi results were significantly higher at calving compared with pre-calving (0.167 vs. 0.214, P < 0.05) and 30 DIM indexes (0.214 vs. 0.178, P < 0.05). There was a positive correlation between NEFA (0.44, P < 0.05) and BHBA (0.28, P < 0.05) serum levels and OSi. The results observed, consolidate the goodness of OSi in detecting oxidative stress in transition cows.

**Key Words:** oxidative stress, transition dairy cow, negative energy balance

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**499 Meta-analysis of the effects of prepartum dietary cation-anion difference on performance and health of dairy.** J. E. Santos\(^1\), H. M. Golder\(^2\), E. Block\(^1\), and I. J. Lean\(^3\), \(^1\)University of Florida, Gainesville, FL, \(^2\)Schub, Camden, NSW, Australia, \(^3\)Arm & Hammer Animal Nutrition, Princeton, NJ.

Objectives were to use meta-analytic methods to determine the effects of changes in DCAD prepartum on productive performance and health of dairy cows. The literature was systematically reviewed and 42 experiments that manipulated the mineral composition prepartum, including 134 treatment means and 1,803 cows, were included in the meta-analysis. Five experiments with 15 treatment means reported responses for 151 nulliparous cows. Data collected included mineral composition of diets, parity, breed, days fed prepartum diets, and means and respective SEM for urine pH, DMI, BW, BCS, productive performance, concentrations of minerals and metabolites in blood, and incidence of diseases. Random effects meta-analyses were conducted weighting by the inverse of SEM squared to account for the precision of each experiment. Models include the effects of DCAD, parity group prepartum, and other covariates that showed significance in univariable analysis. Final models were selected based on parsimony, biological relevance, and model fit. Reducing the DCAD reduced DMI prepartum but improved postpartum intake. Interactions between DCAD and parity group were observed for yields of milk, FCM, fat, and protein because reducing the DCAD improved those responses in parous cows; however, reducing the DCAD either had no effect on yields of milk and protein, or reduced the yield of FCM and fat in nulliparous cows. The model predicted that reducing the DCAD from +200 to −100 mEq/kg would increase DMI postpartum 1.0 kg/d and milk yield 1.7 kg/d. Concentrations of Ca in blood on the day of calving and postpartum increased with a reduction in DCAD, which explained the reduction in risk of milk fever observed in parous cows fed diets with negative DCAD. As the DCAD decreased, the risk of retained placenta and metritis also decreased, resulting in fewer disease events per cow in both nulliparous and parous cows. These results support the recommendation that parous cows should be fed diets with negative DCAD, but data available did not allow for detection of the ideal negative DCAD that optimizes production and minimizes health problems in parous cows.

**Key Words:** DCAD, health, transition cow

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Hyperlipidemia develops with hepatic steatosis and insulin antagonism in domestic ruminants. Enhanced hepatic fatty acid uptake contributes to de novo ceramide synthesis in non-ruminants. In turn, circulating ceramide antagonizes insulin sensitivity in skeletal muscle tissue. Our objective was to determine whether the induction of hyperlipidemia modifies hepatic ceramide concentrations and the mRNA expression of ceramide synthases (CerS). Six non-pregnant, nonlactating Holstein dairy cows (682 kg ± 22), were used in a crossover design with treatments consisting of i.v. infusion (100 mL/h) of either saline (control) or triacylglycerol (TG) emulsion (Intralipid 20%; Fresenius Kabi) for 16 consecutive hours. The feeding level was set at 120% of estimated energy requirement with meals offered every 2 h. Blood was collected at regular intervals and liver biopsied at 16 h. LC/MS was used to quantify ceramides, monohexosylceramides (GlcCer), and lactosylceramides (LacCer) in liver. Real-time PCR was utilized to evaluate CerS isoform expression. Data were analyzed using a mixed model (fixed effects of treatment and random effect of cow). As previously established, TG infusion increased hepatic TG, and plasma total fatty acid and ceramide levels by 16 h, relative to control (P < 0.01). Hepatic total ceramide and very long chain C22:0, C24:0, C26:0 ceramide concentrations were increased during TG infusion (~72%; P < 0.05). TG infusion also enhanced hepatic very long chain GlcCer and LacCer levels (e.g., C22:0 GlcCer; P < 0.05). However, hepatic C16:0 and C18:0 ceramide levels were not modified by treatment. In support of enhanced de novo synthesis of very long chain ceramides during TG infusion, C22:0 and C24:0 dihydroceramide concentrations were elevated 70–110% (P < 0.05). Moreover, C22:0 and C24:0 ceramide were positively correlated with their dihydroceramide precursors (r ≥ 0.88, P < 0.01). Bovine liver primarily expressed CerS2 and CerS6, and TG selectively enhanced CerS2 mRNA by 60% (P < 0.05). We conclude that hyperlipidemia promotes the de novo synthesis and accumulation of very long chain ceramides in dairy cattle experiencing hepatic steatosis.

**Key Words:** ceramide, hepatic steatosis, hyperlipidemia

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501 Diet starch content and fermentability affect markers of inflammatory response and oxidative stress during early lactation. R. I. Albornoz1, L. M. Sordillo1, B. J. Bradford2, L. K. Manedova2, and M. S. Allen1,1Michigan State University, East Lansing, MI, 2Kansas State University, Manhattan, MI.

Our objective was to evaluate effects of diet starch content and fermentability (SF) on inflammatory response and oxidative stress markers during the early postpartum (PP) period and its carryover effects. Fifty-two multiparous Holstein cows were used in a randomized block design experiment with a 2 x 2 factorial arrangement of treatments. Diets were formulated to 22% (LS) or 28% (HS) starch with dry ground corn (DGC) or high moisture corn (HMC) as the primary starch source. Treatments were fed from 1 to 23 d PP and then switched to a common diet until 72 d PP to measure carryover (CO) effects. Diets were formulated to 22% forage NDF and 17% CP for the treatment period (TP) and 20% forage NDF, 17% CP and 29% starch for the CO period. Blood was collected before feeding (0730 h) once a week during TP and every second week during the CO period. Blood plasma was analyzed by colorimetry for concentrations of haptoglobin (HAP), albumin and reactive oxygen species (ROS), with LPS-binding protein (LBAP) and TNF-α evaluated during the TP only. Data were analyzed separately for TP and CO using a Mixed Model including treatment interactions with time. During the TP, treatments interacted to affect concentrations of TNF-α, HAP and LBAP ($P < 0.07$), with HMC increasing their concentrations for HS (9.29 vs. 8.42 pg/mL, 0.54 vs. 0.41 mg/mL and 5.85 vs. 4.67 μg/mL, respectively) and decreasing their concentrations for LS (5.88 vs. 11.3 pg/mL, 0.29 vs. 0.44 mg/mL and 4.41 vs. 6.02 μg/mL, respectively) compared with DGC. Effects of treatments diminished over time for LBAP and HAP with no differences by the end of the TP. Opposite treatment interaction was observed for albumin, with HMC tending to decrease albumin for HS (3.25 vs. 3.34 g/dL) and increase albumin for LS (3.38 vs. 3.29 g/dL; $P = 0.13$) compared with DGC. HMC tended to increase ROS compared with DGC (57.5 vs. 52.0 RFU/μL; $P = 0.07$). Results during the TP suggest that feeding LS-DGC and HS-HMC elicited a more pronounced inflammatory response, with ROS increased by HMC treatments.

Key Words: diet starch, inflammation, early lactation

502 Lactation performance and energetic metabolism of transition cows fed rumen protected glucose. C. S. McCarthy1,2, B. C. Dooley1, E. H. Bransion1, A. J. Kramer1, E. A. Horst1, E. J. Mayorga1, M. Al-Qaisi1, M. A. Abeyta1, G. Perez-Hernandez1, B. M. Goetz2, A. R. Castillo1, M. R. Knobbe1, C. A. Macgregor2, J. P. Russi2, J. A. D. R. N. Appuhumay1, L. H. Baumgard1, and H. A. Ramirez-Ramirez1,1Iowa State University, Ames, IA, 2Universidad Autonoma Chapingo, Chapingo, Mexico, 3University of California, Cooperative Extension, Merced, CA, 4Grain States Soya, Inc., West Point, NE, 2Rutiscet Argentina, General Villegas, Buenos Aires, Argentina.

Carbohydrate supply and availability in the small intestine may limit milk production in transition dairy cows. Thus, experimental objectives were to evaluate the effects of rumen protected glucose (RPG) on milk production and post-absorptive metabolism in transition dairy cows. Fifty-two multiparous cows were blocked by previous 305ME and randomly assigned to one of 2 iso-energetic and iso-nitrogenous treatments: (1) control diet (CON; n = 26) or (2) a diet containing RPG (RPG, pre-fresh 8.4% RPG DM basis, post-fresh 9.5% RPG DM basis; n = 26). Cows received their respective dietary treatments from d = -21 to 28 relative to calving via individual feeding gates. Weekly BW, BCS, milk samples and fecal pH were recorded until 28 DIM, whereas milk yield was recorded through 105 DIM. Blood samples were collected on d -7, 3, 7, 14, and 28 relative to calving. Data were analyzed using repeated measures in the MIXED procedure of SAS. Fecal pH was similar ($P = 0.87$) among treatments; however, compared with pre-calving, both treatments had a reduction in pH following calving (7.2 vs 6.6; $P < 0.01$). Milk yield was similar among treatments ($P = 0.37$) for 1 to 28 DIM (42.8 ± 1.2 kg/d), as well as through 105 DIM ($P = 0.92$; 47.3 ± 1.3 kg/d). Dry matter intake pre-calving (12.0 ± 0.7 kg/d) and post-calving (22.0 ± 0.7 kg/d) were unaffected by treatment ($P ≥ 0.65$). Milk fat, protein and lactose were similar among treatments ($P ≥ 0.40$; 4.36 ± 0.13%, 3.66 ± 0.11% and 4.73 ± 0.06%, respectively). Plasma concentration of BUN and glucose were similar ($P ≥ 0.57$) among treatments; however, postpartum concentration of circulating BHBA tended ($P = 0.13$) to be 0.24 mmol/L lower with a concurrent reduct ($P < 0.01$) in NEFA concentration in the RPG-fed cows compared with CON (630 vs. 456 ± 68 μEq/L). Circulating insulin tended to be increased ($P = 0.06$; 27%) in RPG-fed cows compared with CON. Based upon circulating hormones and metabolites, it appears that treatment influenced energy partitioning pathways in the periparturient period such that RPG-fed cows mobilized less adipose tissue compared with the control cows while maintaining milk yield.

Key Words: bypass carbohydrates, ketosis, transition period

503 Elevated prepartum adiposity predisposes cows to hepatic steatosis with distinct postpartum lipidome remodeling. J. E. Rico1,2, A. N. Davis1,2, and J. W. McFadden1,2,1Cornell University, Ithaca, NY, 2West Virginia University, Morgantown, WV.

Obesity promotes hepatic steatosis via (1) enhanced fatty acid (FA) uptake and triacylglycerol (TAG) esterification, (2) increased partitioning of FA toward the synthesis of lipid mediators of metabolic disease such as ceramide and diacylglycerol (DAG), and (3) the inflammation-driven degradation of sphingomyelin (SM) and phosphatidylcholine (PC), which may compromise lipoprotein secretion. We aimed to determine whether elevated prepartum adiposity predisposes dairy cows to a modified hepatic lipidome reflecting metabolic impairment during the peripartum. Lean (BCS 3.0 ± 0.2; n = 13) and overconditioned (OVER; BCS 3.9 ± 0.3; n = 12) Holstein dairy cows were enrolled −28 d, and liver tissue was biopsied at d −12 and 10, relative to parturition. Untargeted lipidomics was performed using quadrupole time-of-flight mass spectrometry. Multivariate analysis of normalized, auto-scaled lipids included ANOVA and Pearson correlation coefficient procedures. Lipidomics revealed 406 hepatic lipids including 83 TAG, 106 monoalkyl-diacylglycerols (MADAG), 22 DAG, 32 ceramides, 30 SM, 41 phosphatidylethanolamines (PE). Elevated postpartum plasma FA levels were accompanied by increased liver lipid content (7 versus 11%; $P < 0.05$) and plasma β-hydroxybutyrate (430 versus 506 μM; $P < 0.01$) in OVER. Omics revealed 98 complex lipids affected by adiposity ($P < 0.05$). Relative to lean, OVER displayed elevations in TAG, MADAG, DAG, and select ceramides, while showing stronger reductions in PC postpartum ($P < 0.05$). A total of 13 PC decreased in OVER, relative to lean (e.g., PC 36:6; $P < 0.05$). Several SM were lower in OVER (e.g., SM 40:3; $P < 0.05$), although the changes were not uniform across all SM moieties (e.g., SM 46:1 increased in OVER; $P < 0.05$). Total ceramides were positively correlated with total DAG, MADAG, DAG, and select ceramides, while showing stronger reductions in PC postpartum ($P < 0.05$). A total of 13 PC decreased in OVER, relative to lean (e.g., PC 36:6; $P < 0.05$). Several SM were lower in OVER (e.g., SM 40:3; $P < 0.05$), although the changes were not uniform across all SM moieties (e.g., SM 46:1 increased in OVER; $P < 0.05$). Total ceramides were positively correlated with total DAG, MADAG, DAG, and select ceramides, while showing stronger reductions in PC postpartum ($P < 0.05$). A total of 13 PC decreased in OVER, relative to lean (e.g., PC 36:6; $P < 0.05$). Several SM were lower in OVER (e.g., SM 40:3; $P < 0.05$), although the changes were not uniform across all SM moieties (e.g., SM 46:1 increased in OVER; $P < 0.05$). Total ceramides were positively correlated with total DAG, MADAG, DAG, and select ceramides, while showing stronger reductions in PC postpartum ($P < 0.05$). A total of 13 PC decreased in OVER, relative to lean (e.g., PC 36:6; $P < 0.05$). Several SM were lower in OVER (e.g., SM 40:3; $P < 0.05$), although the changes were not uniform across all SM moieties (e.g., SM 46:1 increased in OVER; $P < 0.05$). Total ceramides were positively correlated with total DAG, MADAG, DAG, and select ceramides, while showing stronger reductions in PC postpartum ($P < 0.05$). A total of 13 PC decreased in OVER, relative to lean (e.g., PC 36:6; $P < 0.05$). Several SM were lower in OVER (e.g., SM 40:3; $P < 0.05$), although the changes were not uniform across all SM moieties (e.g., SM 46:1 increased in OVER; $P < 0.05$).
504 Time course of changes in lactation performance, blood metabolites, inflammation and milk fatty acids during subacute ruminal acidosis induction and recovery in dairy cows. E. Sandri1, Y. Couture2, R. Gervais3, J. Levesque1, and D. Rico*1, 1CIRSAD, Deschambault, QC, Canada, 2Université de Montréal, Saint-Hyacinthe, QC, Canada, 3Université Laval, Quebec, QC, Canada.

Twelve ruminally cannulated cows (120 ± 52 DIM; 35.5 ± 8.9 kg of milk/d; mean ± SD) were randomly assigned to treatment in a Latin square design with 21-d periods. Treatments were: (1) subacute ruminal acidosis (SARA) induction, (2) recovery, and (3) control. SARA was induced by feeding a diet containing 29% starch, 24% NDF, and 2.8% fatty acids (FA), whereas the recovery and control diets contained 20% starch, 31% NDF, and 2.3% FA. Experimental sampling took place on d 0, 3, 7, 10, 14, 17, and 21 of each period. Data were analyzed as repeated measures using the MIXED procedure of SAS. Dry matter intake and milk yield were increased during induction of SARA from d 10 to 21 and from d 14 to 21, respectively (P < 0.05). Milk fat concentration was reduced from d 3 to 14 of SARA induction, whereas lower milk fat yield was observed on d 3 only (P < 0.05). The acetate-to-propionate ratio was lower, whereas the concentrations of total volatile FA and lactate were greater during SARA as compared with the control period (P < 0.05). Plasma insulin and lipopolysaccharide binding protein concentrations increased during SARA induction, whereas plasma nonesterified FA and milk BHBA decreased (P < 0.05). The ratio of milk 10:0 to 11:0 increased during the SARA induction period (P < 0.05), but concentration of 10:0:18:1 remained below 0.5% of FA, whereas 10:0 to 12:0 was not detected. The ratio of 10:0:11:0 18:1 was positively correlated with the acidosis index (area under pH < 5.8/DMI; r = 0.36; P < 0.05). Negative associations were observed between the acidosis index and the milk fat concentrations of iso 14:0, iso 15:0, iso 16:0, iso 17:0, and anteiso 17:0 (r = 0.23 to –0.30, P < 0.05). Plasma cytokines (IFNα, IFNγ, IL-13, IL-1α, IL-1 F5, IL-21, IP-10, MIG, MIP-1β, and TNFα) were not affected by treatment at any time point. From d 3 to 21, most parameters were not different between the recovery and the control periods. Induction of SARA resulted in a rapid and transient reduction in milk fat synthesis, which was not strongly associated with ruminal biohydrogenation.

Key Words: acidosis, dairy cows, milk fatty acids

505 Injectable trace minerals (selenium, copper, zinc, and manganese) alleviates inflammation and oxidative stress during an aflatoxin challenge in lactating multiparous Holstein cows. R. T. Pate* and F. C. Cardoso, Department of Animal Sciences, University of Illinois, Urbana, IL.

Trace minerals are vital in oxidative stress; however, limited research is available on the effects of trace mineral supplementation during an aflatoxin (AF) challenge. The objective of the study was to determine the immunological effects of 2 subcutaneous supplementations of 15 mg/mL Cu, 5 mg/mL Se, 60 mg/mL Zn, and 10 mg/mL Mn (Multimin 90, Multimin North America, Fort Collins, CO) given at 1 mL/90.7 kg of BW in response to an AF challenge. Fifty-eight Holstein cows [BW (734 ± 60kg); DIM (191 ± 93)] were assigned to 1 of 3 treatments in a randomized complete block design. The experimental period (63 d) was divided into an adaptation phase (d 1 to 56) and a measurement phase (d 57 to 63). From d 57 to 59 cows received an AF challenge, which consisted of 100 μg of AFB1/kg of dietary DMI administered orally via balling gun. Treatments were: saline injection and no AF challenge (NEG), saline injection and AF challenge (POS), and trace mineral injection and AF challenge (MM). Injections were performed subcutaneously on d 1 and 29 at 1 mL/90.7 kg of average BW. Blood was sampled on d 0, 56, 60, and 63, and liver samples were taken on d 0 and 60. Two treatment orthogonal contrasts, CONT1 (NEG vs. POS) and CONT2 (POS vs. MM), were made. Milk urea nitrogen and BUN were higher for cows in POS (14.3 mg/dL and 16.5 mg/dL, respectively) than cows in MM (13.3 mg/dL and 15.8 mg/dL, respectively; P = 0.03 and 0.04, respectively). Liver concentrations of Se and Fe were higher for cows in MM (4.6 and 214.4 μg/kg liver DM, respectively) compared with cows in POS (4.0 and 190.8 μg/kg liver DM, respectively; P = 0.04 and 0.02, respectively). Cows in MM tended to have higher plasma glutathione peroxidase activity (30.2 nmol/min/mL) compared with cows in POS (24.2 nmol/min/mL; P = 0.10). An upregulation of liver GPX1 was observed for cows in POS (1.07 ± 0.05) compared with cows in MM (0.95 ± 0.05; P = 0.01). In conclusion, subcutaneous supplementation of trace minerals induced a positive antioxidant response during an AF challenge.

Key Words: aflatoxin, trace mineral, blood urea nitrogen

506 Characterization of hepatic sphingomyelin during the peripartum. A. N. Davis*1,2, J. E. Rico1,2, and J. W. McFadden1,2, 1Cornell University, Ithaca, NY, 2West Virginia University, Morgantown, WV.

Ceramide mediates insulin resistance in obese diabetics. In dairy cattle, the transition from gestation to lactation is characterized by the accrual of ceramide in liver, skeletal muscle, and circulation. Current evidence suggests that the de novo synthesis of ceramide from saturated fatty acids contributes to hepatic ceramide synthesis; however, sphingomyelin (SM) hydrolysis may also contribute to ceramide supply. Our objective was to characterize changes in hepatic SM during the peripartum in dairy cattle. Twenty-five pregnant, multiparous lean (BSC 3.0 ± 0.2) or overconditioned (OVER; BSC 3.9 ± 0.3) Holstein cows were enrolled 28 d before expected parturition. Blood samples were routinely collected. Liver biopsies and the hyperinsulinemic-euglycemic clamp were performed 2 wk before and after parturition. Sphingolipids were quantified using mass spectrometry. Data were analyzed using a mixed model with repeated measures. Similar to hepatic ceramides, C24:0 and C22:0 SM were the most abundant SM species. Although adiposity and time did not modify total SM levels, the hepatic concentrations of C16:0, C18:0, and C20:0 SM increased with time (P < 0.01). In contrast, hepatic C24:0, C24:1, and C26:0 decreased postpartum (P < 0.01). Total dihydro-SM (DHSM) increased with time (P < 0.01); albeit, C16:0, C24:0, and C26:0 DHSM decreased after parturition (P < 0.01). Hepatic C18:0 and C20:0 SM, and C20:0 DHSM levels were greater in OVER (P < 0.01) relative to lean. In contrast, very long-chain C26:0 and C26:1 SM, and C26:1 DHSM were lower in OVER (P < 0.05), relative to lean. Hepatic total DHSM and individual SM were positively correlated with liver lipid content (e.g., C16:0, C18:0, C20:0; P < 0.01), whereas C26:0 SM and DHSM were inversely associated with steatosis (P < 0.01). Similar relationships were observed between hepatic SM and circulating fatty acids. Prepartum, long-chain SM were positively associated with insulin sensitivity (clamp index; P < 0.05), whereas very long-chain SM were negatively related to insulin action (P < 0.05). The observed reciprocal response between long-chain and very long-chain SM mirror peripartal changes in hepatic and plasma ceramide.

Key Words: liver, peripartum, sphingomyelin