Physiology and Endocrinology I

78  Post-ruminal choline ion supplementation during a feed restriction-induced negative energy balance alters milk production and liver triacylglycerol concentration in Holstein cows. D. N. Coleman*1, M. Vailati-Riboni1, A. A. Elolimy1, F. C. Cardoso1, M. Miura2, and J. J. Loor1, 1University of Illinois, Urbana, IL, 2Ajinomoto Co. Inc., Tokyo, Japan.

The objective was to investigate the effects of post-ruminal choline ion (CHO) supplementation to cows during a feed restriction-induced negative energy balance on metabolism, liver triacylglycerol (TG), and milk production. Ten primiparous rumen-cannulated Holstein cows (158 ± 24 DIM) were used in a replicated 5 × 5 Latin square design with 4 d treatment periods (d 1–4), and 10 d recovery periods (d 5–14). Treatments were (1) ad libitum intake with abomasal infusion of water (A0), (2) restricted intake (60% of net energy for lactation requirements) with abomasal infusion of water (R0), (3) restricted intake with abomasal infusion of 6.25 g/d CHO (R6.25), (4) restricted intake with abomasal infusion of 12.5 g/d CHO (R12.5), and (5) restricted intake with abomasal infusion of 25 g/d CHO (R25). Liver biopsies were performed in the morning on d 5 after the abomasal infusion ended, and tissue analyzed for TG content. Body weight and BCS were recorded on d 1 and 5. Blood was collected on d 1–5 for analysis of nonesterified fatty acids (NEFA) and β-hydroxybutyrate (BHB). Milk production was recorded daily and composite samples were analyzed for components. Two contrasts, CONT1 (A0 vs. R0) and CONT2 (R0 vs. the average of 6.25, 12.5 and 25 g/d CHO), and tests of linear and quadratic treatment effects of CHO dose were performed. BW, milk yield (MY) (P < 0.0001) and energy balance was lower in R0 and milk fat % greater compared with A0. Feed restriction also increased liver TG and plasma concentrations of NEFA and BHB. Supplementation of CHO vs. R0 decreased NEFA and milk fat % and increased MY. Supplemental CHO led to a linear increase in MY and a linear decrease in milk fat %. There was a linear decrease in liver TG with CHO supplementation (R0: 3.48 mg/g wet tissue, R6.25: 2.70 mg/g, R12.5: 1.96 mg/g, R25: 2.50 mg/g). These results suggest that supplementation of CHO at 25 g/d during a feed restriction-induced negative energy balance leads to the greatest improvement in MY, whereas 12.5 g/d CHO leads to greater improvement in liver TG storage. The mechanisms associated with these responses merit further research.

Key Words: choline, feed restriction, metabolism

79  Methionine supply during the periparturient period alters plasma amino acid profiles and liver metabolism in dairy cows. F. Batistel*1, R. R. C. Yambaru1, Y.-X. Pan1, C. Parys2, and J. J. Loor1, 1University of Illinois, Urbana, IL, 2Evonik Nutrition & Care GmbH, Hanau-Wolfgang, Germany.

The objective of this study was to investigate the effect of methionine supply during the periparturient period on plasma amino acid concentrations and liver metabolism (TCA cycle, 1-carbon metabolism, transsulfuration pathway, and gluconeogenesis) in dairy cows. Multiparous cows were used in a block design and assigned to a control diet or the control plus rumen-protected methionine (MET; Mepron, Evonik Nutrition & Care GmbH). Mepron was fed from −28 to 30 d relative to parturition at a rate of 0.09% and 0.10% of DMI during the prepartum and postpartum period, respectively. That rate ensured that the ratio of Lys to Met in the metabolizable protein was close to 2.8:1. Blood was sampled from from 15 cows/treatment at −14, +7, +21, and +30 d relative to calving date. Liver was sampled from 8 cows/treatment at −10, +10, and +30 d relative to parturition. Targeted metabolomics (LC-MS) was performed to quantify 32 metabolites. Activity of betaine-homocysteine S-methyltransferase (BHMT), methionine synthase (MTR), and cystathionine-β-synthase (CBS) was measured. mRNA expression of the other enzymes was measured by RT-PCR. Compared with control, feeding MET increased DMI in the prepartum and postpartum period as well as milk yield. A treatment × time interaction was observed for the plasma concentration of Asn, Cys, and Gly due to the concentrations in MET-supplemented cows during the prepartum period. Compared with control, MET-fed cows had greater concentration of Met, Lys, Thr, Leu, Val, and Phe. Liver from MET cows had greater concentrations of metabolites related to the TCA cycle (isocitric acid, α-ketoglutaric acid, and malic acid), 1-carbon metabolism (Met) and transsulfuration pathway (glutathione and Tau) than control cows. Activity of CBS was greater in MET-supplemented cows compared with control. Compared with control, MET cows had greater mRNA expression of enzymes related to the TCA cycle (4CO2 and F4H), 1-carbon metabolism (MAT1), transsulfuration pathway (CBS), and gluconeogenesis (PCK1). Results indicate that feeding MET to a Met to Met ratio of 2.8:1 during the periparturient period increases blood amino acid concentrations, oxidation of substrates and synthesis of antioxidants in the liver.

Key Words: amino acids, metabolomics

80 Insulin sensitivity and glucose utilization in response to methionine supply during the periparturient period in dairy cows. F. Batistel*1, C. C. I. Garces1, C. Parys2, and J. J. Loor1, 1University of Illinois, Urbana, IL, 2Evonik Nutrition & Care GmbH, Hanau-Wolfgang, Germany.

The objective was to examine the effect of methionine supply during the periparturient period on peripheral insulin sensitivity via glucose tolerance test and glucose utilization by skeletal muscle in dairy cows. Multiparous cows were randomly assigned to a control diet or the control plus rumen-protected methionine (MET; Mepron, Evonik Nutrition & Care GmbH). Mepron was fed from −28 to 30 d relative to parturition at a rate of 0.09% and 0.10% of DMI during the prepartum and postpartum period, respectively, to ensure a ratio 2.8:1 Lys to Met in the metabolizable protein. The glucose tolerance test was conducted at day −12 and +12 relative to calving in 12 cows per treatment. A sterile solution of 50% dextrose was administered intravenously at a dose of 0.25 g of glucose per kg of BW over the course of 5 min. Blood samples were collected from the tail vein or artery at −15, −5, 5, 10, 15, 30, 60, 120 min relative to administration of glucose. Hind-leg muscle was sampled via puncture biopsy at day −10 and +10 relative to parturition and was used to measure protein expression of the insulin-sensitive transporter SLC2A4. In the prepartum period, increased MET supply was associated with greater plasma glucose baseline values, maximum concentration of glucose after infusion, and reduced time required for plasma glucose concentration to return to baseline values and plasma glucose area under the curve (AUC). A similar response was observed for the insulin after glucose infusion; MET led to greater plasma insulin baseline values, maximum concentration of insulin after infusion, and plasma insulin AUC while the time required for plasma insulin concentration to return to baseline values was not affected by MET. Protein expression of SLC2A4 was greater in the MET-supplemented cows during the prepartum period. During the postpartum period, MET-supply increased plasma glucose AUC and none of the other parameters measured were affected by treat
mements. Overall, the data indicate differences in glucose utilization during the prepartum and postpartum period in response to methionine supply.

Key Words: metabolism, muscle

81 Postpartum supplementation with rumen-protected branched-chain amino acids: Effects on production and plasma metabolites. F. A. Leal Yepes*,1,2, S. Mann1, T. R. Overton1, J. J. Wakshlag2, and D. V. Nydam2, 1College of Agriculture and Life Sciences, Ithaca, NY, 2College of Veterinary Medicine, Ithaca, NY.

The objective was to evaluate the effect of rumen protected branched-chain amino acids (RPBCAA; 375 g of 27% l-leucine, 85 g of 48% l-isoleucine and 91 g of 67% l-valine) with or without propylene glycol (PG) oral supplementation on milk production, dry matter intake, free fatty acids (NEFA), BHB, and plasma urea nitrogen (PUN) during the early postpartum period in dairy cows. Multiparous Holsteins were enrolled in blocks of 3 and randomly assigned to either the control group or one of the 2 treatments from calving until 35 d. The Control group (n = 26) received 200g of dry molasses; the RPBCAA group (n = 23) received RPBCAA mixed with 200g of dry molasses; the RPBCAA plus PG (RPBCAAPG) group (n = 25) received RPBCAA mixed with 200g of dry molasses plus 300 mL of PG once daily from calving until 7 DIM. Blood was sampled 3 times per week from calving until 21 DIM. Milk yield, energy corrected milk (ECM), dry matter intake (DMI) and PUN were analyzed using repeated measurements ANOVA (Table 1). Chi-squared tests were generated for differences among groups in the number of hyperketonemia events (HYK), defined as concentration of BHB in plasma ≥1.2mmol/L during the first 15 DIM. The number of plasma samples classified as HYK was 57, 22 and 44 in groups control, RPBCAA and RPBCAAPG, respectively (P = 0.001). BCAA are mainly oxidized by the tricarboxylic acid cycle to produce ATP during catabolic states. Therefore, the use of RPBCAA might be a feasible and manageable option to reduce the incidence of HYK in dairy cows during early lactation. The higher PUN in the treatments groups reflects the inclusion of BCAA in the ration.

Table 1 (Abstr. 81).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>BCAA</th>
<th>BCAA+PG</th>
<th>Control</th>
<th>P-value</th>
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</thead>
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<tr>
<td>CP, % DM</td>
<td>16.0</td>
<td>15.8</td>
<td>15.6</td>
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<tr>
<td>Milk yield, kg/d</td>
<td>43.9 ± 2.4</td>
<td>44.9 ± 2.4</td>
<td>41.9 ± 2.4</td>
<td>0.20</td>
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<tr>
<td>ECM, kg/d</td>
<td>52.4 ± 2.0</td>
<td>53.2 ± 2.0</td>
<td>50.4 ± 1.6</td>
<td>0.10</td>
</tr>
<tr>
<td>DMI, kg/d</td>
<td>23.7 ± 0.4</td>
<td>24.0 ± 0.4</td>
<td>23.2 ± 0.4</td>
<td>0.30</td>
</tr>
<tr>
<td>NEFA, μEq/L</td>
<td>548 ± 2.9</td>
<td>504 ± 2.9</td>
<td>580 ± 2.9</td>
<td>0.52</td>
</tr>
<tr>
<td>BHB, mmol/L</td>
<td>0.80 ± 1.07</td>
<td>0.86 ± 1.0</td>
<td>0.96 ± 1.1</td>
<td>0.06</td>
</tr>
<tr>
<td>PUN, mg/dL</td>
<td>10.2 ± 1</td>
<td>9.56 ± 1</td>
<td>8.37 ± 1</td>
<td>0.0006</td>
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</tbody>
</table>

Key Words: branched-chain amino acids, hyperketonemia, milk yield

82 Reducing milking frequency from three to twice a day during the first month of lactation improves energy balance and metabolic status of cows with minor effects on yields. U. Moalem,*1, H. Kamer1,2, A. Hod1,2, L. Livshits1, G. Kra1, S. Jacoby1, Y. Portnick1, and M. Zachut1, 1Department of Ruminants Science, Volcani Center, Rishon LeZion, Israel, 2Department of Animal Science, the Hebrew University of Jerusalem, Rehovot, Israel.

Reducing the milk production during early lactation might be of interest to improve the energy balance (EB) of high yielding dairy cows; therefore, the objectives were to test the effects of reducing the milking frequency from 3 to twice a day during the first 30 DIM, on yields, intake, efficiency, and the metabolic status. Forty-two multiparous cows were divided into 2 groups according to previous lactation performance, parity, and body weight. The control cows were milked 3 times a day (3ML), and the treatment cows were milked twice a day until 30 DIM (2ML), and then 3 times a day. Both groups were followed until 100 DIM. Milk samples were taken twice a week from 3 or 2 consecutive milkings until 45 DIM for milk solids analysis. Individual DMI, milk yields, and BW were recorded daily. Blood samples were taken 3 times weekly from 14 d prepartum until 45 DIM. Data were analyzed using the PROC MIXED model of SAS for the first 30 DIM, and then from 31- to 100 DIM for carry-over effects. Milk yields during the first 30 DIM were 9.4% higher (44.3 and 40.5 kg/d, respectively; P < 0.01), milk-fat percentage was lower (4.21 and 4.57%, respectively; P < 0.001), and yields of all milk solids were higher in the 3ML cows than in the 2ML cows. DMI and FCM (4%) were similar between groups and the EB during the first 30 DIM was better in the 2ML than in the 3ML cows (1.28 and −1.74, respectively; P < 0.007); milk/DMI, but not FCM/DMI, was higher in the 3ML cows. From 31 to 100 DIM, no differences were observed in milk yield (56.9 kg/d for both groups), milk solids yields, DMI or milk/DMI; however, fat percentage was higher in the 2ML and the EB was better in the 3ML cows. Blood glucose concentrations between 0 and 30 DIM were higher (P < 0.0003); β-hydroxybutyrate were lower (P < 0.02), NEFA were higher (P < 0.002), and insulin were lower (P < 0.08) in the 2ML than in the 3ML cows. In conclusion, reducing the milking frequency to twice a day during the first 30 DIM improved the EB and the metabolic status, with minor effects on production.

Key Words: milking frequency, energy balance, metabolic status

83 Endocrine effects of milking frequency and anti-inflammatory treatment in early lactation. C. M. Ylioja*, M. Garcia, L. K. Mamedova, and B. J. Bradford, Kansas State University, Manhattan, KS.

Inflammatory signals in early lactation may aid in the allocation of nutrients toward milk production through altered sensitivity of endocrine signals. We sought to measure effects of anti-inflammatory treatment, as well as the impact of reducing nutrient demand by the mammary gland, on endocrine signaling in early lactation. Multiparous Holstein cows were enrolled at calving and randomly assigned to either sodium salicylate (SS; 2 g/L) or control (CTL; molasses carrier) treatment, administered via drinking water for the first 5 d of lactation, and to a milking frequency (MF) of either once (1×) or 3 times daily (3×), in a 2 × 2 factorial design (n = 8–9). Mixed models were used to assess repeated measures over time. Analysis of plasma samples collected daily before feeding on d 1 to 5 showed that insulin levels were decreased with more frequent milking (0.32 vs. 0.24 ± 0.02 ng/mL; P = 0.02), and also decreased over time compared with 1× (interaction P = 0.02). Insulin was also decreased with SS treatment (0.31 vs. 0.25 ± 0.02 ng/mL for CTL and SS, respectively; P = 0.04). Treatment × MF interactions for plasma glucagon (P = 0.05) and resistin (P = 0.05) revealed increases in both hormones only in 3 × cows treated with SS. Glucagon concentration was greater on d 5 for 3 × vs. 1 × cows (35.5 vs. 24.9 ± 2.9 pg/mL; P = 0.01). Circulating TNFα was also increased by frequent milking (56.1 vs. 34.1 ± 5.3 pg/mL; P < 0.01). On d 5 of the study, cows underwent a glucose clamp protocol with a 2-h euglycemic phase followed by a 2-h hyperinsulinemic-euglycemic phase; blood samples were collected in the last 30 min of each phase. During hyperinsulinemia, SS increased resistin compared with CTL (124 vs. 64 ± 19 pg/mL; P =...
0.03). Hyperinsulinemia decreased glucagon only in the 3 × cows (MF × phase interaction \( P = 0.05 \)). These results suggest that greater MF (and negative energy balance) may promote inflammatory signaling and alter adipose and pancreatic sensitivity to endocrine signals in early lactation. Manipulation by SS treatment triggers additional endocrine responses to maintain metabolic homeostasis in this window of time.

**Key Words:** inflammation, insulin sensitivity, endocrine

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**84** Expression and activity of the branched-chain α-keto acid dehydrogenase (BCKDH) in different tissues of early-lactating dairy cows. L. A. Webb*1, H. Sauerwein2, D. von Soosten2, S. Dänicke2, and H. Sadri3,1, 1Institute of Animal Science, Physiology and Hygiene University, Bonn, Bonn, North Rhine-Westphalia, Germany; 2Institute of Animal Nutrition, Friedrich-Loeffler Institut, Federal Research Institute for Animal Health, Brunswick, Lower Saxony, Germany; 3Department of Clinical Science, Faculty of Veterinary Medicine, University of Tabriz, Tabriz, Iran.

Break-down of branched-chain amino acids (BCAA) plays a major role in the metabolic adaptation to the increased energy needs due to lactation. We aimed to specify the potential role of various metabolically active tissues in BCAA catabolism of early-lactating dairy cows. Liver, muscle (M. semitendinosus), mammary gland (MG), subcutaneous (scAT); tail head) and visceral adipose tissue (vAT; omental fat) of 25 primiparous Holstein cows were collected on d 1, 42 and 105 postpartum (p.p.) during slaughter and examined for mRNA and protein abundance and the activity of the rate-limiting enzyme BCKDH. Target genes were quantified by qPCR, protein abundance was measured via Simple West technology, and enzyme activity was determined spectrophotometrically. Data were analyzed using a Linear Mixed Model (fixed: tissue, time, tissue × phase interaction \( P = 0.02), week of calving (Wk0), first week postpartum (wk +1) and second week postpartum (wk +2). BCKDH was significantly different across all time points studied (0.9 wk −2, 2.8 wk 0, 4.7 wk +2, \( P < 0.05, n = 4 \) per time point). ApoCII is postulated to have lipopolysaccharide-neutralizing effects. Relative amount of serum amyloid A was also divergent (0.4 wk −2, 1.8 wk 0, 1.0 wk +2, \( P < 0.05, n = 4 \) per time point), with smaller changes noted in α 1 antitrypsin, paraoxonase, and 3 different glycoproteins. Proportion of HDL was not different across time points (75.7% ± 5.4 wk −2, 83.7% ± 6.5 wk 0, 85.3% ± 3.8% wk+2, \( P > 0.06 \)). In addition to the well-recognized decline in HDL that occurs during transition, our data indicate the composition of HDL varies across this time as well.

**Key Words:** lipoprotein, proteome, transition

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**86** Association between bile acid with energy balance, and glucose to insulin ratio during the transition period. S. H. Cheong*, E. Behling-Kelly, W. R. Butler, and M. S. Roberson, Cornell University, Ithaca, NY.

Bile acids are traditionally known for their role in lipid digestion and recently bile acids have been shown to have potential endocrine activity. Pregnancy state elevates bile acid concentration in humans, but the effects of pregnancy on bile acid concentrations have not been studied in cattle. Our objective was to report the bile acid profile during the transition period and to determine if bile acid concentrations are associated with energy balance, glucose and insulin. Multiparous Holstein cows (n = 48) were characterized for plasma total bile acid concentration, energy balance, nonesterified fatty acids (NEFA), BHB, glucose and insulin at 5 time points: 3 wk prepartum (wk −3), 2 wk prepartum (wk −2), week of calving (Wk0), first week postpartum (wk +1) and second week postpartum (wk +2). Blood was collected at approximately 0900 h and fresh TMR was given at 0800 h daily. Cows were individually fed in tie-stalls with daily feed offered and refused weighted to determine feed intake. Average daily energy balance was calculated based on energy intake and energy requirements for maintenance, pregnancy or lactation for each of the time periods. Data were analyzed as repeated measures using PROC MIXED of SAS. Total bile acid concentration was significantly lower during pregnancy and increased postpartum (in \( \mu \)mol/L, wk −3 = 15.7 ± 1.3, wk −2 = 14.9 ± 1.3, wk 0 = 38.7 ± 2.6, wk +1 = 65.1 ± 5.0, wk +2 = 75.2 ± 9.1, \( P < 0.001 \)). Plasma total bile

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**85** Characterizing changes in the proteome of high-density lipoprotein over the transition period in dairy cows. E. Behling-Kelly*1, S. Davidson2, D. Nydam1, F. Leal-Yepes1, and S. Mann1, 1Cornell University, Ithaca, NY; 2University of Cincinnati, Cincinnati, OH.
acid concentration was positively associated with NEFA ($P < 0.001$) and BHBD ($P = 0.009$); and negatively associated with energy balance ($P < 0.001$) and insulin ($P < 0.001$); but not associated with glucose ($P = 0.19$). Glucose to insulin ratio was also higher in cows with increased plasma total bile acid ($P < 0.001$). Taken together, increased plasma total bile acid was associated with poorer energy balance and higher glucose to insulin ratio during the transition period but further studies are warranted. This work was supported by the USDA National Institute of Food and Agriculture, Research Animal Health project NYCY-480867.

**Key Words:** bile acids, energy balance, insulin resistance

87  **PBMC mitochondrial enzyme activity in high- and low-producing Holstein cows during early lactation.** A. Niesen*1, H. Rossow1, and O. Genthner-Schroeder2, 1UC Davis, Davis, CA, 2Purina Animal Nutrition Center, Gray Summit, MO.

Mitochondria are central to metabolism and the primary energy producers for all biosynthesis, including lactation. The objective of this study was to determine if high and low producing dairy cows exhibit differences in mitochondrial enzyme activities during early lactation. Fifty-six Holstein cows were assigned to one of four groups: primiparous high or low ECM (41.8 vs 33.2 kg/d) and multiparous high or low ECM (56.8 vs 44.3 kg/d). Group assignments were made after data were collected by averaging ECM for primiparous cows and then for multiparous cows and assigning below average cows to the low group and above average cows to the high group. Whole blood samples were collected at one time point within (70 ± 11 DIM) and processed for crude mitochondrial extracts from peripheral blood mononuclear cells (PBMCs). Mitochondrial function of the extracts was assessed by measuring the activity rates of citrate synthase, complex I, complex IV, and complex V using kits from Abcam (Cambridge, MA). Milk samples were collected 9 times within a week of blood collection and analyzed for major components using a MilkoScan FT2 by FOSS (Mulgrave, Australia). Data were analyzed using the Mixed procedure of SAS (Version 9.4, SAS Inst. Inc., Cary, NC) for high and low ECM with cow as the experimental unit of interest and dependent variables parity, and DIM as a covariate. Complex V enzyme activities tended to be higher in multiparous than primiparous cows (0.30 vs. 0.20 mOD/min/ug respectively; ($P = 0.1$). Citrate synthase activity was lower in multiparous animals than primiparous (0.92 vs.1.3 mOD/min/ug respectively; ($P = 0.006$). Complex I activity was lower in low producing cows than high producing cows for both primiparous and multiparous groups (0.022 vs. 0.020 mOD/ min/ug), (0.028 vs. 0.031 mOD/min/ug), respectively; ($P = 0.04$) and not affected by parity ($P > 0.1$). These findings suggest that complex I enzyme activity may be a marker of ability to produce milk and support previous findings that mitochondrial density (citrate synthase activity) decreases with age in dairy cattle.

**Key Words:** mitochondria, lactation, PBMC

88  **Effects of level of DCAD and duration of feeding on responses to glucose tolerance test and insulin challenge in prep- partum dairy cows.** A. Vieira-Neto*1, C. Lopera1, R. Zimpel1, F. R. Lopes Jr.1, P. Molinari1, B. Faria1, M. L. Gambarini1, E. Block2, W. W. Thatcher1, C. Nelson1, and J. E. P. Santos1, 1University of Florida, Gainesville, FL, 2Church and Dwight Animal Nutrition, Ewing, NJ.

Objectives were to determine the effects of acidogenic diets (AD) fed for 21 or 42 d on glucose metabolism and tissue insulin responsiveness. Ninety Holstein cows at 230 d of gestation were randomly assigned to receive diets with −70 or −180 mEq/kg DM for 21 (Short) or 42 d (Long). Cows in Short received a diet with +110 mEq/kg from 233 to 254 d of gestation. Therefore, in the first 21 d cows were fed +110, −70, or −180 mEq/kg DM, whereas in the last 21 d of gestation they were fed either −70 or −180 mEq/kg DM. The glucose tolerance tests (GTT) were performed at 250 and 270 d of gestation by infusing 0.25 g of dextrose/kg BW within 2 min. The following day, cows received 0.1 IU of insulin/kg BW intravenously (insulin challenge, IC). Jugular blood was sampled at min −15, −5, and 0 to establish a baseline, and from 5 to 180 min relative to infusions; concentrations of glucose, NEFA, and insulin were determined and area under the curve (AUC) and change in AUC relative to baseline (rAUC) were calculated. Liver was sampled after the GTT and subcutaneous adipose tissue was sampled after the GTT and IC for RT-qPCR. Data were analyzed by ANOVA with mixed models using the Mixed procedure of SAS. At GTT250, the rAUC for glucose increased ($P = 0.04$) in cows fed AD (+110 = 264.5, −70 = 285.5, and −180 = 270.4 ± 6.4 mM/min), which is explained by the smaller ($P = 0.04$) rAUC for insulin in cows fed AD (+110 = 1,420, −70 = 1,079, −180 = 852 ± 208 ng/mL/min). At IC250, cows fed AD tended ($P = 0.06$) to have increased NEFA (+110 = 0.24, −70 = 0.30, and −180 = 0.33 ± 0.04 mM). At GTT270, cows in Long had greater ($P < 0.05$) rAUC for glucose than cows in Short (Long = 1,201 vs. Short = 1,110 ± 61 mM/min), which is explained by the smaller ($P < 0.04$) rAUC for insulin in Long than Short (Long = 969 vs. Short = 1,409 ± 157 ng/mL/min). Hepatic expression of G6PC, PCK1, PCK2, and PC did not differ among treatments after GTT250 and GTT270. Treatments did not affect adipose tissue expression of ATGL, ACC, B2AR, HSL, and PLIN1. Metabolic acidosis induced by AD reduced insulin release in response to a GTT and adipose tissue responsiveness to an IC. Feeding AD for 42 d reduced insulin release in response to GTT.

**Key Words:** adipose tissue, DCAD, glucose

89  **Association of residual feed intake with abundance of ruminal bacteria and biopolymer hydrolyzing enzyme activities during the peripartal period and early lactation in Holstein dairy cows.** A. Elolimy*,1, J. Arroyo1,2, F. Batistel1, M. Iakiviak1, and J. Loor1,3, 1Department of Animal Sciences, University of Illinois, Urbana, IL, 2Departamento de Nutrición Animal, Instituto de Producción Animal, Facultad de Veterinaria, Universidad de la Republica, San José, Uruguay, 3Division of Nutritional Sciences, Illinois Informatics Institute, University of Illinois, Urbana, IL.

Residual feed intake (RFI) in dairy cattle typically calculated at peak lactation is a measure of feed efficiency independent of milk production level. The objective of this study was to evaluate differences in ruminal bacteria, biopolymer hydrolyzing enzyme activities, and overall performance between the most- and the least-efficient dairy cows during the peripartal period. Twenty multiparous Holstein dairy cows with ad performance between the most- and the least-efficient dairy cows during the peripartal period. Compared with the least-efficient cows, the most-efficient cows had greater relative abundance of bacteria, biopolymer hydrolyzing enzyme activities, and overall performance between the most- and the least-efficient dairy cows during the peripartal period. Twenty multiparous Holstein dairy cows with ad libitum access to a total mixed ration from d −10 to d +60 relative to the calving date were used. Cows were classified into most-efficient (i.e., with low RFI, n = 10) and least-efficient (i.e., with high RFI, n = 10) based on a linear regression model involving DMI, FCM, changes in BW, and metabolic BW. The most-efficient cows had −2.6 kg/d lower DMI ($P < 0.05$) at wk 4, 6, 7, and 8 compared with the least-efficient cows. In addition, the most-efficient cows had greater relative abundance of total ruminal bacterial community ($P < 0.05$) during the peripartal period. Compared with the least-efficient cows, the most-efficient cows had 4-fold greater relative abundance of Succinivibrio dextrinosolvens ($P < 0.05$) at d −10 and d +10 around parturition and tended ($P < 0.10$) to have greater abundance of Fibrobacter succinogenes and Megaplasma elsdenii. In contrast, the relative abundance of Butyrivibrio proteoclasticus and Streptococcus bovis was lower ($P < 0.05$) whereas...
Succinimonas amylolytica and Prevotella bryantii tended to be lower ($P < 0.10$) in the most-efficient cows around calving. During the peripartal period, the most-efficient cows had lower enzymatic activities of cellulase, amylase, and protease compared with the least-efficient cows. The results suggest that shifts in ruminal bacteria and digestive enzyme activities during the peripartal period could, at least in part, be a mechanism for better feed efficiency in dairy cows.

**Key Words:** residual feed intake (RFI), bacteria, enzyme