would consistently polymerize a blend of citric acid (6%), glucose (20%), and lactose (74%). Seven-gram samples of the sugar acid blends were added to 8 Teflon MarsXpress vessels. The set temperature, ramp time, and hold time were varied to melt the powder blend and achieve polymerization, without reaching decomposition. All vessels were continuously monitored for temperature during the reaction via an infrared thermometer. The reacted samples were cooled and dissolved in water, passed through ion-exchange resins, and then separated and detected by HPLC-ELSD. An initial heating profile with a 5-min ramp time to a 180°C target temperature imitated extrusion conditions known to result in polymerization. Even though polymerization was observed with this heating profile, the reactants did not reach the target temperature and temperature variability between vessels occurred. These challenges led to modifications of the heating profile including an increase in the ramp time (15 min) and a reduction in the temperature (140°C). Uneven heating was still a challenge so the formula was modified by adding a small amount of water (<1% wt/wt) to increase dipole rotation due to the microwave energy. The inclusion of a polar solvent resulted in consistent, even heating. Product resulting from the lower-temperature, longer-time heating profile demonstrated successful polymerization. The elevated pressure in the microwave reaction system, when compared with the open extrusion system, allowed for polymerization at a lower temperature. This benchtop polymerization method allows for experimentation of numerous formulas and the identification of inhibitors. Understanding these factors for permeate or acid whey will allow for polymerization into a value added ingredient, soluble fiber.

Key Words: lactose, polymerization, microwave

0716 Effect of microencapsulated iron salts on cheddar cheese divalent cation balance and composition.

A. Arce* and Z. Ustunol, *Michigan State University, East Lansing*.

Milk is considered an important source of macro- and micronutrients but naturally low in iron content. Cheese and other dairy products had been fortified with iron with low success due to negative changes in composition and organoleptic attributes. There is limited information about using microencapsulation of iron compounds in dairy products. Minerals have the ability to displace one another in any system; consequently, it is expected that encapsulation will avoid divalent cation displacement within the cheese matrix. The objective of this study was to analyze divalent cation balance in fortified cheddar cheese with microencapsulated ferrous sulfate. Furthermore, proximate analysis was done to provide more information about any compositional changes after fortification. Cheddar cheese was manufactured using standard cheddar cheese procedures a total of three times. Cheddar cheese was fortified with either large microencapsulated ferrous sulfate (LMFS; 0.9536 g microencapsulated ferrous sulfate/kg cheese and 700–1,000 μm diameter) or small microencapsulated ferrous sulfate (SMFS; 1.7801 g microencapsulated ferrous sulfate/kg cheese and 220 to 422 μm diameter). Iron treatment was incorporated to cheddar cheese processing in the salting step but omitted for the control. After 90 d of aging, calcium, iron, magnesium, and zinc content were analyzed using atomic absorption spectroscopy and percent recoveries were calculated. Moisture, ash, fat, and protein analysis were done using AOAC methods. All collected data was analyzed using one-way ANOVA and Tukey's HSD test ($P = 0.05$). Iron content for all treatments were significantly different ($P < 0.05$): approximately 0.030 mg Fe/g cheese for the control, 0.134 mg Fe/g cheese for LMFS, and 0.174 mg Fe/g cheese for SMFS. Results showed 81.3% iron recovery for LMFS and 90.0% iron recovery for SMFS. Proximate analysis and magnesium, zinc, and calcium content were not significantly different when comparing fortified cheeses with the control. Overall, microencapsulated ferrous sulfate caused no major changes in terms of cheddar cheese composition and successfully increased iron content. Microencapsulated ferrous sulfate with smaller diameter showed slightly better results for iron retention in cheddar cheese. The proposed fortified cheddar cheese can help increase total iron intake for children, pregnant women, vegetarians, and those whose diets are likely to be deficient in iron by providing at least 5 mg Fe (30% RDA) per serving.

Key Words: fortification, cheese, minerals

ADSA PRODUCTION DIVISION GRADUATE STUDENT ORAL COMPETITION: MS

0717 Rumen development in Holstein calves.

K. E. Mitchell*, *University of California, Davis, Davis*.

Feed intake in calves is very important for future production and health, but there are many issues that can influence starter intake such as weather, rumen development, and overall calf health. The objectives of this study were to observe the interaction of starter grain intake and rumen development. Data from 122 Holstein bull and heifer calves were collected from age 2 to 69 d, time of exit from hutch including fecal scores (1–3), DMI, medication, and milk intake. Daily starter grain samples were pooled by week and analyzed for nutrient content by Analab (Agriking, Fulton, IL). Blood samples were collected from a subset of 38 calves and analyzed for glucose (mg/dL) and β-hydroxybutyrate (BHBA; mmol/L) levels with Precision Extra (Abbott Diabetes Care, Inc., Alameda, CA) blood meters. At 1, 6, and 9 wk, blood samples were also analyzed using a VetScan Large Animal Profile rotor (Abaxis Inc., Union City, CA). The rotor tested for albumin (ALB), alkaline phosphatase (ALP), aspartate aminotransferase (AST),

calcium (Ca), creatine kinase (CK), γ glutamyl transferase (GGT), phosphorus (P), magnesium (Mg), total protein (TP), and urea nitrogen (BUN). The Abaxis blood parameters indicate immune status and, indirectly, liver function (ALB, Glob, TP, and GGT), liver and bone function (ALP, Ca, P, and Mg), liver and kidney function (AST and BUN) and muscle damage (CK). Weekly outcomes, average DMI, average milk intake, and blood parameters were analyzed using the MIXED procedure of SAS with repeated measured by calf, hutch, and gender as fixed effects and the random variable week. Hutch and gender were not significant but week was significant for all comparisons. Alkaline phosphatase and Ca were all elevated whereas AST, TP, and Glob were lower than expected values. Blood urea nitrogen and CK were within the expected range for adult cows and steadily increased over the experimental period. Total protein ($P < 0.064$), AST ($P < 0.0001$), Glob ($P < 0.0076$), BHBA ($P < 0.0001$), and BUN ($P < 0.013$) increased with increasing DMI. Glucose ($P < 0.0001$), however, decreased with increasing DMI. Increases in these parameters also show changes as the rumen develops. Therefore, starter grain intake is an important factor for rumen development in a Holstein calf.

Key Words: blood parameters, calves, rumen development

0718 Milk fat secretion in lactating dairy cattle is influenced by soybean particle size and fatty acid profile. K. A. Weld* and L. E. Armentano, *University of Wisconsin – Madison, Madison*.

It is well established in the literature that when feeding free vegetable oils, oleic acid has a smaller negative effect on milk fat secretion than does linoleic acid. The objectives of these experiments were to analyze the effects of oleic and linoleic acid fed as part of full fat soybeans and to analyze the interaction between soybean particle size and fatty acid profile. Trial 1 used 63 cows (28 primiparous and 35 multiparous; 111 ± 20 d in milk [DIM]). Cows were housed in a common pen with 32 electronic feed gates and fed conventional or high-oleic (Plenish) whole raw beans for 3 wk following a covariate adjustment period. The second trial used 20 cows (10 primiparous and 10 multiparous; 88 ± 10 DIM) in a tie stall barn, using two complementary 5 × 5 Latin squares per parity. Raw Plenish or conventional beans, either ground (GP and GC) or whole (WP and WC), formed 4 iso-fat diets in a 2 × 2 factorial, plus a fifth treatment was a low-fat diet without soybeans. Diets were 55% forage and isonitrogenous and contained 2.9 to 3.9% added ether extract from soybeans (15.5–18.7% soybeans, DM basis). In trial 1, there was a parity × diet interaction ($P < 0.10$); there were no diet effects with primiparous cows ($P > 0.10$), but for multiparous cows, feeding Plenish beans increased milk fat yield ($P < 0.05$). In trial 2, when there was a significant interaction ($P < 0.10$) between bean type and particle size, we tested GP vs. GC and WP vs. WC. If the interaction was not significant ($P > 0.10$), the main effects of bean type and particle size were tested. There was a significant interaction between bean type and particle size for both milk fat yield and concentration ($P < 0.05$). GP resulted in greater milk fat yield and concentration than GC ($P < 0.05$), whereas there was no difference between WP and WC ($P > 0.10$). Diet affected milk yield with the Plenish diets resulting in lower milk yield ($P < 0.05$). In both trials, the increase in milk fat yield was due to an increase in 18-carbon milk fatty acids ($P < 0.05$) and there was not a difference in short-chain fatty acid yield ($P > 0.10$). Plenish high-oleic soybeans result in moderately increased milk fat compared with conventional soybeans, and this difference is greater when soybeans are fed ground rather than whole.

Key Words: linoleic, oleic, soybeans

Table 0718.

Variable	Trial 1			Trial 2					
	Conventional Multiparous	Plenish Multiparous	SE	Low Fat	Ground Conventional	Ground Plenish	Whole Conventional	Whole Plenish	SE
DMI (kg/d)	26.5	26.8	0.9	26.5	26.3	26.3	26.7	26.6	0.6
Milk (kg/d)	45.1	45.0	1.2	48.0	48.8	47.2	48.5	46.8	1.0
Protein (%)	3.05	3.06	0.05	3.18	3.09	3.18	3.08	3.13	0.04
Protein (kg/d)	1.36	1.40	0.06	1.51	1.50	1.49	1.49	1.40	0.03
Fat (%)	3.84	4.07	0.10	3.25	3.09	3.50	3.40	3.53	0.16
Fat (kg/d)	1.70	1.84	0.06	1.54	1.49	1.64	1.64	1.63	0.08

0719 Effects of heat stress and dietary zinc source on mammary tight junction of lactating dairy cows. X. Weng*[1], A. P. A. Monteiro[1], J. Guo[1], J. K. Bernard[1], J. DeFrain[2], and S. Tao[1], [1]*University of Georgia, Tifton,* [2]*Zinpro Corporation, Eden Prairie, MN*.

Dietary Zn has been shown to alter gut integrity in monogastrics under heat stress. However, the effect of Zn on mammary tight junction (MTJ) integrity in heat-stressed lactating dairy cows has not been studied. Seventy-two multiparous lactating Holstein cows (2.9 ± 1.1 parity and 99.7 ± 55.5 d in milk) were randomly assigned to 4 treatments with a 2 × 2 factorial arrangement to study the effect of environment and Zn source on performance and MTJ integrity (n = 18/treatment). Treatments included two environments, cooled (CL) or not cooled (NC), and two Zn sources, 75 ppm supplemental Zn as ZnCl (IOZ) or 35 ppm ZnCl + 40 ppm Zn–methionine complex (ZMC). The experiment was divided into baseline and environmental challenge phases, 84 d each. During the baseline phase, all cows were cooled (fans and misters over the freestall and feeding areas; average temperature–humidity index = 73) and fed respective dietary treatments, whereas during the environmental challenge phase, NC cows were not cooled (average temperature–humidity index = 78). Feed intake was measured daily. Milk yield was recorded at each milking (3x/d) and composition was analyzed weekly. Vaginal temperature was measured every 5 min for 4 d/wk. Milk and plasma samples were collected weekly for analyses of milk BSA and plasma lactose. Deprivation of cooling decreased DMI ($P < 0.01$). Energy-corrected milk yield decreased ($P < 0.01$) for NC cows relative to CL cows (24.5 vs. 34.1 kg/d). An interaction between environment and Zn source ($P = 0.04$) occurred for milk fat percent as CL cows fed ZMC had lower milk fat percent relative to other groups. Relative to CL cows, NC cows had lower milk lactose and solids-not-fat percent ($P = 0.05$) but higher concentration of milk urea nitrogen ($P < 0.01$). Vaginal temperature was higher ($P < 0.01$) in NC cows relative to CL cows (39.9 vs. 39.0°C). Plasma lactose was similar between treatments at the start of the baseline phase but increased in cows fed IOZ and was unchanged in cows fed ZMC throughout the baseline phase (Zn source × day, $P = 0.06$). Relative to CL cows, plasma lactose tended to increase in NC cows over time (environment × day, $P = 0.09$), indicating increased MTJ permeability, and feeding ZMC tended to decrease plasma lactose during the environmental challenge phase relative to IOZ ($P = 0.11$). In conclusion, removing active cooling impairs lactation performance and feeding a portion of dietary Zn as ZMC improves the integrity of MTJ as evidenced by the decreased permeability of lactose through MTJ.

Key Words: heat stress, mammary tight junction, zinc

0720 Effects of feeding forage and concentrate, separately or as a total mixed ration, on ruminal methane emission, fermentation characteristics, and total tract digestibility. B. Rajaraman*[1], A. Selvaraj[2], C. H. Lee[2], and K. H. Kim[1,2], [1]*Graduate School of International Agricultural Technology, Seoul National University, Pyeongchang, the Republic of Korea,* [2]*Green Bio Science and Technology, Seoul National University, Pyeongchang, the Republic of Korea*.

Very little research is available on the advantages of feeding systems, specifically how forage and concentrate feeding, separately (SF) or as a total mixed ration (TMR), affects methane production from enteric fermentation of ruminant. Three experiments were performed at three different levels of daily feed intake (1.8, 2.1, and 2.6% of BW) to investigate methane production from the different feeding systems by using a quadruplicated 2 × 2 crossover design. Each experiment was conducted using eight male Holsteins with BW ranging from 230 to 570 kg. Animals were provided either SF or TMR containing 73% concentrate and 27% forage, with the same ratio of same ingredients and grasses, twice a day. Animals fed SF received the forage first for 30 to 40 min and then received the concentrate. In experiment 2, the ruminal fermentation characteristics (1.5, 3.0, and 4.5 h after morning feeding) and indirect total tract digestibilities were evaluated based on rumen fluid and fecal grab samples, respectively. Animals fed TMR in experiment 1 and 2 emitted significantly more methane (169.9 vs. 140.1 ± 6.9 L/d [$P < 0.05$] and 138.4 vs. 114.19 ± 4.2 L/d [$P < 0.01$], respectively) and lost more methane energy (7.1 vs. 5.6 ± 0.4% [$P = 0.01$] and 4.0 vs. 3.4 ± 0.2% [$P < 0.01$], respectively) compared with those fed SF. No differences ($P > 0.1$) were observed in methane emissions and methane energy losses for animals fed diets at 2.6% of BW in experiment 3, although those fed TMR emitted slightly more methane than those fed SF. Cattle that received SF exhibited significantly lower ($P < 0.05$) ruminal pH and higher ($P < 0.05$) ammonia N concentration, total VFA, and individual VFA production compared with those fed a TMR at 4.5 h after feeding. A significantly ($P < 0.05$) lower acetate:propionate ratio (2.2 vs. 2.6) in those fed SF reflected the shift in hydrogen transfer toward the formation of more propionate than in those fed TMR. Significantly higher levels of isobutyrate and isovalerate ($P < 0.05$) were observed in those fed SF compared with those fed TMR. The total tract digestibilities of CP, NDF, and OM were not affected by the feeding system. Overall, these results indicate that, compared with TMR, SF significantly reduces methane emission from ruminants and increases VFA production without affecting the total tract digestion.

Key Words: methane, rumen, separate feeding

0721 The effect of dietary fats on fatty acid composition, gene expression, and vitamins status in preruminant calves. C. Y. Tsai*, W. I. Loucks, C. M. Scholte, K. C. Ramsey, M. E. Doumit, and P. Rezamand, *University of Idaho, Moscow*.

Dietary saturated (SFA) and unsaturated fat (UFA) alters fatty acid composition of various tissues, serum, and lipid-soluble vitamins. The objective was to examine the effect of dietary SFA and UFA on adipose, liver, serum, polymorphonuclear (PMN) and peripheral blood mononuclear cells' (PBMC) fatty acid profiles, selected gene expression of inflammatory mediators, and their relation with vitamin content in preruminant calves. Twelve Holstein male calves were randomly assigned to two treatments. Starting at 3 d of age, 6 calves on SFA received 120 mL palm oil/d and 6 calves on UFA received 80 mL flaxseed oil plus 40 mL CLA. After 50 d, all animals were euthanized and samples were obtained. Gas chromatography was used to analyze fatty acid composition. High-performance liquid chromatography was used to analyze α-tocopherol and retinol in liver tissues as well as α-tocopherol, retinol, and β-carotene in serum. Liver and adipose tissue were analyzed for relative gene expression of interleukin (IL)-1β, IL-6, IL-8, IL-10, IL-12, interferon-γ, peroxisome proliferator-activated receptor-γ, TNF-α, retinol binding protein-4, and NF-κB. The PBMC were examined for gene expression of IL-1β, IL-6, TNF-α, and intercellular adhesion molecule-1; PMN were analyzed for expression of caspase-1, IL-8 receptor, and L-selectin (L-SEL). Data were analyzed using the PROC TTEST of SAS with significance declared at $P \leq 0.05$. The UFA had greater α-linolenic acid (α-LA) compared with SFA calves in (NEFA, neutral lipids [NL], and phospholipids [PL]) fractions of liver, adipose, and serum as well as PBMC and PMN. The higher content of α-LA in calves fed UFA resulted in greater EPA in all three lipid fractions of serum as well as NL and PL fractions of adipose tissue. In addition, PBMC and PMN had higher EPA in UFA calves. The UFA group, however, had lower γ-linolenic acid compared with SFA calves in all three fractions of liver as well as NL and PL fractions of serum. Dietary UFA also increased total PUFA in three lipid fractions of serum and adipose. The lipid-soluble vitamins content in serum was reduced by dietary UFA. Moreover, L-SEL expression was upregulated in calves receiving UFA. This may indicate that UFA supplementation elevated the substrate of PUFA biosynthesis but possibly degraded the lipid soluble vitamins to protect these fatty acids from oxidation. This may influence the migration of PMN from the blood to tissues, affecting overall inflammatory responses.

Key Words: calves, fatty acid composition, gene expression

0722 Effect of OmniGen-AF and heat stress during the dry period on subsequent performance of cows. T. F. Fabris*[1], J. Laporta[1], F. N. Correa[1], Y. M. Torres[1], D. J. Kirk[2], D. J. McLean[2], J. D. Chapman[2], and G. E. Dahl[1], [1]*Department of Animal Sciences, University of Florida, Gainesville,* [2]*Phibro Animal Health Corp., Quincy, IL*.

Heat stress in dairy cows during the dry period impairs milk production in the next lactation. Feeding OmniGen-AF (OG) to lactating cows during heat stress increases DMI and lowers respiration rate (RR) and rectal temperature (RT), but effects in dry cows are not known. We hypothesized that OG supplementation before, during, and after the dry period (approximately 160 d) would overcome the effects of heat stress and improve performance. Treatment groups were heat stress (HT; only shade; $n = 17$), heat stress with OmniGen-AF (HTOG; 56 g/d; $n = 19$), cooling (CL; shade, fans, and sprinklers; $n = 16$), and cooling with OmniGen-AF (CLOG; $n = 11$). Cows were randomly assigned to treatments based on previous mature equivalent milk production. Cows were dried off 45 d before expected calving and after parturition; cows were kept under the same cooling system and management until 60 DIM. Cooling cows during the dry period reduced RT (38.8 vs. 39.0 for CL vs. HT, respectively; $P < 0.01$) and RR (44 vs. 73 for CL vs. HT, respectively; $P < 0.01$). Respiration rate was also decreased by OG supplementation (56 vs. 61 for OG vs. non-OG, respectively; $P < 0.01$). There was an interaction between OG supplementation and HT ($P < 0.1$); HTOG cows had lower RT compared with HT cows. During the dry period, OG reduced DMI relative to non-OG cows ($P < 0.1$). Calf birth weight was greater in calves from CL cows (CL vs. HT; $P < 0.01$). In cows, no differences in hematocrit, total protein, and BCS among treatments were detected. Cows on CLOG had higher BW (kg) at parturition (CLOG, 794.9 kg; CL, 746.8 kg; HTOG, 762.9 kg; and HT, 720 kg). Gestation length was approximately 4 d longer for CL cows compared with HT cows ($P < 0.01$). Cows on CLOG, CL, and HTOG treatments produced more milk (5.2 ± 1.9, 4.8 ± 1.6, and 4.6 ± 1.4 kg/d, respectively) than HT cows (35.9 ± 1.5 kg/d). Body weight after parturition and DMI were evaluated up to 60 DIM and averaged DMI 19.4 ± 0.7 kg/d, with no differences observed among treatments. These results confirm that exposure of dry cows to heat stress negatively impacts milk production in the subsequent lactation. Active cooling of dry cows and OG supplementation can reduce the negative effects of heat stress in the dry period.

Key Words: cooling systems, heat stress, OmniGen-AF

0723 Feed efficiency is associated with reproductive performance in dairy cows. E. M. Bart*[1], M. D. Hanigan[2], D. M. Spurlock[3], M. J. VandeHaar[4], and R. R. Cockrum[1], *[1]Virginia Polytechnic Institute and State University, Blacksburg, [2]Virginia Tech, Blacksburg, [3]Iowa State University, Ames, [4]Michigan State University, East Lansing*.

For residual feed intake (RFI) to be used as an alternative measure of feed efficiency in the dairy industry, it must not be unfavorably correlated with fertility. Previous research in beef cattle, sheep, and pigs suggests that reproduction is impacted by RFI status. Therefore, the objective of this study was to determine the phenotypic relationship between RFI and reproductive performance in dairy cows. Feed, milk, and health data were collected on 1,513 Holstein cows in various stages of production at Virginia Tech and Iowa State University for 84 d. Daily measurements of DMI, milk yield, weekly milk composition, and monthly BW were used to calculate RFI. Cows with lower RFI were identified as more feed efficient. Four measures of reproductive performance were examined: number of services (NS; n = 1,037), previous days dry (DD; n = 760), days open (DO; n = 716), and days to first calving (DFC; n = 472). Correlation and ANOVA analyses with ad hoc comparisons using a Tukey adjustment were performed in R. For the ANOVA, cows were categorized into top 5% (high RFI; n = 50), middle 5% (medium RFI; n = 50), and bottom 5% (low RFI; n = 50). Correlations were calculated between reproductive measures and RFI. There was a weak positive phenotypic correlation (r_p = 0.18 ± 0.04, P < 0.01) between NS and DO with RFI, suggesting that feed-efficient cows may require fewer services to become pregnant and shorter periods to become bred. There was also a weak negative phenotypic correlation (r_p = −0.14 ± 0.04, P < 0.01) between DFC and RFI, suggesting increased days for feed-efficient cows to produce their first calf. Medium-RFI cows had greater DD (P = 0.046; 109.5 ± 13.9) compared with high-RFI cows (63.3 ± 11.7), but neither differed (P ≥ 0.12) from low-RFI cows. High-RFI cows had increased NS (P = 0.016; 4.80 ± 0.54 services) compared with low-RFI cows (3.05 ± 0.33 services), but neither differed (P ≥ 0.14) from medium-RFI cows. Low-RFI cows had lower DO (P ≤ 0.05; 83.61 ± 10.4 d) than both medium- (126.0 ± 14.3 d) and high-RFI cows (115.9 ± 10.4 d). Therefore, feed-efficient cows had decreased NS and DO. Overall, results suggested that selection for RFI will not unfavorably impact reproduction in dairy cows.

Key Words: feed efficiency, reproductive performance, residual feed intake

0724 Use of 1,25(OH)2 vitamin D_3 to maintain postpartum blood calcium and improve immune function in dairy cows. A. Vieira Neto*, I. A. Peixoto, F. R. Lopes Jr., R. Zimpel, C. Lopera, L. D. P. Sinedino, K. N. Galvão, C. D. Nelson, and J. E. P. Santos, *University of Florida, Gainesville*.

Objectives were to determine the effects of a slow-release injectable formulation of 1,25-dihydroxyvitamin D_3 (calcitriol) on mineral metabolism and measures of immune function in recently calved Holstein cows. Cows were blocked by parity (2 vs. >2) and calving sequence and, within each block, randomly assigned to subcutaneously receive 300 µg of calcitriol (DHVD; n = 25) or vehicle (CON; n = 25) within 6 h of calving. Blood and urine were sampled before treatment application, 12 h later, and on d 1, 2, 3, 5, 7, 9, 12, and 15 postpartum. Samples were analyzed for total (tCa) and ionized Ca (iCa), magnesium (Mg), phosphorus (P), calcitriol, NEFA, β-hydroxybutyrate (BHBA), glucose, serotonin (5-HT) and crosslaps (CTX-1). Neutrophil function was evaluated in the first week postpartum. Intake of DM and production performance was evaluated for the first 42 d postpartum. Data were analyzed by ANOVA with mixed models using the MIXED procedure of SAS. DHVD increased (P < 0.01) concentrations of calcitriol within 4 h of application from 24 to 420 pg/mL, which returned to baseline within 3 d. Blood iCa and tCa took 12 and 24 h, respectively, to increase after treatment with vitamin D compared with CON. Concentrations of iCa (CON = 1.05 vs. DHVD = 1.18 mM), tCa (CON = 2.11 vs. DHVD = 2.35 mM), and P (CON = 1.51 vs. DHVD = 2.06 mM) remained elevated (P < 0.01) in DHVD until 3, 5, and 7 d postpartum, respectively. Concentration of Mg (CON = 0.76 vs. DHVD = 0.67 mM) was less (P < 0.01) in DHVD cows until 5 d postpartum. DHVD cows excreted more urinary Ca (CON = 0.6 vs. DHVD = 1.7 g/d; P < 0.01) and Mg (CON = 3.6 vs. DHVD = 5.5 g/d; P = 0.02) in the first 5 and 1 d postpartum, respectively. Concentrations of glucose, NEFA, BHBA, 5-HT, and CTX-1 in plasma did not differ between treatments. DHVD improved neutrophil function compared with CON. Relative to a reference cow, the percentage of neutrophils with oxidative burst activity (CON = 80.0 vs. DHVD = 101.0%; P = 0.03), the mean fluorescence intensity (MFI) for oxidative burst (CON = 96.0 vs. DHVD = 105.0%; P = 0.09), and the MFI for phagocytosis (CON = 94.0 vs. DHVD = 110.0%; P = 0.03) were all greater for DHVD than CON cows. Intake of DM and yields of milk and milk components did not differ between treatments. Administration of 300 µg of calcitriol at calving was safe and effective in increasing plasma concentrations of calcitriol, iCa, tCa, and P for the first few days after treatment and improved measures of innate immune function in early lactation Holstein cows.

Key Words: calcitriol, hypocalcemia, transition period

0725 Effect of 2,4-thiazolidinedione treatment in the inflammatory response to induced subclinical mastitis in dairy goats receiving adequate vitamin supplementation. F. Rosa*[1], M. Moridi[2], J. S. Osorio[1], J. Lohakare[1], S. Filley[1], J. L. Belveal[1], J. J. Bruton[1], E. Trevisi[3], C. Estill[1], and M. Bionaz[1], [1]*Department of Animal and Rangeland Sciences, Oregon State University, Corvallis,* [2]*University of Guilan, Rasht, Iran (Islamic Republic of),* [3]*Università Cattolica del Sacro Cuore, Piacenza, Italy*.

Mastitis is one of the most costly diseases for the dairy industry. A prior experiment in our laboratory indicated a positive role of 2,4-thiazolidinedione (TZD), a peroxisome proliferator-activated receptor γ (PPARγ) agonist, on the inflammatory response after induced subclinical mastitis in dairy goats fed hay without supplements. Despite this, lack of effect on expression of targets genes in adipose tissue and mammary cells and in vitro data suggested the possibility that TZD did not activate PPARg due to an insufficient activation of its obligate heterodimer nuclear receptor RXR by 9-*cis*-retinoic, a metabolite of vitamin A. This study investigated the hypothesis that continuous activation of PPARγ by TZD in goats supplemented with adequate amount of vitamin A can improve inflammatory response to subclinical mastitis in lactating dairy goats. To test this, 12 Saanen multiparous goats in mid lactation received a diet that met NRC requirements, including vitamin A. Does received a daily intrajugular injection of either TZD ($n = 6$) or saline (CTRL; $n = 6$). Following 14 d of treatments, all goats received an intramammary infusion (IMI) of *Streptococcus uberis* to induce subclinical mastitis in the right half with the left half used as control. Metabolic, inflammation, and oxidative-status profiling in blood including 19 parameters was performed. Milk yield and SCC and rectal temperature were assessed. Data were analyzed by GLIMMIX of SAS with treatment (TRT) and time and TRT × time interaction as main effects and goat as random effect. For milk and SCC, mammary half was also included in the main effect (including interactions). Significance was declared at Tukey's corrected $P < 0.05$. Milk yield and SCC were not affected by TZD administration. However, the udder receiving IMI had greater SCC. In blood within 2 d from IMI, ceruloplasmin, haptoglobin, and glucose were increased whereas Zn was decreased. At 3 d after IMI, AST/GOT, gGT, and bilirubin decreased, whereas by 6 to 11 d after IMI, urea, protein, albumin, globulin, NEFA, and creatinine increased. All these data confirmed successful induction of subclinical mastitis. There was a tendency for TZD to have a higher globulin and lower BHBA compared with CTRL and a tendency for a higher increase in haptoglobin after IMI (TRT × time, $P = 0.06$) with a quick recovery, indicating a stronger response of the liver to inflammation. No other parameters measured were affected by TZD treatment. Our findings indicate that addition of TZD has mild effect on inflammatory response in animals receiving adequate amount of vitamin A.

Key Words: immune response, mastitis, 2,4-thiazolidinedione

0726 Effect of increasing milk feeding frequency of an elevated plane of nutrition on glucose and insulin kinetics in male Holstein calves both before and after weaning. J. A. R. MacPherson*[1], J. Haisan[1], S. J. Meale[2], S. I. Pletts[1], and M. Steele[1], [1]*Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada,* [2]*UMR Herbivores, INRA, Vetagro Sup, Saint-Genès-Champanelle, France*.

The objective of this study was to investigate how feeding elevated levels of milk replacer before weaning, at different feeding frequencies, could influence glucose and insulin kinetics both before and after weaning. Ten male Holstein calves (42.2 kg ± 1.8 birth weight) were randomly assigned to 2 treatments whereby calves were offered 8 L of milk replacer (150 g/L; 26% CP and 18% CF) per day in two (2x) or four feedings (4x) via an automated feeding system. Calves were gradually stepped down by 1 L/d from wk 7 until weaning on wk 8 (0 L). Postprandial blood samples were collected on wk 4 and 7 via jugular catheters during the 1000-h meal every 30 min up to 240 min after feeding. A glucose tolerance test was conducted on wk 4, 7, and 10 via the jugular catheter the day following the postprandial measurements, with 540 mg glucose/kg $BW^{0.75}$ infused after a 12-h feed restriction. Statistics were determined using SAS PROC MIXED and any data not normally distributed was logarithmically transformed. Postprandial glucose area under the curve over 240 min (AUC_{240}) tended ($P = 0.06$) to differ between treatments overall (2x: 383.51 ± 60.08 mmol/L; 4x: 246.68 ± 64.2 mmol/L) but both treatments were able to adequately control glycemia. Postprandial insulin AUC_{240} differed ($P = 0.01$) by treatment with 2x calves (13,808 ± 3,136 µU/mL) having higher insulin concentrations compared with 4x calves (4,716 ± 3,250 µU/mL), and both treatments demonstrated a decrease in insulin AUC_{240} ($P < 0.01$) with increasing age (wk 4: 14,287 ± 2,818 µU/mL; wk 7: 4,237 ± 2,686 µU/mL), which can most likely be attributed to meal size relative to calf BW. Additionally, there was no effect observed for any of the measurements (time to maximum concentration, maximum concentration, AUC_{240}, basal concentration, or change in concentration) for the glucose tolerance test between treatments or across ages, suggesting that feeding frequency in this study had no effect on insulin sensitivity. These findings suggest that feeding 8 L/d at a frequency of 2x or 4x are both viable feeding methods that do not compromise insulin sensitivity.

Key Words: calf, feeding frequency, insulin sensitivity

0727 Repeatability of residual feed intake across dietary forage concentration. M. J. Carrasquillo-Mangual*, E. Liu, and M. J. VandeHaar, *Michigan State University, East Lansing*.

Residual feed intake (RFI) has received considerable attention as a possible breeding goal in the near future. For RFI to be useful as a breeding goal, it should be repeatable for cows under different types of diets. Our objective for this study was to determine the repeatability of RFI across two levels of dietary forage NDF. Holstein cows in mid lactation were studied in winter (n = 32) and summer (n = 32). The study followed a crossover design with 2 treatment periods of 31 (winter) and 28 d (summer). Cows were milked twice daily and fed treatment diets once daily. Treatments were a high-forage–low-starch diet (HF; 36% NDF and 19% starch) and a low-forage–high-starch diet (LF; 26% NDF and 32% starch). Forage composed 70% of the DM in the HF and 47% in the LF. Dry matter intake and milk yield were recorded daily. Body weight was measured 3x weekly and milk composition was measured for 4 consecutive milkings each week. Body condition score was measured at the beginning and end of each experimental period. Statistical analysis was performed using the GLM procedure (SAS 9.4). An RFI value was obtained for each cow under each treatment; cows were ranked using SD of the RFI value as HRFI (greater than +0.5 SD), MRFI (±0.5 SD) or LRFI (less than −0.5 SD). A group rank was established for all cows under each treatment diet. The HF decreased DMI by 2.5 kg/d and milk yield by 3 kg/d when compared with the LF. Body weight changed by 0.4 kg/d on the LF but 0.2 kg/d on the HF. Fat yield, BW, and BCS were not altered by treatments. The decrease in DMI as well as the difference in energetic density of the diet could explain the differences observed in production performance as there was no significant difference in energy partitioned toward milk production. The RFI ranking was relatively repeatable (r = 0.44). Of all animals, 48% maintained their group ranking across treatments whereas 47% changed ranking by 1 group. Only 5% moved in the ranking from the HRFI to the LRFI group or vice versa. In conclusion, although intake, production, and energy partitioning were significantly altered by dietary treatments, RFI was relatively repeatable across these diets. Therefore, genomic breeding values of RFI estimated from cows fed a high-starch diet should still be useful when animals are fed more forage and less starch.

Key Words: dairy cow, residual feed intake

ADSA PRODUCTION DIVISION GRADUATE STUDENT ORAL COMPETITION: PHD

0728 Effects of supplementing rumen-protected methionine on lactational performance of Holstein dairy cows during early and mid lactation. M. A. Fagundes*[1], S. A. Blaser[2], S. Y. Yang[2], J. S. Eun[1,2], and J. O. Moon[3], [1]*School of Veterinary Medicine, Utah State University, Logan,* [2]*Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan,* [3]*CJ CheilJedang Research Institute of Biotechnology, Suwon, the Republic of Korea*.

Supplementing rumen-protected methionine (RPMet) has been shown to maintain milk and milk protein yields when dietary MP is decreased by 5% due to its direct impacts on milk protein synthesis in the mammary gland. The present study investigated production responses of lactating dairy cows to RPMet supplementation in suboptimal protein (SOPD; 15.5% CP) and normal protein diet (NPD; 16.5% CP). Eight lactating dairy cows (53 d in milk, on average) were blocked by parity and days in milk, and the experiment was performed in a duplicate 4 × 4 Latin square design. Within each square, cows were randomly assigned to a sequence of 4 diets during each of the four 21-d periods (14 d of treatment adaptation and 7 d of data collection and sampling). A 2 × 2 factorial arrangement was used; SOPD or NPD was combined without or with RPMet: SOPD without RPMet, SOPD with RPMet (S+Met), NPD without RPMet, and NPD with RPMet (N+Met). An experimental RPMet product from CJ CheilJedang (Suwon, the Republic of Korea) was supplemented in the S+Met and the N+Met at 30 g/cow per day. Supplementation of RPMet did not affect DMI (25.4 kg/d) and milk yield (40.6 kg/d). Supplementing RPMet resulted in a similar milk true protein concentration (2.80%) with a numerical increase in milk protein yield at 3.6%. In contrast, supplementing RPMet increased milk fat concentration (P = 0.02) and yield (P = 0.03) and 3.5% fat-corrected milk (FCM) yield (P = 0.05) and tended to increase energy-corrected milk (ECM) yield (P = 0.06) regardless of CP level. In addition, trends were observed for increased 3.5% FCM yield/DMI (P = 0.09) and ECM yield/DMI (P = 0.10), and the positive effects were greater under NPD than SOPD, resulting in trends toward interaction between CP and RPMet (P = 0.06). Overall results in the current study suggest that supplementing RPMet in SOPD and NPD improved milk fat concentration, possibly due to increases in apolipoprotein and phospholipid syntheses in the liver, leading to an increase in fatty acid supply to the mammary gland via very-low-density lipoproteins.

Key Words: feed efficiency, lactational performance, rumen-protected methionine