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Nicolas Bedere, Luc Delaby, Vincent Ducrocq, Ségolène Colette, Catherine Disenhaus

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Graduate Student Competition: ADSA Production Division

Graduate Student Oral Competition, PhD

274 Carry-over effect of an individual feeding strategy on milk production of Holstein cows managed for extended lactation. Charlotte Gaillard*¹, Nicolas C. Friggens², Martin R. Weisbjerg¹, and Jakob Sehested¹, ¹*Aarhus University, Foulum, Tjele, Denmark*, ²*AgroParisTech, INRA UMR 0791 MoSAR, Paris, France*.

Feeding can induce significant individual variation in cows' milk production. Previous studies showed that an increase of energy density of the ration for a short period in early lactation induced greater total milk yield and persistency, defined by the shape of the lactation curve. The objective of our feeding strategy was to reduce the intensity of mobilization and thereby to sustain the mobilization for a longer period. We hypothesized that a supply of energy during the mobilization period of each individual cow will have a positive carry-over effect on milk production. A total of 53 Holstein cows performed extended lactations (461 ± 7 d). They were housed in free stalls with access to a milking robot. The group 1 (G1) were fed a control partially mixed ration, with a 60:40 forage:concentrate ratio (energy density 11.8 ± 0.1 MJ of ME/kg of DM), for the full lactation. The group 2 (G2) received a diet enriched in energy (ratio 50:50, energy density 12.1 ± 0.1 MJ of ME/kg of DM) followed by the control diet. The diet shift of G2 was defined individually when DIM ≥ 42, and live weight gain ≥ 0 kg/d on a 5 d average. The production data were smoothed using the *fda* package in R software. The daily smoothed data and the associated slopes were analyzed using a linear mixed effects model with parity and treatment as fixed effects. From calving to 42 DIM, an interaction indicated that the ECM of multiparous G2 was higher than for G1 (42.8 vs. 40.1 ± 1.5 kg ECM/d), while the primiparous presented opposite effects (29.0 vs. 32.5 ± 2.2 kg ECM/d) ($P = 0.02$). The 300 d following the shift in diet, G1 and G2 had similar ECM (35.0 ± 1.0 kg ECM/d, $P = 0.76$) but the curves had different slopes. From 0 to 100 d from shift, the ECM increased for the primiparous G2 while it decreased for the primiparous G1 (+0.008 vs. -0.01 ± 0.007 kg ECM/d, $P = 0.04$). From 201 to 300 d from shift, the ECM decreased faster for G2 than for G1 (-0.06 vs. -0.04 ± 0.008 kg ECM/d, $P = 0.02$). To conclude, the treatment had a 100-d positive carry-over effect only on primiparous persistency, as well as a 300 d negative carry-over effect on the ECM persistency for all the cows.

Key Words: extended lactation, persistency, individual feeding strategy

275 Moisture, temperature, cow health, and bedding bacteria relationships in compost bedded pack barns. Elizabeth A. Eckelkamp*, Joseph L. Taraba, Robert J. Harmon, Katherine A. Akers, and Jeffrey M. Bewley, *University of Kentucky, Lexington, KY*.

Attracting global interest, the compost bedded pack barn (CB) is a loose housing system bedded with shavings or sawdust, without the stalls and partitions found in freestall and tie-stall housing. The objective of this study was to assess relationships among compost bedded pack (CB) moisture and temperature, ambient weather conditions, cow hygiene, mastitis indicators, and bedding bacterial counts. The CB moisture and temperature are affected by ambient conditions, which in turn alter the conditions experienced by the cow and the bacteria in the bedding. The study was conducted using data from 8 CB farms in Kentucky from May 2013 to May 2014. Biweekly, one observer hygiene scored 50 cows per farm and collected CB internal temperature at 20 cm depth

(CIT), moisture, nutrient profile, and bedding samples for bacteriological culture from 9 areas in each barn. Somatic cell count and high SCC prevalence (HSP, percent of cows with SCC ≥ 200,000 cells/mL) were collected from DHIA. The MIXED procedure of SAS 9.3 (SAS Institute, Inc., Cary, NC) was used to assess fixed effects for all models. Stepwise backward elimination was used to remove non-significant interactions ($P \geq 0.05$) with all main effects remaining in the models regardless of significance. Internal temperature increased with increasing BTHI ($P < 0.01$) and decreased with increasing milk yield ($P < 0.01$). Compost moisture content decreased with increasing BTHI ($P < 0.01$). Herd hygiene score decreased with increasing BTHI ($P < 0.01$) and increased with increasing CB moisture ($P = 0.02$). Herd SCC and HSP both increased with increasing BTHI ($P < 0.01$), but did not change with compost factors. Staphylococcus ($P = 0.01$), streptococcus ($P = 0.01$), and bacillus ($P = 0.03$) species growth in the bedding decreased with increasing CIT while coliform species growth ($P = 0.02$) increased with increasing CIT. Maintaining higher internal temperature did not reduce all bedding bacteria levels. In CB farms, BTHI affected cow hygiene and udder health indicators more than CB moisture and CIT.

Key Words: compost bedded pack barn, bedding bacteria, somatic cell count

276 Effect of dry period length and dietary energy source in dairy cows on natural antibody titers and somatic cell count in milk. Novi Mayasari*^{1,2}, Wilke Rijks¹, Ger de Vries Reilingh¹, Gerrit Remmelink³, Bas Kemp¹, Henk Parmentier¹, and Ariette van Kneegsel¹, ¹*Adaptation Physiology Group, Department of Animal Science, Wageningen University, Wageningen, Gelderland, the Netherlands*, ²*Faculty of Animal Husbandry, Universitas Padjadjaran, Bandung, West Java, Indonesia*, ³*Livestock Research, Wageningen University and Research Centre, Wageningen, Gelderland, the Netherlands*.

Omission of the dry period of cows improved energy balance (EB) and showed variable effects on somatic cell counts (SCC) and natural antibodies (NAb) in milk. A glucogenic diet compared with lipogenic diet enhanced plasma NAb binding keyhole limpet hemocyanin (KLH). NAb in milk were associated with SCC. It was hypothesized that during negative energy balance, NAb either have a role or reflect in inflammatory processes and are associated with SCC. The objective was to study effects of dry period length and dietary energy source on titers of NAb binding KLH and lipopolysaccharide (LPS) in milk, SCC and mastitis. In total, 167 Holstein-Friesian dairy cows were randomly assigned to treatments. Treatments consisted of 3 dry period lengths: 0-, 30- or 60-d and 2 early lactation diets (glucogenic or lipogenic), in a 3 × 2 factorial design. Cows enrolled in this study were clinically healthy and had SCC in milk < 250,000 cell/mL. Milk samples for NAb and SCC measurement were sampled weekly and 4 times per week, respectively, from wk 1 until 14 postpartum. The data collected were statistically analyzed using ANOVA and logistic regression. Cows with a 0-d dry period had higher titers of IgG and IgM binding KLH and LPS and higher SCC in milk compared with cows with a 30- or 60-d dry period ($P < 0.01$). Mastitis incidence was 17% and did not differ between dry period lengths or lactation diets. A glucogenic diet showed higher titers of IgM binding LPS and tended to have higher titers of IgG binding LPS in milk compared with a lipogenic diet ($P < 0.01$ and $P = 0.08$, respectively).

Higher titers of IgG and IgM binding KLH and IgG binding LPS were associated with increased risk of high SCC ($P < 0.05$). Higher IgG and IgM binding KLH and LPS were also associated with increased risk of mastitis ($P < 0.05$). The results demonstrate that cows with a 0-d dry period and fed a glucogenic diet showed high titers of IgG binding LPS in milk. Moreover, we can conclude that IgG and IgM binding KLH or LPS in milk might be additional valuable tools to detect increased risks for mastitis in dairy cows.

Key Words: dry period, somatic cell count, antibodies

277 Towards a better understanding of the effect of genetic merit for milk production on post-partum cyclicity of first lactation dairy cows. Nicolas Bedere^{*1}, Luc Delaby¹, Vincent Ducrocq², Ségolène Leurent-Colette³, and Catherine Disenhaus¹, ¹INRA-Agrocampus-Ouest UMR 1348 PEGASE, Saint-Gilles, France, ²INRA UMR 1313 GABI, Jouy-en-Josas, France, ³INRA UE 326 Domaine Expérimental du Pin-au-Haras, Exmes, France.

Milk genetic merit is known to affect commencement of luteal activity (CLA) in dairy cows. This effect is considered to be due to energy exported in milk production. We hypothesize that cows with genetic predisposition to export milk energy through milk yield would have degraded cyclicity compared with those exporting energy through fat and protein contents. This study aimed to identify and quantify the effect of breed and genetic groups on postpartum cyclicity of primiparous dairy cows. From 2006 to 2013, an experiment was conducted on 194 primiparous dairy (Holstein) and dual purpose (Normande). Within breeds, cows were classified into 2 groups with regards to their estimated breeding value (EBV). Cows with high EBV for milk yield were included in a "Milk" group (MG) and those with high EBV for fat and protein content were included in a "Content" group (CG). Within breeds, exported milk energy and weight loss were similar for cows in both MG and CG groups. Interval from calving to CLA was studied performing survival analyses (Weibull regression). Progesterone profile, milk yield and body condition were analyzed using Chi²-test and ANCOVA. Holstein cows produced more milk (+1450 kg, $P < 0.001$) and lost more body weight (BW: -1.4kg/wk, $P < 0.01$) than Normande ones. Normande and Holstein cows had different baseline hazard functions for CLA, Normande cows having earlier CLA than Holstein ones. Within breeds, cows in the CG group had earlier CLA (associated HR = 2.0, $P = 0.001$) than cows in the MG group. For Holstein only, BW loss from wk 1 to 14 of lactation tended to be associated with later CLA ($P < 0.1$). Within breeds, no effect of milk yield on CLA was observed. Prolonged luteal phases were frequent (18% of cows) and neither associated with breed nor with differences between MG and CG. Interovulatory intervals were longer for Holstein than for Normande cows (+1.7 d, $P < 0.001$) because of a longer luteal phase and a longer interluteal interval. To conclude, this study showed that cows with genetic predisposition to export milk energy through fat and protein contents had earlier CLA than those exporting milk energy through yield.

Key Words: genetic merit, cyclicity, primiparous cows

278 Forage yield, quality, and digestibility when intercropping vining soybean with MasterGraze seed corn at different seeding rates. Ishwary Acharya^{*1}, David Casper¹, Xingyou Gu², and Ahamed Charif², ¹Dairy Science Department, South Dakota State University, Brookings, SD, ²Department of Plant Science, South Dakota State University, Brookings, SD.

The production of forage resulting from the intercropping of corn and soybean at planting has the potential to yield greater quantities of digestible nutrients to meet the nutrient requirements of lactating dairy cows. A field plot experiment was conducted to measure forage yield, nutrient concentration and digestibility when intercropping MasterGraze (MG) seed corn and vining (V) soybean lines at different seeding rates. A randomized complete block design with 5 different seeding rates [100:0 (T1); 67:33 (T2); 50:50 (T3); 33:67 (T4), and 0:100 (T5) of V and MG] with 3 replicates was used to determine the optimal intercropping seeding rates. Forage was hand harvested 97 d after planting during the 2014 growing season, inoculated, packed into plastic buckets, weighed, and ensiled for 60 or 90 d. Buckets were then re-weighed, opened, and samples of forage collected. Fresh, 60- and 90-d ensiled forage samples were submitted to a commercial laboratory (Analab Inc., Fulton, IL). Fresh forage yield was greatest ($P < 0.05$) for T5 (all MG) compared with other ratios of MG and V (40.7, 78.0, 75.6, 75.5 and 80.9 T/ha for T1, T2, T3, T4, and T5, respectively). Fresh DM yield (16.5, 22.0, 21.1, 20.2, and 18.7 T/ha) and digestible DM (12.3, 15.2, 14.7, 14.1 and 13.9 T/ha) were similar ($P > 0.05$) across all V:MG ratios. Fresh CP yield (3.74, 2.29, 2.14, 1.97, and 1.18 T/ha) was greatest ($P < 0.05$) for T1 compared with other treatments and T2 greater ($P < 0.05$) than T5 with remaining ratios being intermediate and similar. Fresh digestible fiber yield was similar ($P > 0.10$) for all V:MG ratios (3.78, 5.55, 6.02, 5.22, and 6.45 T/ha). The 60 d DM ensiling loss (5.23, 1.34, 1.22, 1.71 and 1.97%) was greatest ($P < 0.05$) for T1 compared with the other V:MG ratios. The 60 d ensiling digestible DM yield (12.3, 15.6, 14.9, 14.0 and 12.9 T/ha) was greatest ($P < 0.05$) for T2 and lowest for T1 with other ratios being intermediate. In conclusion, the intercropping of V and MG holds great potential for increasing the production of forages to meet the nutrient requirements of lactating dairy cows.

Key Words: corn, soybean, yield

279 Intravaginal administration of prostaglandin F_{2α} induces luteolysis in lactating dairy cows. Robert Wijma^{*}, Matias L. Stangaferro, and Julio O. Giordano, Department of Animal Science, Cornell University, Ithaca, NY.

Our objectives were to test the efficacy of PGF_{2α} (PGF) to induce luteolysis and evaluate progesterone (P4) dynamics after intravaginal (IVG) administration in lactating dairy cows. Our hypothesis is that PGF given IVG will induce luteolysis. In 2 experiments, cows were synchronized using Ovsynch (GnRH-7 d-PGF-56 h-GnRH) to induce ovulation and the formation of a corpus luteum (CL). Cows with at least 1 CL ≥ 15 mm 8 d after Ovsynch remained in the study. In Exp 1, cows (n = 31) stratified by parity and number of CL received: 5 mL of saline solution IVG (SAL-IVG, n = 6), 25 mg of PGF im (PGF25-im, n = 7), 25 mg of PGF IVG (PGF25-IVG, n = 6), 50 mg of PGF IVG (PGF50-IVG, n = 6) and 125 mg of PGF IVG (PGF125-IVG, n = 6). In Exp 2, cows (n = 32) stratified as in Exp 1 received: SAL-IVG (n = 7), PGF25-im (n = 7), PGF25-IVG (n = 6), PGF50-IVG (n = 6) as in Exp 1 whereas another group received 2 IVG boluses of 25 mg of PGF 12 h apart (PGF25-2X-IVG, n = 6). Blood was collected at -1 h, 0 h, every 6 h up to 24 h, and then every 12 h up to 96 h after treatment (trt). Concentrations of P4 after treatment were analyzed by ANOVA with repeated measures using PROC MIXED of SAS. Mean separation was conducted with LSD method. In Exp 1, P4 concentrations from -1 to 96 h were affected by trt ($P < 0.01$), time ($P < 0.001$) and trt by time ($P < 0.001$). From 12 to 96 h, all PGF groups had less P4 ($P < 0.05$) than SAL-IVG cows. In Exp 2, from -1 to 96 h P4 concentrations were affected by trt ($P < 0.001$), time ($P < 0.001$) and trt by time ($P < 0.001$). From 12 to 96 h all PGF groups had less ($P < 0.05$) P4 than SAL-IVG cows. From 60 to 96 h,

PGF25–2X-IVG and PGF25-im tended ($P < 0.1$) to or had less ($P < 0.05$) P4 than PGF25-IVG. When data from Exp 1 and 2 were combined, P4 concentrations from –1 to 96 h were affected by trt ($P < 0.001$), time ($P < 0.001$) and trt by time ($P < 0.001$). Concentrations of P4 in all the PGF groups were less ($P < 0.05$) than in the SAL-IVG group from 6 to 96 h. At 60 h, the PGF25–2X-IVG group had less ($P < 0.05$) P4 than the rest of the groups. We conclude that it is possible to induce luteolysis in lactating dairy cows by intravaginal administration of PGF. Two 25-mg boluses 12 h apart were more effective than one bolus of 25, 50 or 125 mg of PGF and as effective as a 25-mg bolus of PGF im.

Key Words: intravaginal, prostaglandin, dairy cow

280 Dry period plane of energy: Effects on glucose tolerance in peripartum dairy cows. Sabine Mann*¹, Francisco A. Leal Yepes², Thomas R. Overton², Joseph J. Wakshlag³, Bethany P. Cummings⁴, and Daryl V. Nydam¹, ¹Department of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY, ²Department of Animal Science, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, ³Department of Clinical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY, ⁴Department of Biomedical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY.

Overfeeding energy during the dry period may affect peripartum insulin sensitivity of dairy cows. The objectives were to describe the effect of different dry period dietary energy strategies on glucose tolerance and on concentrations of insulin, glucagon, glucose, β -hydroxybutyrate (BHBA) and nonesterified fatty acids (NEFA) in the peripartum period. To test our hypothesis that dry period plane of energy leads to changes in glucose tolerance, cows ($n = 84$) were blocked by expected calving date and randomized into 3 treatment groups 57 d before expected parturition: a TMR formulated to supply 100% of energy requirements (C), or 150% of requirements (H), or 100% for the first 28 d of the dry period followed by a TMR supplying 125% of energy requirements until calving (I). At 28 and 10 d pre-, as well as 4 and 21 d postpartum, intravenous glucose tolerance tests (IVGTT; 0.25 g glucose/kg) were performed and the area under the curve (AUC) of glucose and insulin were estimated. Baseline samples were analyzed for concentration of insulin, glucose, NEFA, glucagon and BHBA. Mixed-effects ANOVA were carried out (SAS, v. 9.3). The AUC for glucose and insulin was not different among groups at any time point ($P > 0.10$). Differences in baseline values were most notable on d 4 postpartum (Table 1) and indicated increased postpartum lipolysis and ketogenesis in group H whereas we detected a tendency for lower glucose concentration despite higher glucagon concentration in this group. In conclusion, these findings suggest that prepartum plane of energy had an effect on the hormonal regulation of gluconeogenesis and ketogenesis (as reflected by the concentrations of insulin and glucagon), but did not lead to a detectable effect on peripartum glucose tolerance as assessed by IVGTT.

Contd.

Table 1 (Abstr. 280). Mean (95% CI) baseline concentrations on day 4 postpartum

Item	C	I	H	P-value
Glucose (mg/dL)	60 (57–62) ^a	58 (56–61) ^{ab}	56 (53–58) ^b	0.09
Insulin (μ IU/mL)	2.1 (1.2–3.6) ^a	2.3 (1.3–4.1) ^a	1.1 (0.5–1.7) ^b	0.08
Glucagon (pg/mL)	120 (108–132) ^A	117 (105–129) ^A	137 (127–150) ^B	0.01
NEFA (mEq/L)	1.37 (1.26–1.48) ^A	1.38 (1.27–1.50) ^A	1.63 (1.52–1.74) ^B	0.002
BHBA (mmol/L)	0.75 (0.64–0.88) ^A	0.83 (0.71–0.97) ^{AB}	1.0 (0.85–1.2) ^B	0.06

Row values with different superscript letters differ (^{A,B} $P < 0.05$; ^{a,b} $P < 0.10$) in Tukey's HSD.

Key Words: transition, energy, dairy

281 Infusion of 5-hydroxytryptophan increases serum calcium and mammary gland calcium pump activity during the transition period. Samantha R. Weaver*¹, Austin P. Prichard¹, Elizabeth L. Endres¹, Stefanie A. Newhouse², Rupert M. Bruckmaier³, Matt S. Akins¹, and Laura L. Hernandez¹, ¹University of Wisconsin-Madison, Madison, WI, ²University of Wisconsin-Platteville, Platteville, WI, ³University of Bern, Bern, Switzerland.

Hypocalcemia during the transition period in dairy cows has detrimental effects on animal health, welfare, and production. While clinical hypocalcemia affects 2 to 5% of cows in the US, approximately 50% of cows succumb to subclinical hypocalcemia. Serotonin (5-HT) has been suggested as a therapeutic target for prevention of hypocalcemia. Our objective was to determine the effects of pre-partum intravenous (IV) administration of a 5-HT precursor on calcium homeostasis postpartum in multiparous dairy cows. We hypothesized that the treatment would increase serum calcium and calcium transport into the mammary gland. Twelve (avg. lactation number 3.67 ± 0.43) Holstein cows were IV infused for 5.75 ± 0.82 d pre-partum, beginning approximately 7d before their predicted calving date until calving, with saline (CTL; $n = 6$) or 1.0 mg/kg 5-hydroxytryptophan (5-HTP; $n = 6$), the immediate precursor for 5-HT synthesis. Mammary gland biopsies were performed approximately 2 weeks pre-partum, and d1 and d7 postpartum. Blood and urine were collected daily from the first biopsy through d14 and on d30 of lactation. Colorimetric assays were performed for total calcium in serum and relative mammary mRNA expression was evaluated by RT-PCR. All statistical analysis was performed in SAS using a mixed model ANOVA. Cows infused with 5-HTP had decreased feed intake postpartum compared with CTL ($P = 0.0004$; 34.75 ± 1.6 kg CTL vs. 30.25 ± 2.8 kg 5-HTP) and overall decreased milk yield ($P = 0.0054$; 18.35 ± 1.07 kg CTL vs. 17.10 ± 1.04 kg 5-HTP), although colostrum milk yield was not different ($P = 0.88$). Serum total calcium tended to increase in 5-HTP cows for 14d postpartum ($P = 0.07$; 2.89 ± 0.09 mM 5-HTP vs. 2.66 ± 0.09 mM CTL). Basolateral mammary epithelial cell calcium sensing receptor (CaSR) mRNA was increased in 5-HTP compared with CTL cows ($P = 0.035$), as was apical calcium pump plasma membrane calcium ATPase2 (PMCA2) ($P = 0.018$) on d 1 and d 7 of lactation. These results suggest that 5-HTP treatment prepartum increases postpartum circulating calcium concentrations and calcium transport in the mammary gland.

Key Words: serotonin, calcium, hypocalcemia

282 The use of gene expression in milk fat as an indicator of trace mineral status in dairy cows. M. J. Faulkner¹, E. H. Wall², and W. P. Weiss¹, ¹OARDC, The Ohio State University, Wooster, OH, ²Pancosma, Geneva, Switzerland.

No non-invasive methods exist to accurately evaluate Cu, Zn, and Mn status in dairy cows. Thirty lactating Holstein cows were used to determine whether intake and source of Cu, Zn, and Mn affected erythrocyte Cu/Zn SOD activity and expression of genes in milk fat that are related to Cu and Zn transport. Cows were fed a diet void of supplemental Cu, Zn, and Mn (9, 41, and 41 mg/kg, respectively) for 30 d and then fed 1 of 3 diets for 30 d. One diet (UNSUP) contained no supplemental Cu, Zn, and Mn (9, 41, and 41 mg/kg); one diet (SUL) contained Cu, Zn, and Mn from sulfates (total concentrations = 17, 59, and 54 mg/kg, respectively); one diet (GLY) contained Cu, Zn, and Mn in the glycinate form (B-Traxim 2C, Pancosma; total concentrations = 20, 66, and 58 mg/kg). Data were analyzed using a mixed model with treatment and parity as fixed effects. Using the NRC (2001) model and absorption coefficients (AC), UNSUP provided about 82% of requirements for Cu and Zn for primiparous cows and 95% for multiparous cows. Assuming an AC of 0.05 and 0.20 for Cu and Zn from supplements, supplemented diets provided 1.3 to 2.3 times more absorbed Cu and Zn than requirements. Total RNA was extracted using Tri Reagent from milkfat samples collected on d 60. Expression of 1 Zn transport gene (ZnT4), 2 Zn and Mn transport genes (Zip3 and Zip8), 2 Cu transport genes (ATP7B and CCS), 1 heavy-metal binding gene (MT), and 2 reference genes (KEAP1 and ADSL) were analyzed using qPCR. Activity of SOD was higher ($P = 0.04$) in primiparous than multiparous cows, but was not affected by diet. Expression of CCS, a protein that transports Cu to SOD, and SOD were negatively correlated ($P < 0.06$). Expression of most genes was not affected by treatment; however, MT expression was greater ($P = 0.04$) in primiparous compared with multiparous cows, and Zip8 expression tended ($P = 0.10$) to be greater in cows fed supplemental Cu, Zn, and Mn regardless of source. When supplemental Cu, Zn, and Mn were fed, cow requirements were exceeded and no differences were observed between mineral sources. Zip8 has potential to detect cows with deficient trace mineral status.

Key Words: trace mineral, dairy cow, gene expression

283 Feed efficiency and performance of lactating Holstein dairy cows fed two different concentrations of dried distillers grains with solubles. Eric D. Testroet*, Stephanie Clark, and Donald C. Beitz, Iowa State University, Ames, IA.

Dried distillers grains with solubles (DDGS) has become more nutritionally consistent as the industry has evolved. The objective of this study, therefore, was to evaluate the feed efficiency of lactating Holstein dairy cattle fed 2 different concentrations of DDGS. Thirty cows were fed 0, 10, and 20% DDGS dietary dry matter (DM) as a total mixed ration. Cows were stratified by parity and days in milk into 3 treatment groups of 10 cows in a 3 × 3 Latin square with repeated measures. We hypothesized that feeding 20% DDGS by dietary DM would negatively influence production and efficiency. Feeding DDGS had no consistent effect on dry matter intake (DMI), with the control diet being intermediate to the 10 and 20% diets (25.22, 24.03, and 26.37 kg/day, respectively; $P < 0.0001$). Milk yield was unaffected by feeding DDGS; feeding DDGS, however, caused milk fat depression (3.45, 2.94, and 2.68%; 0, 10, and 20%, respectively; $P < 0.0001$) and reduction of daily fat yield (1.35, 1.15, 1.04 kg/day; $P < 0.0001$) that resulted in decreases in 3.5% fat-corrected milk (FCM) yield (36.20, 32.97, and 31.32 kg/day; $P < 0.0001$) and energy-corrected milk (ECM) yield (40.95, 38.12, and 36.72 kg/day; $P < 0.0001$). Both protein (3.58, 3.62, and 3.65%; $P =$

0.0409) and lactose percentage (5.07, 5.15, and 5.17%; $P = 0.0067$) were increased when cows were fed 20% DDGS; neither protein nor lactose yield, however, was affected. Protein efficiency decreased for cows fed 20% DDGS (35.42, 36.21, and 32.76%; $P < 0.0001$), likely resulting from heat-damaged protein. All measures of energetic efficiency [ECM/DMI, kg ECM/net energy for lactation (NE_L) intake (mcal), and gross energy (GE) of milk produced (mcal)/NE_L caloric intake (mcal)] were decreased when cows were fed 20% DDGS, but not when cows were fed 10% DDGS (ECM/DMI: 1.66, 1.64, and 1.41; kg ECM/NE_L: 1.02, 1.03, 0.89; GE of milk/NE_L caloric intake: 0.65, 0.66, 0.56; $P < 0.0001$). These results indicate that, with the exception of an approximate 0.5% loss of milk fat, the DDGS used in this study can be effectively fed at 10%, but not at 20%, of dietary DM without a loss in feed efficiency.

Key Words: corn, feed intake, milk

284 Including sunflower seed in prepartum diet positively influenced postpartum ovarian function without affecting uterine health. R. Salehi¹, M. G. Colazo², U. Basu¹, A. Ruiz-Sanchez¹, and D. J. Ambrose^{1,2}, ¹University of Alberta, Edmonton, Alberta, Canada, ²Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada.

We investigated the influence of prepartum dietary oilseed supplementation on postpartum (pp) uterine inflammatory status (UIS) based on polymorphonuclear cells (PMN): normal ($\leq 8\%$ PMN) or subclinical endometritis (SCE; $> 8\%$ PMN), and associations among SCE, pro/anti-inflammatory cytokine gene expression and resumption of ovarian cyclicity. We hypothesized that feeding a diet containing sunflower seed (SUN; high linoleic acid) will induce pro-inflammatory effects in the early pp uterus facilitating early resumption of cyclicity. During late gestation (last 5 wk), Holstein cows received 1 of 3 diets supplemented with 8% DM rolled sunflower seed (SUN; $n = 10$) or canola seed (CAN; high oleic acid; $n = 9$), or no oilseed (CON; $n = 9$). Ovaries were scanned 2×/wk until 35 d pp to record first appearance of a 10 (DF) or 16 mm (PreOVF) follicle, and ovulation. Endometrial cell sampling was done 25 ± 1 d pp for cytology and gene expression. Data were analyzed using PROC MIXED, CORR and REG of SAS. Prepartum diets did not influence SCE incidence (SUN: 4/10; CAN: 4/9; CON: 3/9). The mRNA expressions of interleukin (IL)-1 β , IL-6, IL-8, IL-10, tumor necrosis factor (TNF)- α and interferon (INF)- γ were not affected ($P > 0.05$) by either prepartum diet or diet × UIS interaction. Feeding SUN prepartum hastened ($P < 0.05$) the establishment of PreOVF and increased the proportion of cows ovulating within 35 d pp. Regardless of prepartum diet, cows with SCE had higher ($P < 0.05$) mRNA expression of IL-1 β , IL-8, IL-10 and TNF- α than normal cows. The intervals from calving to DF formation and first ovulation were not affected by UIS; however, PreOVF formed earlier ($P < 0.01$) in normal (13.2 ± 0.9) than in SCE (18.7 ± 1.4 d) cows. The mRNA expression of IL-1 β , IL-8, IL-10 and TNF- α were positively correlated with each other ($P < 0.01$) and with PMN% ($P < 0.07$). The interval to PreOVF was determined by IL-1 β , IL-8, IL-10, INF- γ expression, PMN%, and the interval to DF. In summary, feeding SUN prepartum positively influenced pp ovarian function without affecting UIS. Increased endometrial expression of pro-inflammatory cytokines is likely linked to delayed establishment of PreOVF.

Key Words: endometritis, ovarian function, cytokine

285 Pretreatment with saturated and unsaturated fatty acids regulates [1-¹⁴C] C16:0 metabolism in Madin-Darby bovine kidney cells. Katherine E. Boesche*, Stephanie L. Koser, and Shawn S. Donkin, *Purdue University, West Lafayette, IN.*

Metabolic fates of fatty acids (FA) may be influenced by circulating FA concentration. Previous work in our lab demonstrated an ability of C18:3n-3 *cis* to ameliorate gene expression of pyruvate carboxylase (PC) after depression by either C16:0 or C18:0. PC catalyzes oxaloacetate (OAA) synthesis and ostensibly links gluconeogenesis and FA metabolism. Our objective was to determine effects of co-presence of saturated and unsaturated FA pretreatments on cellular partitioning of [1-¹⁴C] C16:0 metabolism to CO₂ or acid-soluble products (ASP) in Madin-Darby bovine kidney (MDBK) cells. We hypothesized that the ratio of saturated to unsaturated FA pretreatments regulates [1-¹⁴C] C16:0 partitioning to CO₂ or ASP. Cells at 80% confluence were exposed for 21h to either individual FA bound to BSA (C16:0, C18:0, C18:1n-9 *cis* or C18:3n-3 *cis*) or FA cocktails in 10:90, 25:75, 50:50, 75:25 or 90:10 ratios for combinations of C16:0: C18:3n-3 *cis* or C18:0: C18:3n-3 *cis* or C18:1n-9 *cis*: C18:3n-3 *cis*. Total pretreatment FA concentration was 1.0 mM and was applied in triplicate to 3 cell replicates. Following pretreatment, cells were incubated in the presence of 1.0 mM [1-¹⁴C] C16:0 for 3h before CO₂ and ASP collection. Data were analyzed using PROC MIXED of SAS. The model accounted for fixed effects of pretreatment and random effects of replicate. Pretreatments with either C16:0 or C18:0 alone significantly ($P < 0.01$) depressed subsequent oxidation of [1-¹⁴C] C16:0 to ASP by 62.7% and 41.2%, respectively, compared with C18:3n-3 *cis* pretreatments. Similar patterns were seen with [1-¹⁴C] C16:0 oxidation to CO₂. ASP production from [1-¹⁴C] C16:0 positively correlated ($r = 0.68$, $P < 0.01$) with PC gene expression from previous experiments. CO₂ production from [1-¹⁴C] C16:0 did not correlate ($r = 0.30$, $P > 0.10$) with PC expression. In conclusion, activation of PC gene expression by C18:3n-3 *cis* may play a critical role in setting the capacity for OAA synthesis and determining metabolic fates of FA. Results show a regulation of ketone production by MDBK cells in response to saturated and unsaturated FA pretreatments.

Key Words: fatty acid oxidation, ketogenesis, pyruvate carboxylase

286 A novel method to determine rumen biohydrogenation kinetics of alpha-linolenic acid (18:3 n-3). Michel Baldin*¹, Natalie L. Urrutia¹, Daniel E. Rico², Kelsie Baxter¹, Yun Ying¹, and Kevin J. Harvatine¹, ¹*Penn State University, University Park, PA*, ²*Université Laval, Québec, QC, Canada.*

Biohydrogenation (BH) of unsaturated fatty acids (FA) has been extensively studied in vitro but BH rates and intermediates formed in vitro may not parallel BH pathways in vivo. The objective was to develop an in vivo method to determine the rate of α -linolenic acid (18:3 n-3) BH and identify intermediates formed. Eleven rumen cannulated high-producing Holstein cows [40 \pm 6 kg milk/d (Mean \pm SD)] were fed at a rate of 6%/h of expected total DMI a diet balanced to 29% NDF and 5.9% EE (1.5% soybean oil). A single bolus consisting of 200 g of flaxseed oil (53% 18:3) and 15 g of tridecanoic acid (13:0) was mixed with rumen contents and rumen digesta was collected at -1, 0.1, 0.5, 1, 2, 3, 4, 6 and 8 h relative to the bolus. Samples were immediately placed in dry ice, stored at -20°C, freeze-dried, methylated and analyzed by gas chromatography. Data were first analyzed using PROC Mixed with repeated measures for time point comparison. Second, the disappearance of 13:0 and 18:3 was fit to a single exponential decay model using the nonlinear procedure of JMP Pro. The bolus increased total fat in the rumen from 4.3 to 6.0% and enriched 13:0 from 0.04 to 2.2% of FA and 18:3 from 2.0 to 11.3% of FA. The fractional rate of

disappearance of 13:0 was 0.4%/min ($r^2 = 0.98$) and of 18:3 was 2.5%/min ($r^2 = 0.99$), with 18:3 reaching pre-bolus concentration within 4 h. Assuming that 13:0 disappeared only by passage, 18:3 disappeared by passage and biohydrogenation, and the rate of passage of 13:0 and 18:3 are the same, the extent of bolused 18:3 BH was 85%. The concentration of *cis*-9,*trans*-11,*cis*-15 18:3 peaked at 1.2% of FA at 1 h (8-fold increase), *trans*-11, *cis*-15 18:2 peaked at 3.9% of FA at 2 h (13-fold increase), and *trans*-11 18:1 peaked at 6.6% FA at 3 h (43% increase). In conclusion, the in vivo method resulted in the expected extent of biohydrogenation and biohydrogenation intermediates, but the rate of ruminal biohydrogenation of 18:3 was much higher than that commonly observed in vitro. The method developed provides an in vivo assay of ruminal biohydrogenation for use in future experiments.

Key Words: biohydrogenation, fatty acid

287 Effects of feeding algae rich in docosahexaenoic acid (DHA) on lactation and reproductive performance of dairy cows.

Leticia D. P. Sinedino*¹, Thiago F. Fabris¹, Cesar D. Narciso², Leticia R. Lucena¹, Paula M. Honda¹, Gilson G. Maia¹, Maurice P. Boland³, Charles R. Staples¹, William W. Thatcher¹, and Jose E. P. Santos¹, ¹*University of Florida, Gainesville, FL*, ²*Sequoia Veterinary Services, Tulare, CA*, ³*Alltech Animal Nutrition and Health, Nicholasville, KY.*

Previous work by our group showed that supplementing diets with Ca salts containing fish oil fatty acids improved pregnancy per AI (P/AI) in dairy cows. Objectives were to determine the effects of supplementing DHA by feeding algae on lactation and reproductive performance of Holstein cows. The hypothesis was that feeding DHA improves P/AI in dairy cattle. Weekly cohorts of cows were blocked by parity and randomly assigned at 27 DIM to a control [CON; n = 372, 115 primiparous and 258 multiparous] or an algae supplemented (ALG; n = 366, 105 primiparous and 261 multiparous) diet. Cows were fed the same TMR; however, ALG received 100 g/cow/d of a 17% DHA supplement top-dressed and hand-mixed onto the TMR for 120 d. Milk yield was recorded daily and sampled every 3 wk for analysis. Cows were subjected to the Presynch-Ovsynch protocol starting at 44 \pm 3 DIM and those in estrus after 58 \pm 3 DIM were inseminated on the same day, otherwise, they received timed AI at 80 \pm 3 DIM. Pregnancy was diagnosed on d 60 after AI. Data were analyzed by ANOVA, logistic regression or the Cox's proportional hazard model using the GLIMMIX and PHREG procedures of SAS. Intake of DM did not differ between treatments (ALG = 24.8 vs. CON = 25.5 \pm 0.6 kg/d). Milk yield was greater ($P = 0.01$) in ALG than CON (43.6 vs. 42.5 \pm 0.3), but yield of energy-corrected milk was similar between treatments and averaged 39.2 \pm 0.2 kg/d. Feeding ALG reduced ($P = 0.03$) content and yield of milk fat (3.08 vs. 3.23 \pm 0.03% and 1.30 vs. 1.34 \pm 0.01 kg/d); however, ALG increased ($P < 0.01$) yields of protein (1.23 vs. 1.20 \pm 0.01 kg/d) and lactose (2.07 vs. 2.02 \pm 0.01 kg/d). Feeding ALG increased ($P = 0.04$) the proportion of primiparous cows that resumed estrous cyclicity by 58 DIM (77.6 vs. 65.9%) and P/AI at first AI (47.6 vs. 32.8%). Feeding ALG increased ($P < 0.01$) P/AI at all AI in all cows (41.4 vs. 30.8%). Cows fed ALG became pregnant 21 d (103 vs. 124 d) sooner ($P < 0.01$) than those fed Control (adjusted HR = 1.38; 95% CI = 1.13 to 1.69). Supplementing DHA by feeding ALG did not affect intake of DM, increased yields of milk and protein, but reduced milk fat content and yield. Cows fed ALG had improved estrous cyclicity, P/AI, and reduced interval to pregnancy.

Key Words: dairy cow, docosahexaenoic acid, reproduction