Ruminant Nutrition: Dairy: Fat and Fatty Acids Supplementation

648 Effect of altering the ratio of dietary n-6 to n-3 fatty acids on lactational performance and acute phase response to an intramammary lipopolysaccharide challenge. L. F. Greco*[1], J. T. Neves Neto[1], A. Pedrico[1], R. Ferrazza[1], F. S. Lima[1], R. S. Bisinotto[1], N. Martinez[1], E. S. Ribeiro[1], M. Garcia[1], G. C. Gomes[1], M. A. Ballou[2], W. W. Thatcher[1], C. R. Staples[1], and J. E. P. Santos[1], [1]*University of Florida, Gainesville,* [2]*Texas Tech University, Lubbock.*

Objectives were to evaluate the effects of altering the dietary ratio of n-6/n-3 fatty acids (FA) on lactation performance and acute phase response of cows after a challenge with *Escherichia coli* lipopolysaccharide (LPS). Diets were supplemented (1.43% of dietary DM) with a mixture of Ca salts of fish, safflower, and palm oils (Virtus Nutrition, Corcoran, CA) to create different ratios of n-6/n-3 FA; 4, 5 and 6 parts of n-6 to 1 part of n-3 FA (R4; R5; R6). Multiparous (45) Holsteins were blocked by milk yield between 6 and 10 DIM, and assigned randomly to the 3 treatments at 15 DIM, in a randomized complete block design. Blood was sampled and analyzed weekly for the first 5 wk in the study. At 75 DIM, cows underwent a LPS challenge 3h after the morning milking. Ten µg of LPS in PBS solution was infused via teat canal of one quarter. Body temperature and concentrations of acute phase proteins and cytokines in plasma were measured every 2 h up to 14 h, and then at 24 and 48 h relative to the challenge. Milk was sampled separately from each quarter at the same time points as blood and at 72 and 96 h post challenge. Milk somatic cell count was measured from the infused quarter and from the 3 mammary quarters pooled. Data were analyzed using PROC GLIMMIX of SAS for repeated measures with orthogonal polynomials. Lactation performance improved with decreasing ratio of n-6 to n-3 FA in the diet (Table). Based on IL-6 response, cows fed the R4 diet had an attenuated inflammatory response to the LPS challenge (Table). Overall, decreasing the dietary ratio of n-6 to n-3 FA improved performance of dairy cows.

Table 1.

	Diet				*P*-value	
	R4	R5	R6	SE	Linear	Quadratic
DMI, kg/d	26.1	24.6	24.7	0.5	0.05	0.17
FCM, kg/d	48.0	45.4	43.4	0.8	0.01	0.73
FCM/DMI	1.86	1.87	1.78	0.03	0.07	0.21
Milk fat, kg/d	1.71	1.60	1.53	0.03	0.01	0.73
Milk protein, kg/d	1.32	1.28	1.24	0.02	0.01	0.94
BW, Kg	621	632	627	5.6	0.44	0.28
Energy balance, Mcal/d	−1.22	−0.79	1.03	0.69	0.03	0.41
NEFA, mM	0.31	0.26	0.25	0.02	0.06	0.46
LPS Challenge						
Body temperature, °C	39.1	39.3	39.1	0.08	0.62	0.09
IL-6, pg/mL	113.5	353.4	365.1	86.6	0.04	0.28
IFN-γ, pg/mL	10.3	29.9	17.9	9.0	0.51	0.17
Milk SCC × 10^6/mL	3.68	4.33	3.58	0.25	0.78	0.03

Key Words: dairy cow, fatty acid

649 Comparison of two supplemental fat sources differing in saturated fatty acid content on the production response of lactating dairy cows. J. K. Bernard* and N. A. Mullis, *University of Georgia, Tifton.*

Thirty-two lactating Holstein cows were used in a 10 wk study to evaluate the production response to supplemental fat sources differing in linoleic acid concentration. Diets included distiller's grains with solubles and whole cottonseed plus supplemental fat provided by a blend of tallow (86.1%) and soybean oil (13.9%) containing 15% linoleic acid (CON) or a prilled saturated fatty acid blend (SFA, EB-Select, Milk Specialties Global Animal Nutrition). Diets contained 6.57 and 6.53% fat (DM) for CON and SFA, respectively. Cows were fed CON for 2 wk, then blocked by parity and DIM and randomly assigned to fat supplements within block for the following 8 wk. No differences were observed in DMI among treatments. Yield of milk, fat, lactose, solids-not-fat, and ECM and milk fat percentage were lower ($P < 0.05$) and tended to decrease ($P < 0.05$) throughout the study for cows fed CON compared with SFA. Efficiency (ECM/DMI) was higher ($P < 0.01$) for SFA compared with CON. Milk urea nitrogen concentrations were lower for CON compared with SFA. Cows fed CON gained more ($P < 0.01$) BW than cows fed SFA during the study. Concentrations of most short and medium chain fatty acids in milk were lower ($P < 0.05$) for CON compared with SFA, whereas concentrations of C14:1, C16:1 and C18:1n9t were higher ($P < 0.05$) for CON compared with SFA. Results of this study are consistent with previous research in which feeding high linoleic acid supplements resulted in the formation of *trans* fatty acids that have been associated with depressed milk fat. These results suggest that feeding 15% linoleic acid negatively affects milk yield and composition.

Table 1. Effect of supplemental fat on DMI and performance

	Treatment			*P*-value	
	CON	SFA	SE	TRT	TRT × Week
DMI, kg/d	27.5	26.6	1.2	0.2909	0.0357
Milk, kg/d	40.6	43.2	0.5	0.0124	0.0005
Fat, %	3.08	3.58	0.12	0.0004	0.0467
Fat, kg/d	1.25	1.55	0.06	0.0013	0.0009
Protein, %	2.91	2.86	0.07	0.2475	<0.0001
Protein, kg/d	1.18	1.23	0.02	0.1851	0.5408
ECM, kg/d	38.5	43.6	1.04	0.0004	0.0010
Efficiency	1.40	1.64	0.04	0.0016	0.0149
MUN, mg/dL	9.43	12.60	0.49	0.0027	0.0005

Key Words: fatty acid supplementation, milk yield, milk fatty acid

650 Incorporation of n-6 and n-3 fatty acids into plasma lipid fractions of lactating cows: Chronic effect of abomasal infusion of linoleic and linolenic acids. C. L. Preseault, L. C. Nagengast, J. C. Ploetz, C. M. Klein, and A. L. Lock*, *Michigan State University, East Lansing.*

Six rumen-fistulated Holstein cows (252 ± 33 DIM and 44 ± 6 kg milk/d) were randomly assigned to one of 2 treatments in a repeated measures design to examine the effect of abomasal infusions of linoleic (18:2) and linolenic (18:3) acids on the incorporation of n-6 and n-3 fatty acids (FA) in plasma lipid fractions. Treatments were abomasal infusions (67 g/d total FA) of (1) n-6 FA blend (N6) providing 43 g/d 18:2 and 8 g/d of 18:3; or (2) n-3 FA blend (N3) providing 43 g/d 18:3 and 8 g/d 18:2. FA were provided every 6 h for 20 d. Blood was collected d −2, d −1, and 0 h before the first infusion and d 2, 4, 8, 12, 16, and 20. Blood was also collected 18 and 20 d following termination of infusions. FA concentrations of plasma phospholipids (PL), cholesterol esters (CE), triglycerides (TG), and NEFA were determined. Data were analyzed using PROC MIXED in SAS with day as the repeated measure. Concentration of total FA in each lipid fraction was not affected by treatment ($P > 0.37$). N3 increased the

concentration of 18:3 and total n-3 FA in all lipid fractions ($P < 0.002$). Increases became evident between d 2 to 4 and by d 20 the concentration of 18:3 was increased 127, 224, 270, and 317% compared with N6 for NEFA, TG, CE, and PL, respectively ($P < 0.001$). N6 increased the concentration of 18:2 and total n-6 FA in CE and PL ($P < 0.04$); by d 20 the concentration of 18:2 was increased 19 and 9% compared with N3, respectively. In NEFA, N6 increased the concentration of 18:2 ($P < 0.04$) but not total omega-6 FA ($P = 0.11$); 18:2 and total n-6 FA were not different in TG ($P > 0.78$). Pre vs. post infusion results indicated that 18 to 20 d following termination of infusions the concentration of individual FA in CE, PL, and TG had returned to pre-infusion levels ($P > 0.13$); 18:3 and total n-3 FA remained slightly higher in NEFA for N6 ($P < 0.03$). Abomasal infusions of 18:2 and 18:3 increased the concentration of n-6 and n-3 FA in plasma lipids, respectively, although relative increases in n-3 FA were much greater than that for n-6 FA.

Key Words: dairy cow, plasma lipid, polyunsaturated fatty acid

651 Milk yield and milk fat responses to increasing levels of palmitic acid supplementation of dairy cows receiving low and high-fat diets. J. E. Rico*, M. S. Allen, and A. L. Lock, *Michigan State University, East Lansing.*

Dose-dependent effects of a palmitic acid-enriched fat supplement on feed intake and production responses of dairy cows were evaluated. Basal dietary fat concentration (2.7% or 4.2% ether extract) was used as a split-plot to determine relationships between basal dietary fat concentration and fat supplement dose. A covariate period with a common diet (3.5% ether extract) was included to evaluate treatment interactions. Sixteen Holstein cows (149 ± 56 DIM) were assigned randomly to treatment sequence within basal fat group (n = 8 cows/group). Palmitic acid-enriched fat (PA; Bergafat F100; 87% C16:0) was supplemented at 0, 0.75, 1.50, or 2.25% of ration DM in a 4x4 Latin Square design within each basal fat group. Periods were 14 d with the final 4 d used for data collection. Corn silage and alfalfa silage-based diets were formulated to contain 30% NDF and 16.5% CP. The statistical model included the random effect of cow and the fixed effects of basal group, PA dose, period, and their interactions. 3.5% FCM was used as a covariate in the model to account for initial milk and fat effects. The PA dose increased milk fat concentration (3.78, 3.88, 4.01, and 4.03%, $P = 0.004$), fat yield (1.62, 1.68, 1.78, and 1.70 kg/d, $P = 0.003$), and 3.5% FCM yield (45.3, 46.1, 47.9, and 45.8 kg/d; $P = 0.02$) for 0, 0.75, 1.50, and 2.25% PA, respectively. PA dose had no effect on milk protein and lactose concentration, DMI, BW, or BCS ($P > 0.32$), but tended to increase yields of milk ($P = 0.06$), milk protein ($P = 0.08$), and milk lactose ($P = 0.08$). There were no main effects of basal fat group on the yield of milk or milk components ($P > 0.17$), but feed efficiency (3.5% FCM/DMI) was higher for the high-fat relative to the low-fat basal group (1.74 vs. 1.51; $P = 0.04$). There was an interaction of basal fat group with PA dose for yields of milk ($P = 0.09$) and milk protein ($P = 0.10$), and a trend for yields of milk fat ($P = 0.15$) and 3.5% FCM ($P = 0.13$). Results demonstrate that response to PA varies with dose, and under the dietary conditions tested, the yield of 3.5% FCM and milk fat were optimal when PA was fed at 1.5% of ration DM.

Key Words: fat supplementation, milk fat, palmitic acid

652 Effect of dietary NDF and PUFA concentration on recovery from diet induced milk fat depression (MFD) in monensin-supplemented dairy cows. D. E. Rico*[1], A. W. Holloway[2], and K. J. Harvatine[1], [1]*The Pennsylvania State University, University Park,* [2]*Elanco Animal Health, Greenfield, IN.*

Eight ruminally cannulated and 9 non-cannulated Holstein cows were arranged in a 3x3 Latin Square design. Each period was divided into a 10 d MFD induction and an 18 d recovery phase. Milk fat depression was induced by feeding a low fiber and high oil diet. Treatments during the recovery phase were (1) High forage, low PUFA diet (control; 31.8% NDF, no added oil), (2) Low forage, low PUFA diet (LF; 28.4% NDF, no added oil), and (3) High forage, high PUFA diet (HO; 31.5% NDF, 1.5% soybean oil and 7.8% whole soybeans). All cows were supplemented with monensin (Rumensin 90, Elanco animal health) at 450 mg/d. Milk and milk component yield and milk FA profile were measured every 3 d during the recovery phase. Data were analyzed as repeated measures using Proc Mixed (SAS institute). Time was the repeated variable and cow by treatment was the subject. The model included treatment, time, and their interaction as fixed effects. The preplanned contrasts were control vs HO and control vs LF at each time point. Milk yield decreased progressively for the HO and control diets, whereas it was maintained in the LF diet and was higher ($P < 0.01$) than control on d 15. Milk fat concentration increased progressively during recovery in all treatments, but LF was lower than in control from d 12 to 18 (9%; $P < 0.05$). Milk fat yield increased progressively in all treatments and was not different between control and LF at any time point, but was lower in HO compared with control on d 15. Similar to milk fat yield, yield of de novo synthesized and 16 carbons FA increased progressively and were not different between control and LF, but did not recover in HO. Conversely, yield of preformed FA was not different between LF and control, but was increased by HO compared with control on d 9 and 18 (16 and 12%; $P < 0.05$). Milk trans-10 C18:1 concentration decreased progressively in all treatments, but was higher in both HO and LF compared with control from d 3 to 18 and d 9 to 18, respectively (236 and 67%; $P < 0.01$). Correcting dietary PUFA concentration is the predominant factor affecting the rate of recovery from MFD.

Key Words: dairy cow, milk fat depression, monensin

653 Saturated fat supplementation interacts with dietary forage concentration during the immediate postpartum and carryover periods in Holstein cows. P. Piantoni*, A. L. Lock, and M. S. Allen, *Michigan State University, East Lansing.*

Forty-eight multiparous cows were used in a randomized complete block design experiment with a 2 × 2 factorial arrangement of treatments. Treatment diets were offered from 1 to 29 d postpartum (postpartum period; PP) and contained 20% or 26% forage NDF (fNDF; 50:50 corn silage:alfalfa, DM basis) and 0% or 2% saturated free fatty acid supplement (Energy Booster 100; FAT). From 30 to 71 d postpartum (carryover period; CoP), a common diet (~23% fNDF, 0% FAT) was offered to all cows. During PP, high fNDF decreased DMI by 2 kg/d ($P < 0.01$), while FAT increased it by 1.4 kg/d ($P = 0.05$). In addition, high fNDF with no FAT decreased DMI compared with other diets and this difference increased throughout PP ($P < 0.01$). During CoP, FAT increased DMI for the high fNDF diet but decreased it for the low fNDF diet ($P = 0.10$) and differences among treatments tended to decrease over time ($P = 0.13$). Treatment did not affect 3.5% FCM yield during PP. During CoP, FAT decreased 3.5% FCM yield for the low fNDF diet (51.1 vs. 58.7 kg/d) but not for the high fNDF diet (58.5 vs. 58.0 kg/d; interaction $P = 0.10$). Low fNDF and FAT increased BCS during PP (both 3.0 vs. 2.7; $P = 0.02$) and treatment differences increased over time for fNDF during PP ($P = 0.02$) and CoP ($P = 0.08$). Effects on BCS were sustained through CoP: BCS was increased by FAT (2.62 vs. 2.26; $P = 0.02$) and low fNDF (2.70 vs. 2.18; $P < 0.01$). During PP, low fNDF and FAT decreased feed efficiency (FE; 3.5% FCM/DMI) by 0.31 and 0.23 units, respectively (both $P \leq 0.05$). Early in PP, low fNDF with FAT decreased FE greatly compared with other diets, but this difference decreased over time ($P =$

0.09). Low fNDF reduced FE during CoP (1.82 vs. 1.98; $P = 0.03$), but FAT did not. Supplementation of FAT in PP favored energy partitioning to body reserves and limited DMI depression and BCS loss for the high fNDF diet, which might allow higher fNDF diets to be fed to cows in PP. However, FAT had deleterious effects on production for the low fNDF diet. Diet fNDF and FAT interacted affecting performance not only during the treatment period, but also when cows were fed a common diet.

Key Words: body condition, postpartum, prilled fat

654 Milk production responses to dietary stearic acid vary by production level in dairy cattle. P. Piantoni*, A. L. Lock, and M. S. Allen, *Michigan State University, East Lansing.*

Effects of stearic acid supplementation on feed intake and metabolic and production responses of dairy cows with a wide range of milk production (32.2 to 64.4 kg/d) were evaluated in a crossover design experiment with a covariate period. Thirty-two multiparous Holstein cows (142 ± 55 DIM) were assigned randomly within level of milk yield to treatment sequence. Treatments were diets supplemented (2% of diet DM) with stearic acid (SA, 98% C18:0) or control (CONT, soyhulls). The corn silage and alfalfa based diets contained 24.5% forage NDF, 25.1% starch and 17.3% CP. Treatment periods were 21 d with the final 4 d used for data and sample collection. Compared with CONT, SA increased DMI (26.1 vs. 25.2 kg/d, $P = 0.008$) and milk yield (40.2 vs. 38.5 kg/d, $P = 0.02$). Stearic acid had no effect on the concentration of milk components, but increased yields of fat (1.42 vs. 1.35 kg/d, $P = 0.002$), protein (1.19 vs. 1.14 kg/d, $P = 0.02$), and lactose (1.96 vs. 1.87 kg/d; $P = 0.02$). Stearic acid increased 3.5% fat-corrected milk (FCM, 40.5 vs. 38.6 kg/d, $P = 0.005$), but did not affect feed efficiency (3.5% FCM/DMI, 1.55 vs. 1.53, $P = 0.38$), body weight, or body condition score compared with CONT. Period by treatment interactions ($P \leq 0.15$) were detected for yields of milk and milk components indicating that period 2 was responsible for these treatment effects. The cause of the interactions could not be determined and requires further investigation. Linear interactions between treatment and level of milk yield during the covariate period ($P < 0.10$) were detected for DMI and yields of milk, fat, protein, lactose, and 3.5% FCM; responses to SA were positively related to milk yield of cows. Treatment did not affect plasma insulin, glucagon, glucose, and NEFA concentrations. Results show that stearic acid has the potential to increase DMI and yields of milk and milk components, without affecting conversion of feed to milk, body condition score, or body weight. Moreover, effects on DMI and yields of milk and milk components were more pronounced for higher yielding cows than for lower yielding cows.

Key Words: feed intake, milk fat, stearic acid

655 Effects of rumen-protected conjugated linoleic acid (CLA) on expression of genes involved in hepatic gluconeogenesis and insulin sensitivity in dairy cows. A. Kinoshita[1], L. Locher[1], K. Huber[2], U. Meyer[3], S. Daenicke[3], and J. Rehage*[1], [1]*Clinic for Cattle, University of Veterinary Medicine Hannover, Hannover, Germany,* [2]*Dep. of Physiology, University of Veterinary Medicine Hannover, Hannover, Germany,* [3]*Dep. of Animal Nutrition, Friedrich-Loeffler-Institute, Braunschweig, Germany.*

The aim of this study was to investigate the effects of long-term dietary CLA supplementation on expression of hepatic genes related to insulin signaling, gluconeogenesis and systemic insulin sensitivity in dairy cows. Twenty-one pluriparous German Holstein cows were divided in 2 groups (CLA; n = 11 and control; n = 10), studied from 21 d ante partum (ap) to 224 d postpartum (pp). Cows were fed a diet including 37% concentrate and 63% silage (60% maize silage and 40% grass silage based on dry matter content) ad libitum. From 1 d pp to 182 d pp each group received 4 kg concentrate additionally with 100 g/d of fat supplement (10% C16:0, > 80% C18 fatty acids) including either CLA (Lutrell pure, BASF SE, Germany; 50% C18:0, 10% each C18:1, t10c12-CLA, c9t11-CLA) or not (>80% C18:0). Blood and hepatic biopsy samples were taken at 21 d ap, 1, 21, 105, 182, and 224 d pp. In blood samples concentrations of glucose, NEFA, insulin, β-hydroxybutyrate (BHB) were analyzed and the revised quantitative insulin sensitivity check index (RQUICKI) was calculated. Expression of hepatic mRNA for gluconeogenic enzymes (pyruvate carboxylase; PC, phosphoenol pyruvate carboxykinase; PEPCK isotype 1and 2, glucose-6-phosphatase; G6P), glucose transporters (SLC2A1 and SLC2A2) and insulin receptors (INSRA and INSRB) were measured with real-time RT-PCR using UXT, RPS15 and RPS9 as reference genes. Data was analyzed by SAS PROC MIXED for repeated measures with group and day as fixed effects. CLA supplements did not affect transcription of any investigated genes in liver and the levels of BHB and NEFA in blood. However, CLA cows showed increased mean glucose and insulin levels in blood and decreased RQUICKI compared with controls after d 105 (time and group effects: $P < 0.001$). Hepatic mRNA expression of gluconeogenic enzymes and insulin receptors was not affected by long-term CLA supplementation although systemic insulin sensitivity appeared reduced. Thus, the physiological relevance of observed CLA induced changes in insulin sensitivity remains unclear.

Key Words: fat, herd health, insulin

656 Interaction between rumen unsaturated fatty acid load and forage:concentrate ratio on the formation of biohydrogenation intermediates in continuous culture. Y. Sun*[1], T. C. Jenkins[2], and A. L. Lock[1], [1]*Michigan State University, East Lansing,* [2]*Clemson University, Clemson, SC.*

Three dual-flow continuous fermenter studies examined the interaction between rumen unsaturated fatty acid load (RUFAL) and forage:concentrate ratio (FCR) on the formation of biohydrogenation intermediates (BHI). Cultures (4/treatment) were fed basal diet plus respective fat treatments for 10 d with the last 3 d for sample collection. Study 1 determined if canola (high 18:1) vs. corn oil (high 18:2) at 0, 1, 2, and 3% of diet DM resulted in differences in the formation of BHI. Increased RUFAL caused a nonlinear increase ($P < 0.05$) in daily production of *trans*-10, *cis*-12 18:2 (CLA), which was lower for canola (3.0, 3.7, 3.3, and 6.0 mg/d) vs. corn oil (3.5, 4.3, 8.6, and 18.5 mg/d) for the 0, 1, 2, and 3% treatments, respectively. Total *trans* 18:1 and *trans*-10 18:1 production also increased ($P < 0.05$) nonlinearly with increased RUFAL and was lower ($P < 0.05$) for canola vs. corn oil. Study 2 examined the relationship between FCR (60:40 vs. 40:60) and soy oil (high 18:2) at 0, 1, 2, and 3% of the diet DM on the production of BHI. FCR had no effect on types or amount of BHI. Increasing soy oil linearly increased ($P < 0.05$) production of total *trans* 18:1 and CLA. Study 3 examined the relationship between FCR (60:40 vs. 40:60) and canola oil (high 18:1) at 0, 1, 2, and 3% of the diet DM on the production of BHI. FCR had no effect on types or amount of BHI. Increasing canola oil linearly increased ($P < 0.05$) production of total *trans* 18:1 and CLA, with a nonlinear effect for *trans*-10 18:1 ($P < 0.05$). In all studies, increasing RUFAL increased extent of biohydrogenation of dietary fatty acids ($P < 0.05$). Grinding of forages might have negated FCR effects on BHI. Overall, the relationship between CLA production and fatty acid intake was curvilinear with a significant increase in production when fatty acid intake exceeded 40 g/kg DMI. In conclusion, increasing RUFAL via increased dietary 18:1 or 18:2 led to an increase in the production of BHI, which increased most rapidly when added supplemental fat exceeded 2% of diet DM, reaching higher levels for 18:2 than for 18:1 addition.

Key Words: biohydrogenation, continuous culture, fatty acid

657 Effect of abomasal infusions of *trans* octadecenoic fatty acids on plasma lipids and milk fat synthesis in dairy cows. C. M. Klein* and A. L. Lock, *Michigan State University, East Lansing.*

Four rumen-fistulated Holstein cows (211 ± 12 DIM) were used in a 4 × 4 Latin square experiment to examine the effect of *trans* 18:1 fatty acids (TFA) on plasma lipid fractions and milk fat synthesis. Treatments were abomasal infusions of (1) ethanol (control), (2) conjugated linoleic acid supplement (CLA; positive control), (3) partially hydrogenated safflower fatty acid supplement (SAF), and (4) partially hydrogenated sunflower fatty acid supplement (SUN). CLA provided 5.0 g/d of *trans*-10, *cis*-12 18:2 and SAF and SUN supplied 119 g/d of total TFA. SUN contained more *trans*-4 to *trans*-10 18:1 (57% of total TFA) compared with SAF, which contained more *trans*-11 to *trans*-16 18:1 (53% of total TFA). Treatment periods were 5 d in length with a 7 d washout interval. Daily dose was provided by infusion at 6 h intervals. Data were analyzed using the fit model procedure of JMP. Total fatty acid concentration in plasma lipid fractions was not affected by treatment ($P > 0.18$). Compared with control, SAF and SUN increased the concentration of total TFA in plasma triglycerides 44 and 27% and in phospholipids by 24 and 26%, respectively ($P < 0.01$). Treatments did not affect total TFA in plasma cholesterol esters and NEFA ($P > 0.26$). DMI and the yields of milk, milk protein, and milk lactose were unaffected by treatment ($P > 0.15$). Compared with control, SAF and SUN had no effect on milk fat synthesis ($P > 0.40$), whereas CLA resulted in a 24 and 20% reduction in milk fat concentration and yield, respectively ($P < 0.01$). There were no milk production differences between SAF and SUN ($P > 0.1$). The transfer efficiency for abomasally infused *trans*-10, *cis*-12 18:2 into milk fat was 28% from the CLA treatment. Transfer efficiency of TFA from SAF and SUN was 14 and 16%, respectively. Transfer of individual TFA ranged from ~10 to 30%. *Trans*-10 18:1 transfer was 20 and 22% for SAF and SUN, respectively. In conclusion, TFA had no effect on milk fat synthesis when abomasally infused at 119 g/d, although they were incorporated into plasma triglycerides, taken up by the mammary gland, and incorporated into milk fat.

Key Words: milk fat depression, plasma lipid, *trans* fatty acid

658 Impact of unsaturated free fatty acids and triglycerides on milk fat synthesis in dairy cattle. J. C. Ploetz* and A. L. Lock, *Michigan State University, East Lansing.*

This study determined if altering the amount of unsaturated fatty acids (FA) in the diet as triglycerides or free FA affected feed intake, yield of milk and milk components, and feed efficiency. Eighteen Holstein cows (132 ± 75 DIM) were used in a 3 × 3 Latin Square design. Treatments were diets supplemented (2% of diet DM) with soybean oil (TAG), soybean free FA (FFA), or control (CON, soyhulls). Treatment periods were 21 d with the final 4 d used for sample and data collection. The corn silage and alfalfa haylage-based diets contained 23% forage NDF and 17% CP. Total dietary FA were 2.6, 4.3, and 4.2% DM for CON, TAG, and FFA, respectively. Data were analyzed using the fit model procedure of JMP. Compared with CON, fat treatments decreased DMI (1.0 kg/d; $P < 0.05$) but increased milk yield (2.2 kg/d; $P < 0.01$) and milk lactose concentration and yield ($P < 0.01$). Fat supplements reduced milk fat concentration ($P < 0.05$), averaging 3.30, 3.18, and 3.11% for CON, FFA, and TAG, respectively. Yield of milk fat, milk protein, and 3.5% FCM ($P > 0.17$) remained unchanged. There were no differences in the yield of milk or milk components between FFA and TAG ($P > 0.22$). Fat treatments increased feed efficiency (3.5% FCM/DMI), averaging 1.42, 1.53, and 1.48 for CON, FFA, and TAG, respectively ($P < 0.01$). Although milk fat yield was not affected, fat treatments decreased the yield of de novo (<16-carbon) FA (40 g/d; $P < 0.001$) and increased preformed (>16-carbon) FA (134 g/d; $P < 0.001$). Yield of FA from both sources (16-carbon FA) was reduced by fat treatments ($P < 0.001$) but to a different extent for FFA vs. TAG (72 vs. 100 g/d; $P < 0.05$). Total *trans* 18:1 FA concentration and yield increased with fat treatments ($P < 0.001$) but was higher for TAG vs. FFA ($P < 0.01$). While the ratio of t10 18:1 to t11 18:1 was not affected by treatment ($P = 0.21$) there was a trend for t10c12 18:2 concentration and yield to be higher for fat treatments ($P = 0.06$). In conclusion, FA supplemented at 2% diet DM as either FFA or TAG increased milk yield but did not effectively cause MFD with preformed FA replacing de novo synthesized FA in milk fat.

Key Words: biohydrogenation, milk fat, unsaturated fatty acid

659 Effects of ruminally inert essential fatty acids on postpartum immune-related functions and productivity in lactating dairy cattle. J. Pankowski*[1], J. Noble[2], P. Brennan[3], G. Jarrett[4], and E. Block[1], [1]*Arm & Hammer Animal Nutrition, Princeton, NJ,* [2]*Linwood Management,LLC, Linwood, NY,* [3]*Purina Animal Nutrition LLC, Caledonia, NY,* [4]*Cows Come First LLC, Batavia, NY.*

This prospective field study tested the effects of increasing intestinally available essential FFA (EFA) on production, immune and reproduction parameters in 2 large commercial dairies. A commercially available FFA prilled supplement was replaced with commercially available calcium salts of FA containing both linoleic and linolenic acids at rate of 114 g/cow/d in the 21-d prepartum ration and 340 g/cow/d in the postpartum ration fed until 100 DIM. Measurements, descriptions, and results are in Table1. The effects of treatment on primary response variables were quantified using linear regression analysis. A total of 1909 cows were used to evaluate the base case and 2219 cows were used to evaluate the EFA case. Economics showed a favorable profitability for the use of the EFA supplement. Results from this and other cited trials present evidence that EFA supplementation of pre- and postpartum dairy cattle has positive roles both biologically and economically.

Table 1. Production, reproduction and immune responses to inclusion of intestinally available EFA in pre- and postpartum diets for dairy cows[1,2]

Parameter	Baseline	EFA	P > F
Milk (kg/d)	33.5	36.3	<0.001
FCM 3.5% (kg/d)	34.4	36.3	<0.001
Fat (kg/d)	1.23	1.27	0.006
Protein (kg/d)	1.03	1.07	0.003
BHBA (mg/dL)	5.05	2.82	<0.001
Start up milk yield (kg/d)[3]	15.8	16.6	0.005
First SCC linear score	3.09	2.73	<0.001
Monthly EED (n)[4]	7.6	2.5	<0.001
FSCR (%)[5]	35.4	39.4	0.082
Heat detection rate (%)	66.7	67.7	0.318
Conception rate (%)	35.6	38.2	0.035
Preganancy rate (%)	23.8	25.9	0.034

[1]Baseline: 1 December 2010 through 30 August 2011. EFA: 1 December 2011 through 30 August 2012.
[2]EFA supplement as calcium salts replaced same quantity of saturated fatty acid prills fed during baseline period.
[3]Statistical model corrected for parity and DIM at first DHI test. Average actual milk volumes for baseline and EFA periods were 35.5 and 37.3 kg/d, respectively, with DIM at first DHI test ranging 1 to 39 d and parity ranging 1 to 8.
[4]Average monthly number of early embryonic death defined as animals returning to service at 35 days post insemination following a diagnosis of pregnancy.
[5]First service conception rate.

Key Words: EFA, immune function, reproduction