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## Ruminant Nutrition: Dairy

**466 Effects of including supplemental fat in low and high starch diets on milk production and energy partitioning.** Joshua L. Garver\*, Jonas De Souza, Michael J. VandeHaar, and Adam L. Lock, *Michigan State University, East Lansing, MI.*

Effects of low or high starch diets with or without supplemental fat on the yield of milk and milk components and energy partitioning were evaluated. Thirty-two Holstein cows ( $172 \pm 35$  DIM) were assigned randomly to treatment sequence in replicated  $4 \times 4$  Latin squares with a  $2 \times 2$  factorial arrangement of treatments. Treatment diets contained 16% (LS) or 32% (HS) starch and 0.0% (LF) or 1.5% (HF) palmitic acid-enriched fat supplement (BergaFat F-100). Dietary starch was altered by varying the proportion of ground corn, cottonseed, and soy-hulls, with LS and HS diets containing 17 and 21% forage NDF and 42 and 29% NDF, respectively. Treatment periods were 21 d in length with the final 5 d used for data and sample collection. The statistical model included the random effects of cow and period and the fixed effects of dietary starch level, fat supplementation, and their interaction. Compared with LF, the HF treatment increased DMI in the LS diet (26.8 vs. 25.8 kg/d) and decreased DMI in the HS diet (25.9 vs. 26.5 kg/d; interaction  $P < 0.01$ ). The HF treatment increased milk fat yield in the LS diet (1.57 vs. 1.51 kg/d) but not in the HS diet (1.49 vs. 1.51 kg/d; interaction  $P = 0.06$ ). Compared with LF, the HF treatment also increased milk protein concentration and yield in the LS diet (3.40 vs. 3.35% and 1.31 vs. 1.26 kg/d), but not in the HS diet (interaction  $P = 0.10$  and  $P < 0.05$ , respectively). There was no effect of treatments on milk fat and lactose concentrations or lactose yield. Compared with LF, the HF treatment increased 3.5% FCM (42.2 vs. 41.0 kg/d) in the LS diet but not in the HS diet (40.4 vs. 41.1 kg/d; interaction  $P = 0.07$ ). Similarly, the HF treatment increased ECM (42.3 vs. 41.0 kg/d) in the LS diet but not in the HS diet (40.5 vs. 41.2 kg/d; interaction  $P < 0.05$ ). The milk to feed ratio (ECM/DMI) was not affected by treatments. There was a trend for HS diets to increase change in BCS compared with LS diets ( $P = 0.08$ ). However, fat supplementation did not affect change in BCS. Results demonstrate that under the dietary conditions tested, a palmitic acid-enriched fat supplement fed to mid and late lactation dairy cows maximized yield of milk and milk components when fed in a low starch diet.

**Key Words:** body condition, milk fat, palmitic acid

**467 Effect of breed, energy level of diet, and lactation stage on the evolution of milk lipolysis in dairy cow.** Elise Vanbergue\*<sup>1,2</sup>, Luc Delaby<sup>1</sup>, Ségolène Colette<sup>3</sup>, Yves Gallard<sup>3</sup>, and Catherine Hurtaud<sup>1</sup>, <sup>1</sup>*INRA-Agrocampus Ouest UMR1348 Pegase, Saint-Gilles, France*, <sup>2</sup>*Institut de l'Élevage, Le Rheu, France*, <sup>3</sup>*INRA, Domaine du Pin-au-Haras, Exmes, France.*

Spontaneous lipolysis is the result of the activity of a native milk enzyme, the lipoprotein lipase. Lipolysis leads to a release of free fatty acids (FFA) that cause rancid flavor in milk products. A trial was carried out to study the effects of breed, energy levels, and lactation stage on milk spontaneous lipolysis in dairy cows. Sixty-four cows were used through a year of lactation. Cows were divided into 4 homogenous groups according to their breed [Holstein (HO) or Normande (NO)] and to their feeding system: the intensive system, with a high energy diet (HED) (in winter, corn silage with 30% concentrate; otherwise, pasture with 4 kg/d of concentrate) and the grass system (GS) (in winter, conserved grass with no concentrate; otherwise, pasture with no concentrate). The period of

calving was synchronized between January and March. Individual milk samples were collected every month from both morning and evening milkings. The FFA levels were determined by the difference between the FFA levels after milking and the FFA after 24 h of storage at 4°C. Data were analyzed using SAS mixed procedure. We showed that FFA levels were higher in the evening milks (0.45 vs. 0.25 mEq/100 g of fat,  $P < 0.001$ ) and that evening milks were more susceptible to lipolysis variations. HO cows were more susceptible to lipolysis than NO (0.34 vs. 0.20 mEq/100 g of fat, in morning milks; 0.62 vs. 0.33 mEq/100 g of fat in evening milks,  $P < 0.001$ ). There was no effect of the feeding system on morning milks lipolysis but GS had a tendency to increase milk lipolysis in evening milks (0.41 vs. 0.55 mEq/100 g of fat,  $P = 0.06$ ). Lipolysis was higher in early and late lactation stage, particularly in the GS group. Conserved grass may also affect the lipolysis rate. The energy status in early and late lactation stage is frequently negative so the cows may be more susceptible to a low energy diet. No correlation was found between lipolysis and milk fat content. Poor correlations ( $r < 0.4$ ,  $P < 0.001$ ) were found between lipolysis and milk production, fat globule size, proportion of fatty acid and protein composition, body condition and weight.

**Key Words:** spontaneous milk lipolysis, production factors

**468 Direct and indirect transfer of omega-3 fatty acids to milk fat in dairy cows.** Natalie L. Urrutia\*, Jackie Y. Ying, Samantha R. McKinney, Michael H. Green, and Kevin J. Harvatine, *The Pennsylvania State University, University Park, PA.*

Transfer of dietary fatty acids (FA) to milk has been proposed to fit a 2-pool model with a fast pool representing direct transfer by chylomicrons and a slow pool representing indirect transfer through tissue recycling. The objective of this experiment was to quantify direct and indirect transfer of omega-3 (n-3) FA to milk after an abomasal bolus infusion of n-3 FA. Ten ruminally cannulated multiparous Holstein cows ( $247 \pm 113$  DIM; mean  $\pm$  SD) were used in a crossover design with 7 d periods. Cows were milked 4 times daily (6 h intervals) starting 2 d before initiation of the experiment. Treatments were abomasal infusion of 120 g (infused over 1 h) of a free FA mixture enriched in  $\alpha$ -linolenic acid (18:3 n-3; EALA) or in very long chain n-3 ( $>18C$  n-3; EVLC). The EALA and EVLC treatments provided 80.2 g and 87.6 g of n-3 FA, respectively. Milk was sampled at each milking for determination of milk fat yield and FA profile. The day before bolus infusion was used as a baseline. Total transfer of n-3 FA was analyzed in a model that included random effects of cow nested in sequence, sequence and period and fixed effect of treatment and milk yield (JMP Pro). Time course data was analyzed as repeated measures in SAS and resulting least squares means were fit to a double exponential decay function by nonlinear curve fitting (JMP Pro). Total transfer of n-3 FA to milk differed between treatments ( $P < 0.001$ ) and was 48.2 and 32.7% of the bolus for EALA and EVLC, respectively. Milk n-3 FA concentration and yield peaked at 12 h and returned to baseline at 138 h post infusion in both treatments. Time course of n-3 FA transferred to milk fit a biexponential model ( $R^2 = 0.99$ ). The area (% of total) under the first exponential representing direct transfer was 83.9 and 42.2% and the second exponential representing indirect transfer was 16.1 and 57.8% of the total n-3 FA transferred for EALA and EVLC, respectively. In conclusion, n-3 FA differed greatly in their transfer efficiency mainly due to differences in their direct transfer rates. These differences pre-