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Short communication: Effects of prill size of a palmitic acid–enriched fat supplement on the yield of milk and milk components, and nutrient digestibility of dairy cows

J. de Souza, J. L. Garver, C. L. Preseault, and A. L. Lock[1]
Department of Animal Science, Michigan State University, East Lansing 48824

ABSTRACT

The objective of our experiment was to evaluate the effects of prill size of a palmitic acid–enriched fatty acid supplement (PA; 85% C16:0) on feed intake, nutrient digestibility, and production responses of dairy cows. Twenty-four primiparous and multiparous Holstein cows were assigned based on parity and production level to replicated 4 × 4 Latin squares balanced for carryover effects with 21-d periods. Treatments were a control diet (no added PA), or 2.0% PA added as a small prill size (PA-SM; 284 ± 12.4 μm), a medium prill size (PA-MD; 325 ± 14.7 μm), or a large prill size (PA-LG; 600 ± 17.4 μm) supplement. Overall, PA treatments increased milk fat content (4.25 vs. 3.99%), milk fat yield (1.48 vs. 1.39 kg/d), 3.5% fat-corrected milk (39.2 vs. 37.7 kg/d), and improved feed efficiency (fat-corrected milk:dry matter intake; 1.51 vs. 1.42) compared with control. Compared with control, PA treatments did not affect dry matter intake, body weight, body condition score, and yields of milk, protein, and lactose, but increased neutral detergent fiber digestibility (44.8 vs. 42.4%) and reduced the digestibility of 16-carbon fatty acids (72.3 vs. 79.1%) and total fatty acids (76.6 vs. 80.3%). The PA treatments increased neutral detergent fiber digestibility (44.8 vs. 42.4%) and reduced the digestibility of C16 fatty acids (72.3 vs. 79.1%) and total fatty acids (76.6 vs. 80.3%). Compared with control, PA treatments reduced the contents of de novo synthesized milk fatty acids (23.0 vs. 25.8 g/100 g of fatty acids) and preformed milk fatty acids (36.3 vs. 39.1 g/100 g of fatty acids), but did not affect their yields. In contrast, PA treatments increased the content (40.8 vs. 35.1 g/100 g of fatty acids) and yield (570 vs. 436 g/d) of 16-carbon milk fatty acids compared with control. The PA prill size had no effect on dry matter intake, yield of milk and milk components, or feed efficiency. However, PA-LG tended to increase milk fat content compared with PA-SM (4.28 vs. 4.22%), and it increased 16-carbon fatty acid digestibility compared with PA-MD (74.2 vs. 71.0%) and PA-SM (74.2 vs. 71.7%). Additionally, PA-LG increased total fatty acid digestibility compared with PA-MD (78.1 vs. 75.6%) and PA-SM (78.1 vs. 76.0%). Results demonstrate that PA increased milk fat content and yield, and feed efficiency. Reducing prill size decreased fatty acid digestibility, but it had no effect on animal performance under the dietary conditions and prill sizes evaluated.
Key words: fat supplementation, milk fat, palmitic acid, prill size

Short Communication

Fat supplements are commonly used in dairy cow diets to meet energy requirements and increase the yields of milk and milk components (Rabiee et al., 2012). Supplementation with palmitic acid (C16:0) has been reported to increase milk yield, milk fat content and yield, and feed efficiency (Mosley et al., 2007; Piantoni et al., 2013). However, variation in response to palmitic acid has also been reported, with some studies reporting no effect on milk yield (Lock et al., 2013; Rico et al., 2014) and others reporting increases in milk yield (Mosley et al., 2007; Piantoni et al., 2013). Therefore, understanding potential factors (e.g., basal diet composition, characteristics of fat supplement) that may be associated with this variation may allow for more precise feeding recommendations.

The particle size of saturated fat supplements has been suggested as a factor that may affect fatty acid (**FA**) digestibility and production responses in dairy cows (Eastridge and Firkins, 1991). Eastridge and Firkins (2000) evaluated a tallow triglyceride supplement with different particle sizes but similar iodine values and FA profiles, and observed that reducing the particle size increased FA digestibility, milk fat yield, and FCM. Our recent meta-analysis indicated that the intestinal digestibility of palmitic acid was not reduced up to 500 g/d duodenal flow (Boerman et al., 2015). In contrast, Piantoni et al. (2013) reported a reduction in

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[1]Corresponding author: allock@msu.edu

16-carbon and total-tract FA digestibility when feeding a 99% palmitic acid–enriched supplement (2% of diet DM), an effect that was potentially attributed to the physical characteristics and particle size of the supplement.

Based on the above-mentioned results, we hypothesized that dairy cow responses to palmitic acid supplementation may differ depending on the prill size of the supplement, with a smaller prill size supplement increasing FA digestibility. Therefore, the objective of our experiment was to evaluate the effects of prill size of a palmitic acid–enriched supplement on feed intake, nutrient digestibility, and production responses of dairy cows.

Experimental procedures were approved by the Animal Care and Use Committee of Michigan State University. Twenty-four (8 primiparous and 16 multiparous) mid-lactation Holstein cows at the Michigan State University Dairy Field Laboratory were used in replicated 4 × 4 Latin squares, balanced for carryover effects with 21-d periods. Cows were blocked and assigned to squares based on parity and preliminary 3.5% FCM. At the beginning of the trial, mean DIM, BW, and 3.5% FCM (mean ± SD) were 120 ± 44 d, 660 ± 53 kg, and 44.3 ± 5.1 kg/d, respectively.

Treatments consisted of a control diet containing no supplemental fat (control), and a palmitic acid–enriched supplement (**PA**, 85.1 g/100 g of C16:0 FA) at 2.0% of diet DM fed as small (**PA-SM**), medium (**PA-MD**), or large (**PA-LG**) prill-sized supplement. The particle-size distribution of the fat supplements is presented in Supplementary Table S1 (http://dx.doi.org/10.3168/jds.2016-11610). The mean particle sizes of the fat supplements were 284, 324, and 600 μm for PA-SM, PA-MD, and PA-LG, respectively. Although the average particle size was similar between PA-SM and PA-MD, PA-SM had a greater proportion of particles retained in the 150-μm and 212-μm sieves than PA-MD. In contrast, PA-LG had a greater proportion of particles retained in the 450-μm and 600-μm sieves.

Table 1. Ingredient and nutrient composition of treatment diets

	Treatment[1]			
Item	CON	PA-SM	PA-MD	PA-LG
Ingredient, % of DM				
Corn silage	28.5	28.5	28.5	28.5
Alfalfa silage	16.3	16.3	16.3	16.3
Wheat straw	1.00	1.00	1.00	1.00
Ground corn	23.5	23.5	23.5	23.5
Soybean meal (48% CP)	8.81	8.81	8.81	8.81
Whole cottonseed	5.79	5.79	5.79	5.79
Soy hulls	11.8	9.80	9.80	9.80
Amino acid supplement[2]	1.40	1.40	1.40	1.40
Palmitic acid–enriched supplement[3]	—	2.00	2.00	2.00
Vitamin and mineral mix[4]	1.80	1.80	1.80	1.80
Limestone	0.51	0.51	0.51	0.51
Sodium bicarbonate	0.59	0.59	0.59	0.59
Nutrient composition, % of DM				
DM[5]	49.2	49.2	49.2	49.2
NDF	34.3	33.0	33.0	33.0
CP	15.6	15.4	15.4	15.4
Starch	25.9	25.9	25.9	25.9
Total fatty acids	2.90	4.81	4.82	4.82
C16:0	0.49	2.08	2.11	2.11
C18:0	0.11	0.17	0.14	0.14
C18:1 *cis*-9	0.53	0.67	0.68	0.69
C18:2 *cis*-9,*cis*-12	1.51	1.54	1.54	1.55
C18:3 *cis*-9,*cis*-12,*cis*-15	0.17	0.16	0.16	0.16

[1]CON (control diet, no addition of palmitic acid); PA-SM (small prill of palmitic acid); PA-MD (medium prill of palmitic acid); and PA-LG (large prill of palmitic acid).

[2]LysAAmet (Perdue AgriBusiness, Salisbury, MD).

[3]C16:0-enriched supplement (Wawasan Agrolipids, Johor, Malaysia). The supplement contained (g/100 g of fatty acid) 1.5 of C14:0, 85.1 of C16:0, 2.5 of C18:0, 7.9 of C18:1 *cis*-9, and 99.0 of total fatty acids.

[4]Vitamin and mineral mix contained 34.1% dry ground shelled corn, 25.6% white salt, 21.8% calcium carbonate, 9.1% Biofos (The Mosaic Co., Plymouth, MN), 3.9% magnesium oxide, 2% soybean oil, and <1% of each of the following: manganese sulfate, zinc sulfate, ferrous sulfate, copper sulfate, iodine, cobalt carbonate, vitamin E, vitamin A, vitamin D, and selenium.

[5]Percent of as-fed diet.