DAIRY FACT CHECK
The truth through science.
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Highly Enriched Palmitic Acid (PA) Supplements Decrease Body Condition in Early Lactation

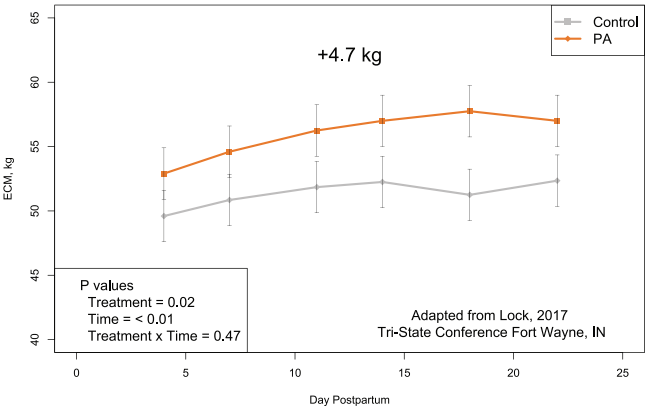
KEY POINTS

- PA-supplemented cows lost an additional 2.76 lb/d of body weight versus control cows.
- Only 54% of this available energy was transferred into Energy Corrected Milk, resulting in 44% of the energy (2.83 Mcal/d) unaccounted for.
- PA-supplemented cows had increased plasma NEFA, BHB, and cholesterol concentrations, and decreased plasma insulin concentrations. This phenotype suggests tissue breakdown and mobilization of body energy stores.
- Gene expression of genes responsible for adispose tissue breakdown were elevated in PA-supplemented cows.
- Hormone sensitive lipase activity was increased in PA-supplemented cows.
- **PA-supplemented cows lost more body weight than control cows due to PA causing increased adipose tissue breakdown.**

Recent research has begun to elucidate the effects of supplementation with highly enriched palmitic acid during early lactation on milk and component production and body weight change.

At the 2017 Tri-State Dairy Nutrition Conference in Fort Wayne, IN, a presentation titled 'Update on Fatty Acid Digestion and Metabolism and Impacts on Milk Production' reported on production responses to highly enriched palmitic acid fat supplements. This presentation included recent unpublished data where purified palmitic acid (PA) was supplemented to fresh cows from 1-24 days in milk versus a no added fat control diet. The results suggested a large increase in yield of Energy-Corrected Milk (ECM; Figure 1) paired with a large decrease in body weight (Figure 2) versus the no-fat control. These findings are in agreement with most field observations that report a substantial increase in milk fat percentage in yield, but some long-term losses in body condition score and potentially reproductive efficiency.

Figure 1. Energy Corrected Milk production in fresh cow supplemented with palmitic acid-enriched fat supplement or a no fat control.



It was also reported that DMI did not differ between PA-supplemented and control cows. Cows fed palmitic acid lost an additional 30 kg (66.1 lb) of body weight versus control cows over the first 24 days of lactation, resulting in a loss of 1.25 kg (2.76 lb) per day. ECM is calculated as equivalent pounds of 3.5% fat, 3.2% protein, and 4.85% lactose milk yield. The NRC (2001) calculation for MCal of NEL per kg of milk is:

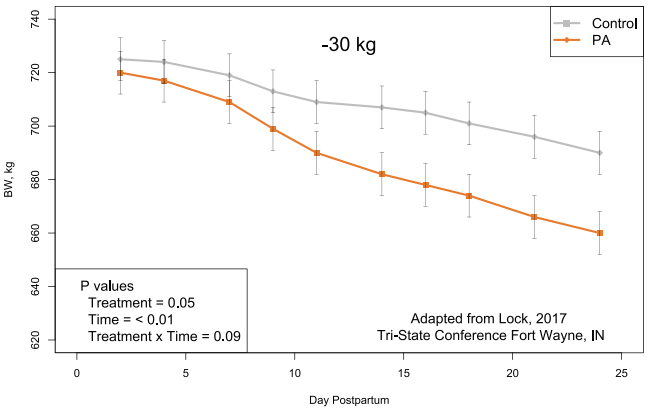
$$\text{Mcal NEL/kg} = [0.0929 \times (\text{Fat \%})] + [0.0563 \times (\text{Protein \%})] + [0.0395 \times (\text{Lactose \%})]$$

Using these two pieces of information, we can determine that the cow requires an additional 0.697 Mcal per kg of ECM. For cows to produce an additional 4.7 kg of ECM as reported in Figure 1, the cow needs an additional 3.28 Mcal NEL per day. The NRC also estimates that a cow with a BCS of 3.25 mobilizes 4.89 Mcal of NEL per kg of body weight loss. The above-mentioned PA-fed cows lost an additional 1.25 kg/d, meaning that an extra 6.11 Mcal NEL per day was available for production. The PA-supplemented fresh cows utilized an extra 3.28 Mcal of NEL per day to improve ECM by 4.7 kg/d, but mobilized 6.11 Mcal NEL per day in lost body weight.

Highly Enriched Palmitic Acid (PA) Supplements Decrease Body Condition in Early Lactation (continued)

In summary, these cows rapidly mobilized a large amount of body energy stores as evidenced by large decreases in body weight, but only converted around 54% of that mobilized energy to increased ECM production. The remaining 46% of mobilized body energy cannot be accounted for, as differences in dry matter intake or net energy intake were not reported.

Figure 2. Change in body weight in fresh cows supplemented with palmitic acid-enriched fat supplement or a no fat control.



Why did these cows lose so much extra body weight?

An abstract presented at the 2017 ADSA Annual Meeting identifies some of the reasoning for this large decrease in bodyweight in PA-fed cows. Similar to the previous experiment, PA was supplemented to cows at 1.5% of DM from 1-24 DIM. Body weight was measured 3 times per week, and blood and milk samples were collected weekly. Adipose tissue samples were also collected at -14 and 10 DIM to analyze gene expression.

Blood metabolite concentrations are shown in Table 1. PA-supplemented cows had increased plasma NEFA, a tendency for increased plasma BHB, decreased plasma insulin and increased plasma cholesterol concentrations. This phenotype is indicative of an animal that is in a 'fasted' state and is mobilizing body fat reserves via lipolysis.

Table 1. Selected blood metabolite concentrations when fresh cows were supplemented with 1.5% palmitic acid at 1-24 DIM.

	Treatment			
Variable	CON	PA	SEM	P <
NEFA, mEq/L	0.59	0.65	0.02	0.03
BHB, mg/dL	12.3	13.6	1.75	0.15
Insulin, µg/L	0.24	0.21	0.01	0.05
Cholesterol, mg/dL	79.5	89.0	4.29	0.03

Relative gene expression for genes involved in lipolysis confirmed that lipolytic activity was increased in adipose tissue (Table 2). These genes code for proteins and enzymes responsible for lipolysis, fatty acid binding and transfer, and fatty acid oxidation in adipose tissue. This further confirms that PA-supplemented cows experienced elevated levels of lipolysis in adipose tissue compared to control cows.

Lastly, the ratio of phosphorylated hormone sensitive lipase (pHSL) to unphosphorylated hormone sensitive lipase (HSL) enzyme was measured in adipose tissue as a direct measure of how much lipolytic activity was occurring. In agreement with the previous data, PA-supplemented cows tended to increase pHSL:HSL ratio (0.22 vs 0.16 for PA and CON, respectively; P = 0.06), indicative of increased hormone sensitive lipase activity in adipose tissue, which is associated with increased body fat mobilization and decreases in body weight and body condition.

Table 2. Relative gene expression of genes involved in lipolysis and fatty acid metabolism in adipose tissue. Values represent change for PA-supplemented cows versus CON cows.

Gene Name	% Change in Expression
ADIPOQ	-20%
LIPE	+25%
ABHD5	+45%
FABP4	+20%

References
• Lock, A.L. and J. de Souza. 2017. Update on Fatty Acid Digestion and Metabolism and Impacts on Milk Production. 2017 Tri-State Dairy Nutrition Conference.
• de Souza, J., Strieder-Barboza, C., Contreras, G.A., and A.L. Lock. 2017. C16:0 supplementation alters markers of adipose tissue lipolysis and inflammation in early lactation dairy cows. Abstr. #T269. 2017 ADSA Annual Meeting.