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Effects of Two Commercial Supplemental Fat Products on Body Condition Score and Cow- and Herd-Level Milk Yield and Composition in a Commercial Dairy Herd in Kansas

A. L. Scanavez
Kansas State University, Manhattan, scanavez@k-state.edu

C. A. Gamarra
Kansas State University, gamarra@k-state.edu

R. S. de Oliveira
Kansas State University, rsaraiva@k-state.edu

See next page for additional authors

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Abstract

Feeding fat supplements to lactating dairy cows is an effective strategy to increase energy density of rations and increase milk yield. However, it is not clear whether supplementing a specific fat supplement for the entire lactating herd provides better results than others in commercial dairy herds. The objective of this study was to compare the effects of fat supplementation with two commercial products on changes in body condition score (BCS) and cow- and herd-level milk production and composition in a large commercial dairy herd. The study was conducted in a herd milking approximately 1,500 Holstein cows. One of two treatments was assigned to the herd in a singlesubject crossover design with 4 periods. Treatments were inclusion of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel; Propel Energy Plus) or 0.22 lb/cow per day of a supplement containing calcium salts of long-chain fatty acids (Control). Treatments were applied to all lactating cows during four consecutive weeks. Milk yield recorded during the last week of each period was used for statistical analyses. In addition, milk samples were collected in the last week of each period to determine test-day milk protein, fat, somatic cell count, and urea nitrogen concentrations. At the beginning and at the end of each experimental period, BCS was assessed from a subset of cows to evaluate BCS change. Herd-level milk fat, protein, and somatic cell count were recorded daily by the milk cooperative. Bulk tank milk fat and protein contents on the fourth week of fat supplementation were similar between Control and Propel treatments. Average milk yield during the fourth week of fat supplementation (yield recorded daily in the last week of the experimental period) was greater for Control than Propel supplementation (83.4 vs. 82.1 ± 1.7 lb/day). In the analyses that used test-day data, milk yield did not differ between Control and Propel treatments. Supplementation with Propel resulted in greater milk fat (4.50 vs. 4.29 ± 0.12%) and reduced milk protein content (3.12 vs. 3.14 ± 0.03%) compared with Control. In addition, milk urea nitrogen was reduced for Control vs. Propel cows (12.5 vs. 13.1 ± 0.04 mg/dL). Supplementation with Propel increased energy-corrected milk (93.9 vs. 91.7 ± 3.1 lb/ day) and fat-corrected milk (96.3 vs. 93.5 ± 3.3 lb/day) yields compared with Control supplementation. Proportion of cows that lost BCS during the fat supplementation periods did not differ between treatments; however, BCS change tended to be more pronounced during supplementation with Propel than Control treatment (-0.03 vs. 0.02 ± 0.04). In conclusion, fat supplementation using the Propel treatment resulted in greater milk fat content, energy-corrected milk, and fat-corrected milk compared with fat supplementation with Control. Our findings suggest that the type of market to which milk is sold should be considered in the choice of fat supplements.

Keywords

fatty acids, milk components, energy-corrected milk, fat-corrected milk

Cover Page Footnote

The authors thank Dr. Troy Wistuba and Michael Thomas from Purina Animal Nutrition (Gray Summit, MO), and the manager, nutritionist, and employees of the collaborating dairy for support during the project.

Authors

A. L. Scanavez, C. A. Gamarra, R. S. de Oliveira, and L. G. Mendonça

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A.L.A. Scanavez, C.A. Gamarra, R.S.S. de Oliveira, and L.G.D. Mendonça

Summary

Feeding fat supplements to lactating dairy cows is an effective strategy to increase energy density of rations and increase milk yield. However, it is not clear whether supplementing a specific fat supplement for the entire lactating herd provides better results than others in commercial dairy herds. The objective of this study was to compare the effects of fat supplementation with two commercial products on changes in body condition score (BCS) and cow- and herd-level milk production and composition in a large commercial dairy herd. The study was conducted in a herd milking approximately 1,500 Holstein cows. One of two treatments was assigned to the herd in a single-subject crossover design with 4 periods. Treatments were inclusion of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel; Propel Energy Plus) or 0.22 lb/cow per day of a supplement containing calcium salts of long-chain fatty acids (Control). Treatments were applied to all lactating cows during four consecutive weeks. Milk yield recorded during the last week of each period was used for statistical analyses. In addition, milk samples were collected in the last week of each period to determine test-day milk protein, fat, somatic cell count, and urea nitrogen concentrations. At the beginning and at the end of each experimental period, BCS was assessed from a subset of cows to evaluate BCS change. Herd-level milk fat, protein, and somatic cell count were recorded daily by the milk cooperative. Bulk tank milk fat and protein contents on the fourth week of fat supplementation were similar between Control and Propel treatments. Average milk yield during the fourth week of fat supplementation (yield recorded daily in the last week of the experimental period) was greater for Control than Propel supplementation (83.4 vs. 82.1 ± 1.7 lb/day). In the analyses that used test-day data, milk yield did not differ between Control and Propel treatments. Supplementation with Propel resulted in greater milk fat (4.50 vs. 4.29 ± 0.12%) and reduced milk protein content (3.12 vs. 3.14 ± 0.03%) compared with Control. In addition, milk urea nitrogen was reduced for Control vs. Propel cows (12.5 vs. 13.1 ± 0.04 mg/dL). Supplementation with Propel increased energy-corrected milk (93.9 vs. 91.7 ± 3.1 lb/day) and fat-corrected milk (96.3 vs. 93.5 ± 3.3 lb/day) yields compared with Control

supplementation. Proportion of cows that lost BCS during the fat supplementation periods did not differ between treatments; however, BCS change tended to be more pronounced during supplementation with Propel than Control treatment (-0.03 vs. 0.02 ± 0.04). In conclusion, fat supplementation using the Propel treatment resulted in greater milk fat content, energy-corrected milk, and fat-corrected milk compared with fat supplementation with Control. Our findings suggest that the type of market to which milk is sold should be considered in the choice of fat supplements.

Introduction

Feeding fat to lactating dairy cows is a strategy commonly used to increase energy density and adjust levels of specific fatty acids in rations. Despite the high fat content in feeds such as cottonseed and full-fat soybeans, rations formulated for high-producing dairy cows usually require supplemental fat. Lactating dairy cows supplemented with fat increase milk yield by approximately 2.3 lb/cow per day and have greater BCS compared with non-supplemented cows. In spite of its consistent benefit to milk yield, fat supplementation usually reduces dry matter intake, and milk fat and protein contents. However, these results are highly heterogenous in the scientific literature. Variability in productive responses resulting from fat supplementation is partially explained by the source and biochemical profile of the fat supplement. In fact, it has been suggested that strategic feeding of a combination of a fat supplement rich in linoleic acid during the transition period followed by supplementation with a fish-oil-based fat supplement improves both reproductive and productive performance of dairy cows compared with other fat supplementation strategies. Nonetheless, this approach has not been widely adopted, given that most herds prefer to rely on a single product as source of supplemental fatty acids. In addition, it is not clear whether supplementing a specific fat for the entire lactating herd provides better results than others. Therefore, decisions on which product to use in dairy operations is frequently made arbitrarily.

Most studies that evaluated the effects of various sources of fat supplementation on milk yield and composition were conducted in facilities (e.g., tie-stall barns) that are not comparable to systems used by large commercial herds. Furthermore, to our knowledge, very limited data are available comparing herd-level indicators such as bulk tank fat and protein content in herds using different sources of supplemental fat. Comparing productive outcomes by supplementing the herd with different fat sources in a commercial setting may aid producers to make more reliable and profitable decisions for their operations.

The objective of the present study was to compare the effects of fat supplementation with two commercial products on changes of body condition score and cow- and herd-level milk production and composition in a large commercial dairy herd located in Kansas.

Experimental Procedures

This study was conducted in a commercial dairy herd located in Kansas from April to July 2019. Approximately 1,500 lactating Holstein cows were housed in two-row free-stall barns bedded with sand and were milked three times daily. Primiparous and multiparous cows were kept in the same pen during the first 2 weeks of lactation. After this period, primiparous and multiparous cows were housed separately until the end of the lactating period. Cooling systems comprised of sprinklers and fans were present in all pens and in the holding area. Lactating cows were fed twice daily with a total mixed ration formulated by a nutritionist. The herd was assigned to one of two treatments in a single-subject crossover design with 4 periods. Treatments were inclusion of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel Energy Plus, Purina Animal Nutrition) or 0.22 lb/cow per day of a supplement containing calcium salts of long chain fatty acids (Control; Megalac, Church and Dwight Co. Inc.). Treatments were designed to result in isoenergetic and isonitrogenous diets (Table 1). Treatment was applied to all lactating cows during four consecutive weeks. After this period, the treatment was changed for all lactating cows. Each treatment was applied during two alternated 4-week periods, in a total of 4 experimental periods.

Milk yield from each cow was automatically recorded daily, and data recorded during the last week of each period were used for statistical analyses. Milk samples were collected by the Heart of America Dairy Herd Improvement Association (Kansas City, MO) from all cows in the last week of each period to determine milk protein, fat, somatic cell count, and urea nitrogen concentrations. Energy-corrected milk and 3.5% fat-corrected milk were calculated using the following formulas: energy-corrected milk = (0.327 × lb of milk yield) + (12.95 × lb of fat) + (7.2 × lb of protein) and fat-corrected milk = (0.432 × lb of milk yield) + (16.216 × lb of fat). At the beginning of each experimental period, a list was generated with all lactating cows and their respective days in milk (DIM). Cows were classified into the following stages of lactation: fresh (15 to 30 DIM), early (31 to 100 DIM), middle (101 to 180 DIM) or late (181 to 230 DIM). Within each stratum, BCS was assessed using a 5-point scale from a subset of 40 cows at the beginning and end of each experimental period to evaluate BCS change. Cows with less than 15 or more than 230 DIM were not included in the BCS analyses. Ambient temperature and relative humidity of 2 pens were recorded every 5 minutes using loggers to calculate temperature-humidity index (THI). Herd-level milk fat, protein, and somatic cell count were recorded daily by the milk cooperative (Dairy Farmers of America). During the study, data regarding lactation number, days in milk, and reproductive status of all lactating cows were extracted daily from the on-farm management software (PCDart, DRMS, Raleigh, NC). Data were analyzed by ANOVA using the PROC GLIMMIX procedure of SAS v. 9.4 (SAS Inst., Cary, NC). For the test-day data and average milk yield during the fourth week of fat supplementation, treatment (Propel and Control), parity (primiparous and multiparous), and days in milk were included as fixed variables, and period as a random variable. Significance was declared at $P \leq 0.05$, and tendencies at $0.05 < P \leq 0.10$.

Results and Discussion

Diets used for lactating dairy cows in the current experiment are presented in Table 1. Increased values of ambient temperature, average THI, and maximum THI were observed in the last 2 supplementation periods (e.g., June and July), which coincided with reduced milk fat and protein contents (Table 2). Despite changes in milk components during periods of increased THI, bulk tank fat and protein contents were comparable between treatments. Further descriptive data are depicted in Table 2. Average milk yield during the fourth week of fat supplementation (yield recorded daily in the last week of the experimental period) was ($P < 0.01$) greater for Control than Propel supplementation (83.4 vs. 82.1 ± 1.7 lb/day, data not shown in tables). In addition, milk yield during the fourth week of fat supplementation was ($P < 0.01$) negatively associated with DIM and was ($P < 0.01$) greater for multiparous than primiparous cows (87.2 vs. 77.8 ± 1.7 lb/day).

Individual milk components were only available at the end of the fourth week of fat supplementation (test-day data). In the analyses that used test-day data, milk yield did not ($P = 0.70$) differ between Control and Propel treatments (Table 3). However, milk fat content was ($P < 0.01$) greater in the Propel than Control treatment (4.50 ± 0.12 vs. 4.29 ± 0.12%). These results contrast with bulk tank milk fat on the fourth week of fat supplementation, which was similar between Control and Propel treatments (Table 2). Even though we observed these contrasting findings (test-day vs. bulk tank data), it should be noted that the analyses using test-day data were adjusted for parity and DIM, therefore, conclusions should be drawn from these specific analyses. The increased milk fat content for Propel compared with Control was likely caused by distinct concentration of unsaturated fats in the supplements. Supplementation with Control resulted in greater ($P = 0.03$) milk protein content and decreased ($P < 0.01$) milk urea nitrogen compared with supplementation with Propel (Table 3). The authors speculate that during supplementation with Propel, cows had greater uptake of fatty acids by the mammary gland to produce milk fat, which likely resulted in less energy available to convert amino acids from the diet into milk protein. However, the magnitude of the difference in milk protein (0.02%) between Control and Propel treatments is likely not economically meaningful for commercial dairy herds. Supplementation with Propel increased ($P < 0.01$) energy-corrected milk and fat-corrected milk by approximately 2.5 lb/cow compared with Control supplementation (Table 3).

Body condition score at the beginning of the fat supplementation period tended ($P = 0.08$) to be lesser in the Control compared with the Propel treatment (2.93 vs. 2.98 ± 0.06; Table 4). No differences ($P > 0.61$) were detected in BCS at the end of supplementation periods, or in DIM at which BCS were assessed in the Control and Propel treatments (Table 4). In addition, the proportion of cows that lost BCS during the fat supplementation periods did not ($P = 0.32$) differ between Control and Propel treatments. Body condition score change tended ($P = 0.10$) to be more pronounced during supplementation with Propel than Control treatment (Table 4). It is possible, given that more energy was necessary for milk fat synthesis during supplementation with Propel, less energy was available to support body fat reserves, resulting in greater BCS change for cows supplemented with the Propel treatment. Even though BCS loss observed during supplementation with Propel was modest, it is possible that greater losses could occur if supplementation was carried out for a longer period. Long-term effects of fat supplementation were not the focus of the current study, but it should be evaluated in future trials.

In conclusion, under the conditions described in the current study, fat supplementation using the Propel treatment resulted in greater milk fat content, energy-corrected milk, and fat-corrected milk than fat supplementation with Control. Because of contrasting findings in fluid milk yield (test-day data vs. yield recorded daily in the fourth week of supplementation) for Control and Propel treatments, the type of market to which milk is sold by the herd is a factor that may be considered in the decision to choose fat supplements. Nonetheless, further studies on the effects of supplementing various sources of fat in commercial settings are necessary to provide dairy producers and consultants with reliable information to support profitable decisions.

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The authors thank Dr. Troy Wistuba and Michael Thomas from Purina Animal Nutrition (Gray Summit, MO), and the manager, nutritionist, and employees of the collaborating dairy for support during the project.

Table 1. Ingredients and chemical composition of diets with Control or Propel fat supplementation

	Fat supplementation[1]	
Item	Control	Propel
Ingredient, % of dry matter		
Corn silage	26.9	26.9
Alfalfa hay	12.1	12.1
Wheat straw	2.6	2.6
OneTrak[2]	31.7	31.7
Corn, ground	18.7	18.7
Cottonseed, whole	5.9	5.9
Mineral mix[3]	1.8	1.8
Control fat supplement	0.37	---
Propel fat supplement	---	0.40
Water	0.005	0.005
Chemical composition		
Crude protein, %	16.0	16.0
Acid detergent fiber, %	18.5	18.5
Neutral detergent fiber, %	29.0	29.0
Starch, %	25.6	25.6
Sugar, %	6.0	6.0
Non-fiber carbohydrates, %	40.0	40.0
Net energy$_L$, Mcal/lb	0.78	0.78

[1]Fat supplementation consisted of either of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel Energy Plus, Purina Animal Nutrition) or 0.22 lb/cow per day of a supplement containing calcium salts of long chain fatty acids (Control; Megalac, Church and Dwight Co. Inc.).
[2]Pre-blended concentrate (Cargill Corn Milling, Blair, NE).
[3]Mineral premix consisted of 39.9% sodium bicarbonate, 24.7% soybean meal, 9.9% magnesium oxide, 8.2% bentonite adsorbent (AB 20, Phibro Animal Health Corporation, Teanek, NJ), 7.0% limestone, 5.3% potassium chloride, and 4.9% DCAD Plus (Arm & Hammer Animal Nutrition, Princeton, NJ).

Table 2. Descriptive information (mean ± SD[1]) of the fourth week of fat supplementation of each period

Item	Fat supplementation[2]			
	Control	Propel	Control	Propel
Month of supplementation	April	May	June	July
Bulk tank milk fat,[3] %	3.92 ± 0.09	3.89 ± 0.04	3.81 ± 0.02	3.81 ± 0.04
Bulk tank milk protein,[3] %	3.16 ± 0.02	3.17 ± 0.01	3.08 ± 0.02	3.10 ± 0.03
Bulk tank SCC,[3] cells/mL × 1,000	196 ± 7	188 ± 20	185 ± 8	199 ± 9
First lactation cows in the herd,[4] %	37.5 ± 0.2	35.0 ± 0.1	41.3 ± 0.1	40.1 ± 0.1
Days in milk of lactating cows[4]	192 ± 0.9	199 ± 0.7	192 ± 0.7	199 ± 0.9
Temperature,[5] °F	56.7 ± 4.2	66.8 ± 5.8	75.9 ± 6.0	75.2 ± 4.3
Relative humidity,[5] %	65.9 ± 10.0	81.1 ± 6.0	73.0 ± 8.1	63.9 ± 6.5
Temperature-humidity index (THI)[5]	56.4 ± 3.3	65.7 ± 5.3	72.7 ± 4.8	71.2 ± 3.0
Maximum THI[5]	63.9 ± 3.2	73.1 ± 4.6	79.5 ± 3.9	77.4 ± 3.1

[1]SD = standard deviation.
[2]Fat supplementation consisted of either of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel Energy Plus, Purina Animal Nutrition) or 0.22 lb/cow per day of a supplement containing calcium salts of long chain fatty acids (Control; Megalac, Church and Dwight Co. Inc.).
[3]Data extracted from the Dairy Farmers of America website (http://www.dfamilk.com/).
[4]Data extracted from the on-farm management software.
[5]Information obtained from loggers installed in 2 pens at the farm to obtain temperature and relative humidity.
SCC = somatic cell count.

Table 3. Test-day traits of cows supplemented with Propel or Control for 4 weeks

Item	Fat supplementation (FS)[1]		*P* – value		
	Propel	Control	FS	Parity	DIM
Milk yield, lb/d	83.1 ± 1.4	82.9 ± 1.4	0.70	<0.01	<0.01
Energy-corrected milk yield,[2] lb/d	93.9 ± 3.1	91.7 ± 3.1	<0.01	<0.01	<0.01
Fat-corrected milk yield,[3] lb/d	96.3 ± 3.3	93.5 ± 3.3	<0.01	<0.01	<0.01
Fat, %	4.50 ± 0.12	4.29 ± 0.12	<0.01	<0.01	<0.01
Protein, %	3.12 ± 0.03	3.14 ± 0.03	0.03	<0.01	<0.01
Milk urea nitrogen, mg/dL	13.1 ± 0.04	12.5 ± 0.04	<0.01	<0.01	<0.01
Somatic cell count, cells/mL × 1,000	207 ± 11	165 ± 11	<0.01	0.03	<0.01

[1]Fat supplementation consisted of either of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel Energy Plus, Purina Animal Nutrition) or 0.22 lb/cow per day of a supplement containing calcium salts of long chain fatty acids (Control; Megalac, Church and Dwight Co. Inc.).
[2]Energy corrected milk yield = (0.327 × lb of milk yield) + (12.95 × lb of fat yield) + (7.2 × lb of protein yield).
[3]Fat-corrected milk yield = (0.432 × lb of milk yield) + (16.216 × lb of fat yield).
DIM = days in milk.

Table 4. Body condition score (BCS)[2] in the beginning and end of the supplementation period of 2 different fat sources

	Fat supplementation (FS)[1]		*P* - value		
Item	Propel	Control	FS	Parity	DIM
Initial BCS	2.98 ± 0.06	2.93 ± 0.06	0.08	<0.01	<0.01
Days in milk at initial BCS	105 ± 4	108 ± 4	0.64	0.40	---
Final BCS	2.96 ± 0.03	2.94 ± 0.03	0.62	<0.01	<0.01
Days in milk at final BCS	137 ± 4	136 ± 4	0.85	0.41	---
BCS change from final to initial[3]	-0.03 ± 0.04	0.02 ± 0.04	0.10	0.73	<0.01
Proportion of cows that lost BCS,[3] %	53.0	47.0	0.32	0.94	0.06

[1]Fat supplementation consisted of either of 0.24 lb/cow per day of a supplement rich in saturated fats (Propel Energy Plus, Purina Animal Nutrition) or 0.22 lb/cow per day of a supplement containing calcium salts of long chain fatty acids (Control; Megalac, Church and Dwight Co. Inc.).
[2]Body condition score was assessed on a scale of 1 (severe underconditioned) to 5 (obese) with 0.25-point increments.
[3]BCS change from initial to final assessment and proportion of cows that lost BCS during each supplementation period was calculated by subtracting final BCS from initial BCS.
DIM = days in milk.