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Lactipro (Megasphaera elsdenii) Increases Ruminal pH and Alters Volatile Fatty Acids and Lactate During Transition to an 80% Concentrate Diet

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Abstract

Direct-fed microbials commonly have been used to enhance performance or to decrease shedding of foodborne pathogens in beef cattle. *Megasphaera elsdenii* is a recently introduced probiotic bacteria marketed under the trade name Lactipro (MS-Biotec Inc., Wamego, KS) and is a key lactate-fermenting bacterium in the rumens of cattle fed high-concentrate diets. *Megasphaera elsdenii* is responsible for metabolizing up to 95% lactic acid within the rumen, and thus is an important species for controlling occurrence of ruminal acidosis. The objective of this study was to evaluate changes in ruminal pH and volatile fatty acid concentration during the transition from a diet with 60% concentrate to a diet containing 80% concentrate after administering five different oral dosages of Lactipro.

Keywords

acidosis, lactate, Megasphaera, diet transition

Authors

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CATTLEMEN'S DAY 2015

Lactipro *(Megasphaera elsdenii)* Increases Ruminal pH and Alters Volatile Fatty Acids and Lactate During Transition to an 80% Concentrate Diet

J.T. Thieszen, C.L. Van Bibber-Krueger, J.E. Axman, and J.S. Drouillard

Introduction

Direct-fed microbials commonly have been used to enhance performance or to decrease shedding of foodborne pathogens in beef cattle. *Megasphaera elsdenii* is a recently introduced probiotic bacteria marketed under the trade name Lactipro (MS-Biotec Inc., Wamego, KS) and is a key lactate-fermenting bacterium in the rumens of cattle fed high-concentrate diets. *Megasphaera elsdenii* is responsible for metabolizing up to 95% lactic acid within the rumen, and thus is an important species for controlling occurrence of ruminal acidosis. The objective of this study was to evaluate changes in ruminal pH and volatile fatty acid concentration during the transition from a diet with 60% concentrate to a diet containing 80% concentrate after administering five different oral dosages of Lactipro.

Experimental Procedures

The study was a randomized complete block experiment using 240 heifers (initial body weight 1,100 lb). Cattle were housed in concrete-surfaced pens with 8 animals per pen and 6 pens per treatment and a total of 5 treatments consisting of oral dosages of 0, 25, 50, 75, or 100 mL of Lactipro at initial processing. Time of ruminal sampling at 5, 10, 15, 20, 25, and 30 hours following introduction of an 80% concentrate diet constituted a second factor. To facilitate timely sampling, cattle were split into two groups that were started on the study 48 hours apart. Cattle were preadapted to a diet containing 60% concentrate. On day 1, half of the animals (15 pens) were given 1 of the 5 dosages of Lactipro, then returned to their feedlot pen. Cattle were immediately fed a ration consisting of 80% concentrate. Five hours after introducing animals to their new diet, five pens (one for each dosage) were relocated to holding pens in the processing area. One animal was removed at random from each of the holding pens, each animal was weighed, and a sample of ruminal contents was harvested via rumenocentesis. This process was repeated until all 8 animals from each pen were weighed and sampled. When the process was completed for the 40 animals, the groups were relocated to their original feedlot pens. This process was repeated with additional feedlot pens at 15 and 25 hours following introduction to the new diet. While animals were being sampled

via rumenocentesis, other members of the research team measured the amounts of unconsumed feed remaining in each of the five feedlot pens, thus making it possible to calculate feed intake between the time of introducing the new diet and removal of cattle from the pens for sampling. Unconsumed feed was placed back into the feed bunks after weighing. On day 3 of the study, the process was repeated for the remaining 15 feedlot pens, but in this case sampling times were carried at 10, 20, and 30 hours after the initial diet change.

Results

Feed intake (dry matter basis) was not affected by treatment ($P = 0.58$), nor was average daily gain ($P = 0.07$). Heifers dosed with 25 or 50 mL of Lactipro had improved feed:gain ($P = 0.034$) compared with other treatments. No differences in ruminal pH were noted among treatments until hour 25, at which time heifers previously dosed with 75 or 100 mL had increased ruminal pH ($P < 0.05$). Concentrations of volatile fatty acids were largely unaffected by treatment until hour 20. Acetic acid concentrations did not differ among treatments at any point ($P > 0.05$). Propionic acid concentrations at hour 25 post-dosing were lower for heifers dosed with 75 or 100 mL compared with other treatments ($P < 0.01$). Butyric acid had increased concentrations for heifers receiving 50 ml at hour 20 ($P = 0.0088$) compared with 25 mL, 75 mL, or 100 mL. Valeric acid also presented differences between treatments at hour 20 ($P < 0.02$), with heifers receiving 50 mL of Lactipro having greater concentrations of valerate compared with 25- or 100-mL dosages. Total volatile fatty acid concentrations at hour 20 were increased for heifers receiving 50 mL of Lactipro compared with their counterparts dosed with 0, 25, or 100 mL ($P < 0.01$).

Discussion

The rumen is an anaerobic microbial ecosystem in which feedstuffs are fermented to produce organic acids. These acids are important energy substrates for the animal. Rate of fermentation of carbohydrates to organic acids is more rapid for grains than for forages, which can result in accumulation of organic acids in the rumen and a decrease in ruminal pH due to limited capacity of the ruminal epithelium to absorb these acids. Substantial ruminal changes also can shift the microbial population to favor lactate-producing organisms. As pH drops, lactic acid production increases. Lactic acid is a relatively strong organic acid compared with volatile fatty acids such as acetate and butyrate, and ruminal pH can decline sharply in the presence of high concentrations of lactate. *Megasphaera elsdenii* is an important lactic acid-fermenting bacteria, but numbers of this organism normally are low in the rumens of cattle that have not been adapted to concentrated feed. Lactate-producing bacteria proliferate rapidly in response to concentrate feeding, but proliferation of lactate-utilizing bacteria, such as *Megasphaera elsdenii,* generally lags. Oral dosing of *Megasphaera* probiotic cultures increases the population of lactate-utilizing bacteria, presumably preventing accumulation of lactic acid. Megasphaera converts lactic acid into acetate, propionate, and butyrate. Under acidotic conditions, it will produce butyrate, caproate, and valerate, with a concurrent reduction of propionate. This explains the reduction in propionate during hour 25 for 75- and 100-mL treatments in the present study. Also, cattle dosed with *Megasphaera elsdenii* at 75 or 100 mL per animal had higher pH during hour 20 and 25 compared with cattle in the control treatment.

Implications

Dosing heifers with *Megasphaera elsdenii* increased ruminal pH, altered volatile fatty acid concentrations, and improved feed efficiency.

Table 1. Diet composition, dry matter (DM) basis

	Step-up diets (% DM)		
Ingredient	60% concentrate	80% concentrate	92% concentrate
Corn gluten feed	30.00	30.00	30.00
Alfalfa hay	40.90	20.00	8.00
Steam-flaked corn	25.00	43.34	55.34
Supplement[1]	1.94	2.00	2.00
Feed additive premix[2]	2.16	2.16	2.16
Glycerin	0	2.50	2.50
Nutrient analysis			
Dry matter, %	76.03	74.82	74.10
Crude protein, %	15.88	14.64	14.00
Neutral detergent fiber, %	32.93	24.13	19.21
Acid detergent fiber, %	19.55	12.36	8.28
Calcium	1.10	0.85	0.70
Phosphorus	0.46	0.47	0.48
Potassium	1.08	0.84	0.70

[1] Formulated to provide the following nutrients on a dry matter basis: 0.25% salt; 0.1 ppm cobalt; 10 ppm copper; 0.6 ppm iodine; 60 ppm manganese; 0.25 ppm selenium; 60 ppm zinc; 1,000 IU/lb vitamin A; and 10 IU/lb vitamin E.

[2] Fed to provide 300 mg monensin (Elanco Animal Health, Indianapolis, IN) and 90 mg of tylosin (Elanco Animal Health) per animal daily.

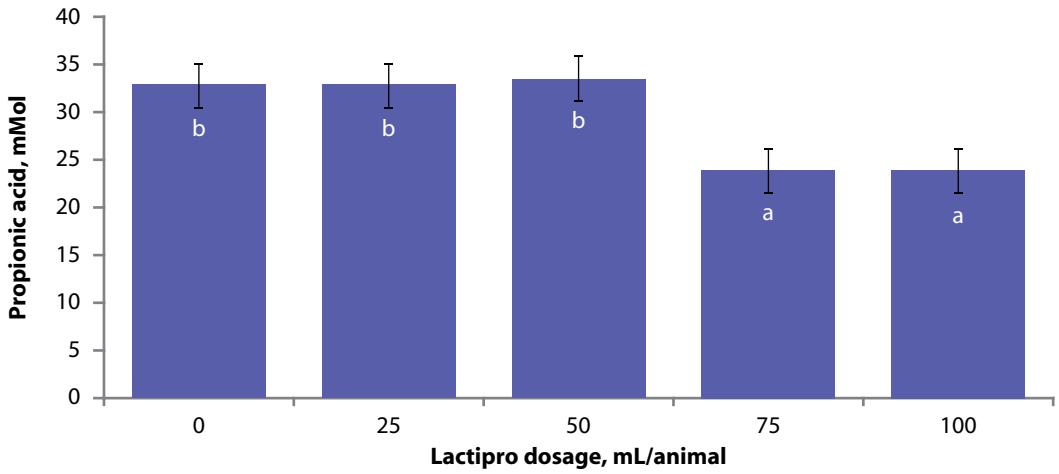

Figure 1. Ruminal concentrations of propionic acid 25 hours after dosing heifers with Lactipro (MS-Biotec Inc., Wamego, KS).

[a,b] Columns without a common letter differ ($P < 0.05$).

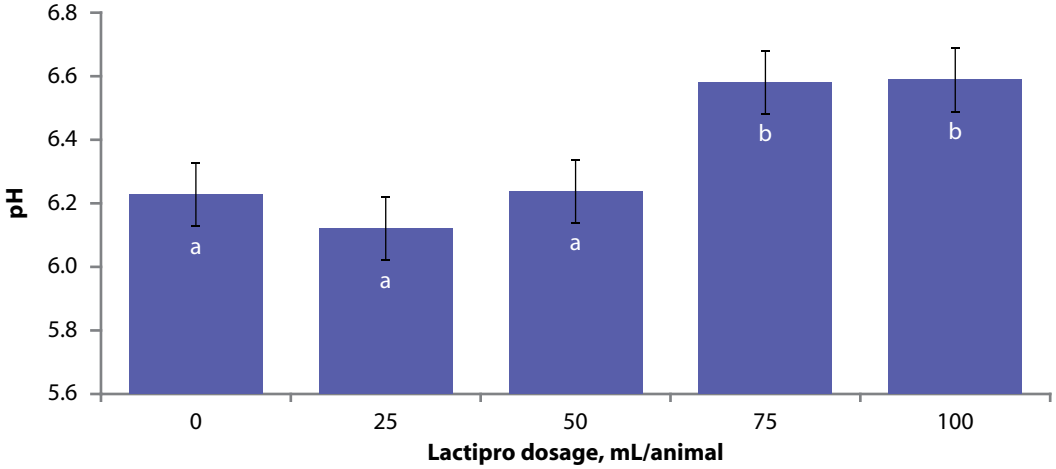

Figure 2. Ruminal fluid pH 25 hours after dosing heifers with Lactipro (MS-Biotec Inc., Wamego, KS).

[a,b,c] Columns without a common letter differ ($P < 0.05$).

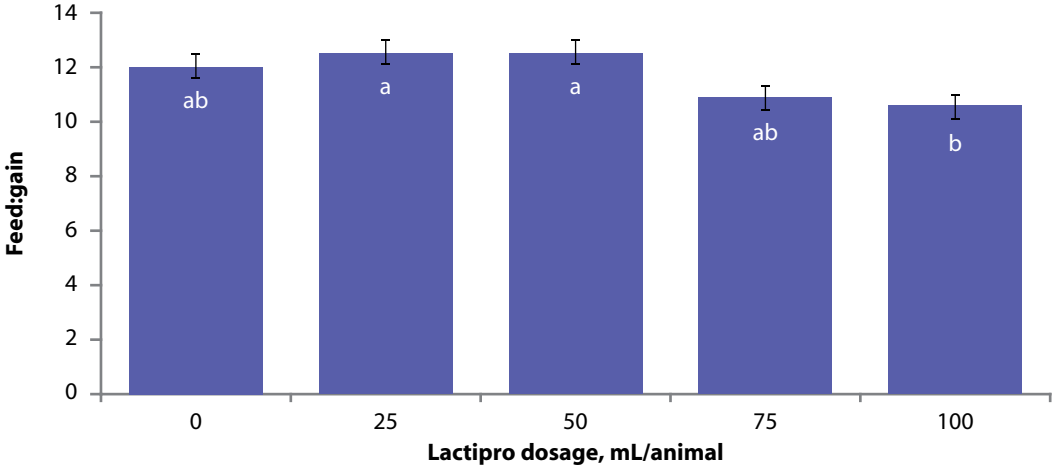

Figure 3. Feed:gain of heifers dosed with Lactipro (MS-Biotec Inc., Wamego, KS).

[a,b,c] Columns without a common letter differ ($P < 0.05$).

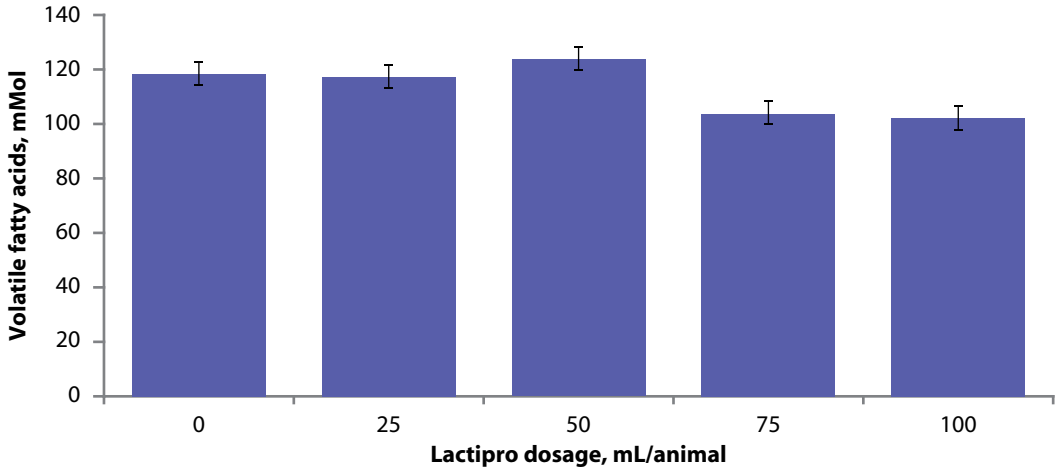

Figure 4. Total concentration of ruminal volatile fatty acids 25 hours after dosing with Lactipro (MS-Biotec Inc., Wamego, KS).