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M.R. McDaniel

James J. Higgins

J.M. Heidenreich

See next page for additional authors

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Effects of megasphaera elsdenii on ruminal pH, ruminal concentrations of organic acids, and bacterial genomes following a grain challenge

Abstract

Upon arrival in feedlots, cattle normally must be adapted to high-concentrate diets. The microbial population in the rumen of incoming cattle normally is suited to digestion of forages, and when cattle are transitioned onto concentrate diets, opportunistic bacteria that produce lactic acid can proliferate rapidly, leading to excesses of lactic acid in the rumen. High levels of lactic acid in the rumen may cause mild to severe acidosis. Megasphaera elsdenii is a lactate-utilizing bacterium that normally is present in rumens of cattle that have been adapted to high-grain diets, but numbers of the organism are relatively low during the step-up phase. Increasing the numbers of lactate-utilizing bacteria in newly arrived cattle by orally dosing with M. elsdenii may be a useful means of reducing the risk of ruminal acidosis in feedlot cattle. Our objectives were to evaluate ruminal parameters and determine efficacy of increasing ruminal populations of lactateutilizing bacteria in cattle following an abrupt diet change and administration of 10 mL (low dose), 100 mL (medium dose), or 1000 mL (high dose) of a culture containing 1.62 x 108 CFU/ mL of live M. elsdenii compared with a control group given a placebo without live Megasphaera.

Keywords

Cattlemen's Day, 2009; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1010; Kansas Agricultural Experiment Station contribution ; no. 09-168-S; Beef; Cattle; Megasphaera elsdenii

Authors

M.R. McDaniel, James J. Higgins, J.M. Heidenreich, M.K. Shelor, G.L. Parsons, P.H. Henning, and James S. Drouillard

Effects of *Megasphaera elsdenii* on Ruminal pH, Ruminal Concentrations of Organic Acids, and Bacterial Genomes Following a Grain Challenge

M. R. McDaniel, J. J. Higgins, J. M. Heidenreich, M. K. Shelor, G. L. Parsons, P. H. Henning, and J. S. Drouillard

Introduction

Upon arrival in feedlots, cattle normally must be adapted to high-concentrate diets. The microbial population in the rumen of incoming cattle normally is suited to digestion of forages, and when cattle are transitioned onto concentrate diets, opportunistic bacteria that produce lactic acid can proliferate rapidly, leading to excesses of lactic acid in the rumen. High levels of lactic acid in the rumen may cause mild to severe acidosis. *Megasphaera elsdenii* is a lactate-utilizing bacterium that normally is present in rumens of cattle that have been adapted to high-grain diets, but numbers of the organism are relatively low during the step-up phase. Increasing the numbers of lactate-utilizing bacteria in newly arrived cattle by orally dosing with *M. elsdenii* may be a useful means of reducing the risk of ruminal acidosis in feedlot cattle. Our objectives were to evaluate ruminal parameters and determine efficacy of increasing ruminal populations of lactate-utilizing bacteria in cattle following an abrupt diet change and administration of 10 mL (low dose), 100 mL (medium dose), or 1000 mL (high dose) of a culture containing 1.62×10^8 CFU/mL of live *M. elsdenii* compared with a control group given a placebo without live *Megasphaera*.

Experimental Procedures

Crossbred Angus steers (n = 20; average initial body weight = 558 lb) fitted with ruminal cannulas were placed into individual stalls with slatted-floor pens equipped with individual feed bunks and automatic water fountains. Cattle were allowed free-choice access to alfalfa hay, salt, and clean water. After an initial 3-week adaptation period, cattle were weighed, blocked according to weight, and assigned randomly within blocks to one of four treatments. Treatments consisted of oral dosing with a placebo (100 mL of killed culture) or a low, medium, or high dose of a live culture containing *M. elsdenii* NCIMB 41125. Background samples were taken from animals at 8:00 a.m. on day 1 of the experimental period to establish ruminal conditions prior to introduction of carbohydrates into the diet. Steers were fasted for 24 hours. Beginning at 8:00 a.m. on day 2, ruminal contents were collected from each animal (hour 0), and the appropriate inoculum was administered as a liquid suspension via the rumen cannula. Immediately following dosing and sampling, steers were given free-choice access to a flaked corn diet with 66% concentrate and 34% roughage (Table 1). Immediately following sampling, ruminal pH was measured and subsamples were taken for analysis of ruminal organic acids.

Results and Discussion

Ruminal lactate concentrations increased ($P<0.05$) in response to the diet change and were lower for cattle that received *M. elsdenii* ($P<0.05$) than for the placebo group (Table 2). No differences were noted in ruminal pH among treatment groups prior to introduction of grain ($P<0.05$). Following inoculation and introduction of the concentrate diet on the morning of day 2, ruminal pH decreased in all steers ($P<0.05$). Compared with the placebo group, cattle administered *M. elsdenii* maintained higher ruminal pH 24 hours after consuming the concentrate diet ($P<0.05$; Figure 1). Ruminal pH remained lower in the placebo group until 48 hours following the grain challenge ($P<0.05$). Although ruminal inoculation of cattle with a placebo or live cultures of *M. elsedenii* had no effect on total ruminal microbial populations ($P>0.05$), ruminal populations of total *M. elsdenii* increased within 24 hours after inoculation ($P<0.05$; Figure 2).

Implications

Dosing cattle with *M. elsdenii* before introducing a concentrate diet may help prevent accumulation of lactic acid and thus avoid severe depressions in ruminal pH. Inoculating cattle with *M. elsdenii* is an effective method of bolstering populations of lactate utilizers. Dosing newly-arrived feedlot cattle with *M. elsdenii* strain NCIMB 41125 may be useful for managing acidosis.

Table 1. Composition of experimental diet

Ingredients	Dry matter (%)
Steam-flaked corn	56.9
Ground alfalfa hay	33.2
Corn steep liquor	6.5
Vitamin mineral premix[1]	3.4
Nutrient composition	
Crude protein, %	15.7
NE_m, Mcal/kg	1.87
NE_g, Mcal/kg	1.23
Calcium, %	1.05
Phosphorus, %	0.36

[1] Formulated to provide 0.1 ppm cobalt, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, 60 ppm zinc, 0.88% potassium, and 2205 IU/lb vitamin A.

Table 2. Ruminal volatile fatty acids and lactate concentrations (mM) before and after introduction of a grain-based diet

			M. elsdenii dose						
Hours	Placebo		Low		Medium		High		
post-challenge	0	24	0	24	0	24	0	24	SEM
Acetate	24.5	29.3	26.0	34.0	26.6	32.6	22.5	40.3	6.03
Propionate	4.6	17.4	5.0	17.1	5.6	28.1	3.9	19.7	3.93
Acetate:Propionate	5.5	9.6	5.8	1.9	4.9	1.2	5.9	2.0	2.34
Butyrate	2.5	13.3	2.0	9.6	3.2	16.0	2.1	19.3	2.99
Lactate	0.0	49.8	0.0	24.6	0.1	3.5	0.0	3.0	7.57

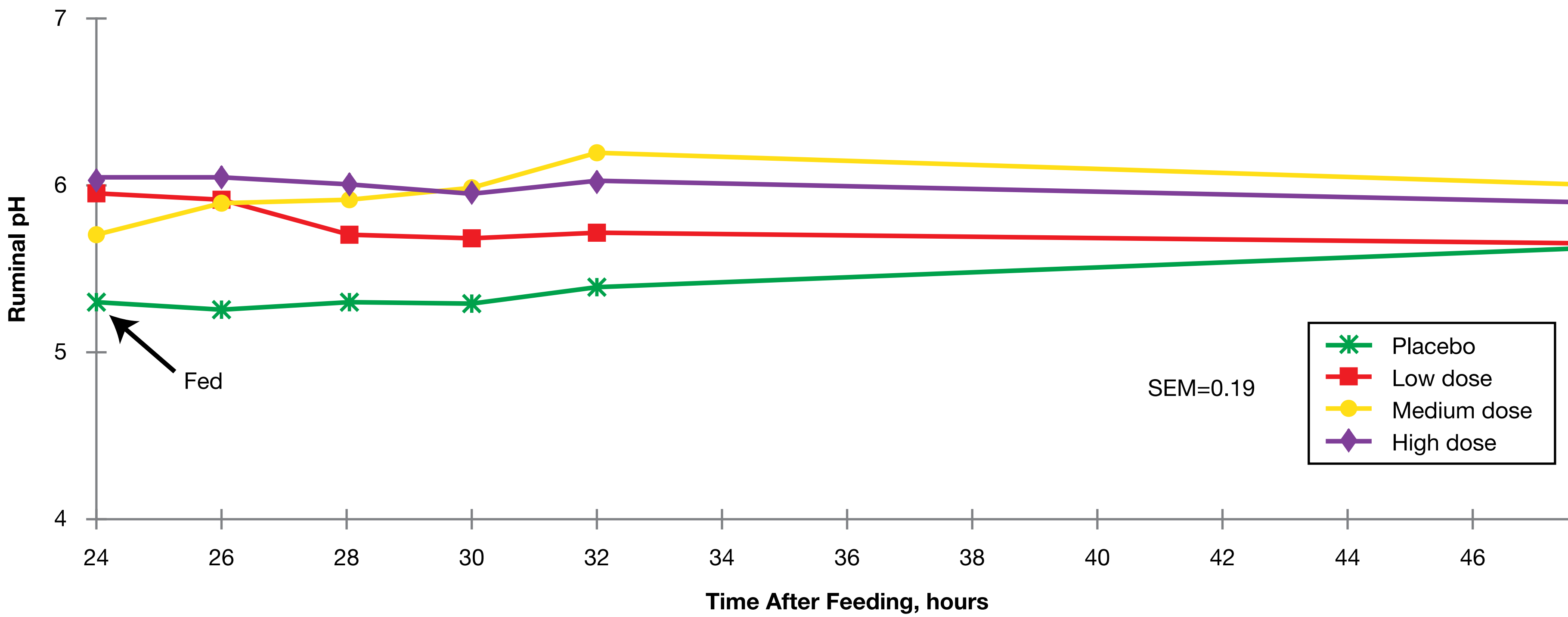

Figure 1. Ruminal pH following inoculation and grain challenge.
Ruminal pH remained higher 24 hours after feeding a grain-based diet in steers given a live dose than in steers given a placebo ($P<0.05$).

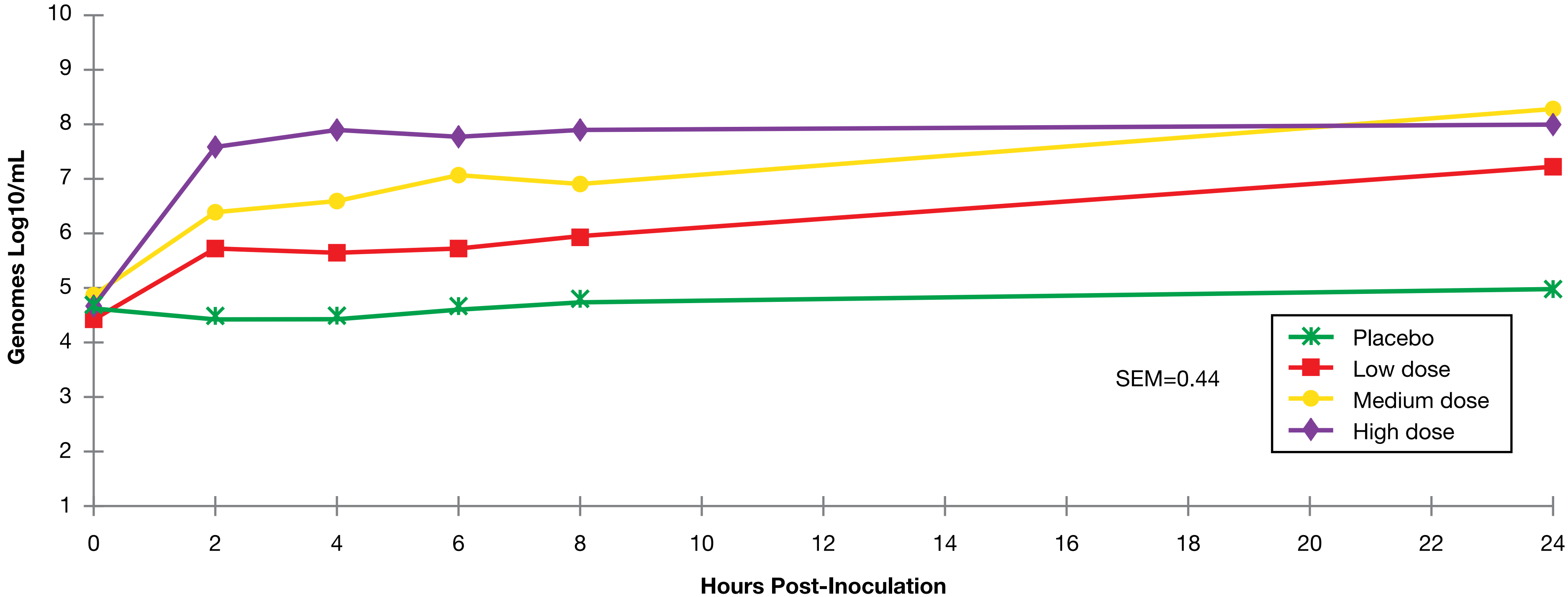

Figure 2. Total ruminal *M. elsdenii* following inoculation and grain challenge.
Ruminal populations of *M. elsdenii* were higher in steers dosed with live cultures ($P<0.05$).