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Total Tract Dry Matter Digestibility and Proportions of Ruminal Propionate Are Increased in High-Energy Limit-Fed Diets Based Primarily on Wet Corn Gluten Feed

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Abstract

Objectives: Study digestion and characteristics of digestion of high-energy limit-fed diets based primarily on wet corn gluten feed.

Study Description: Six ruminally-cannulated Jersey crossbred steers were used to measure total tract diet digestibility, passage rate, volatile fatty acid, and ammonia production, and ruminal pH when limit-feeding high-energy diets based primarily on wet corn gluten feed.

The Bottom Line: High-energy limit-fed diets based primarily on wet corn gluten feed are 15% more digestible and produce a higher concentration of energy yielding volatile fatty acid compared to low-energy full-fed diets without apparent disruptions in ruminal fermentation or health.

Keywords

Stocker cattle, limit-feeding, digestibility

Authors

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K-STATE Research and Extension

CATTLEMEN'S DAY 2018

Total Tract Dry Matter Digestibility and Proportions of Ruminal Propionate Are Increased in High-Energy Limit-Fed Diets Based Primarily on Wet Corn Gluten Feed

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Introduction

Previous research has shown increasing energy in diets fed to newly received growing cattle could increase morbidity. It is thought the increased incidence and severity of subacute and acute ruminal acidosis could be the cause, as dietary energy is most often increased by the removal of dietary roughage and the addition of cereal grains that provide large amounts of starch. Because starch is rapidly fermented in the rumen, the excessive production of organic acids can result, ushering in a variety of metabolic disorders all potentially contributing to increased morbidity. Recently, research conducted at the Kansas State University Beef Stocker Unit has demonstrated limit-feeding high-energy diets based primarily on corn by-products such as wet corn gluten feed could offer a more efficient approach to feeding newly received growing cattle without adversely affecting health. The overall diet digestibility and characteristics of digestion involving limit-fed diets based primarily on wet corn gluten feed has not been extensively studied.

Experimental Procedures

Six ruminally-cannulated Jersey crossbred steers were used to determine diet digestibility and characteristics of digestion in limit-fed diets based primarily on wet corn gluten feed. Experimental diets were formulated to provide 45, 50, 55, and 60 Mcal net energy for gain/100 lb dry matter and were offered at 100%, 95%, 90%, and 85% of a predetermined ad libitum intake, respectively (Table 1). Two weeks before initiation of the trial, all animals were offered the 45/100 treatment to establish an ad libitum intake value. When the trial began, this value was used to dictate feed delivery of the treatments previously described. The trial consisted of 4 consecutive 15-day periods each containing 10 days of diet adaptation, 4 days fecal sampling, and 1 day of ruminal sampling. On days 4-14, chromium oxide was top-dressed and hand-mixed into the ration to be used as an indigestible marker for diet digestibility. Fecal samples were collected from the rectum of the steers on days 11-14 with 3 samples collected each day

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and the sampling time advancing by 2 hours each day such that every 2 hours increment post-feeding was represented. Fecal samples were composited for each steer within each period. The concentration of chromium oxide in feces was used to determine diet digestibility. On day 15, immediately before feeding and after the 0 hour sampling time, cobalt ethylene diamine tetraacetic acid was dosed through the cannula to be used as a marker for liquid dilution rate. Ruminal contents were collected and strained at 0, 2, 4, 6, 8, 12, 18, and 24 hours post-feeding. Ruminal fluid was analyzed for concentrations of volatile fatty acids, cobalt from cobalt ethylene diamine tetraacetic acid, and ammonia. In addition, an indwelling bolus (SmaXtec; Graz, Austria) inserted through the ruminal cannula at initiation of the trial was used to continuously monitor ruminal pH.

Results and Discussion

Results from the trial are in Tables 2 and 3. Ruminal proportions of propionate increased with increasing energy level and decreasing intake ($P<0.01$) in the limit-fed rations most likely as a result of the increased corn, thus ruminal starch fermentation. This is important because propionate is thought to be the most energy yielding volatile fatty acid produced during ruminal fermentation. Ruminal ammonia concentrations increased linearly ($P<0.01$) with increasing energy and decreasing intake. Because cattle on the higher energy diets were being limit-fed, a large proportion, if not all, of the feed offered was consumed in one visit to the bunk, leading to increased levels of ammonia being released during microbial digestion. Total tract diet digestibility also increased linearly ($P<0.01$) with increasing energy and decreasing intake as a result of two very important drivers of diet digestibility. First, increased dietary energy was achieved in the limit-fed diets by the removal of roughage and the addition of more digestible ingredients like dry-rolled corn. Secondly, passage rate through the gastrointestinal tract is a function of intake. When intake is restricted, passage rate slows, and digestibility usually increases as a result of the increased residence time in the tract. This concept was verified as liquid dilution rate decreased linearly ($P<0.01$) with increasing energy and decreasing intake. When compared to the high roughage diet offered for ad libitum intake (45/100), the highest energy, most restricted diet (60/85) was 15% more digestible. Ruminal pH decreased linearly with increasing energy and decreasing intake ($P<0.01$) but was quick to recover and never decreased to levels likely associated with acute ruminal acidosis (Figure 1).

Implications

High-energy limit-fed diets based primarily on wet corn gluten feed are 15% more digestible and produce a higher concentration of energy yielding volatile fatty acids compared to low-energy full-fed diets without apparent disruptions in ruminal fermentation or health.

Table 1. Experimental diets

	Diets[1]			
Item	45/100	50/95	55/90	60/85
Ingredient, % dry matter				
Alfalfa	22.50	17.00	12.00	6.50
Prairie hay	22.50	17.00	12.00	6.50
Dry-rolled corn	8.57	19.08	28.50	38.82
Wet corn gluten feed[2]	40.00	40.00	40.00	40.00
Supplement[3]	6.43	6.92	7.50	8.18

[1]Treatment diets offered based on dry matter intake of 45/100 treatment intake that was offered for ad libitum intake. First number = Mcal net energy for gain/100 lb dry matter. Second number = % of 45/100 treatment offered on dry matter basis.
[2]Cargill Animal Nutrition, Blair, NE.
[3]Supplement pellet was formulated to contain (dry matter basis) 10% crude protein, 8.0% calcium, 0.24% phosphorus, 5.0% salt, 0.55% potassium, 0.25% magnesium, 1.67% fat, 8.03% acid detergent fiber, and lasalocid (Bovatec; Zoetis, Parsippany, NJ).

Table 2. Effects of energy level and intake on dry matter digestibility and characteristics of digestion

	Diet[1]				Standard error of	P-value		
Item	45/100	50/95	55/90	60/85	mean[2]	Linear	Quadratic	Cubic
Number of observations	6	6	5	6				
Dry matter intake, lb/day	21.09	16.56	16.15	15.5	1.8	<0.01	0.08	0.38
Ruminal								
pH[3]	6.07	5.93	5.77	5.65	0.15	<0.01	0.90	0.90
Ammonia,[3] m*M*	10.6	14.7	13.4	15.4	1.27	<0.01	0.16	0.01
Volatile fatty acids total[3] m*M*	118.9	103.2	103.9	98.5	6.75	<0.01	0.24	0.27
Acetate,[3] m*M*	73.3	61.3	59.6	53.1	3.44	<0.01	0.25	0.17
Propionate,[3] m*M*	26.0	24.8	26.0	27.7	2.05	0.20	0.19	0.70
Butyrate,[3] m*M*	15.0	13.0	13.7	12.5	1.16	0.05	0.63	0.24
Digestibility, % dry matter	61.1	62.5	64.6	69.9	2.04	<0.01	0.33	0.77
Liquid passage rate, %/hour[4]	12.6	8.1	8.5	7.3	0.73	<0.01	0.02	0.03

[1]Treatment diets offered based on dry matter intake of 45/100 treatment intake that was offered for ad libitum intakes. First number = Mcal net energy for gain/100 lb dry matter. Second number = % of 45/100 treatment offered on dry matter basis.
[2]Largest value among treatments is reported.
[3]Average of values collected at 0, 2, 4, 6, 8, 12, 18, and 24 hours after feeding.
[4]Calculated values from samples collected at 2, 4, 6, 8, 12, and 18 hours after feeding.

Table 3. Effects of energy level and intake on ruminal VFA profiles

	Diet[1]				Standard error of mean[2]	P-value		
Item	45/100	50/95	55/90	60/85		Linear	Quadratic	Cubic
Number of animals	6	6	5	6				
Volatile fatty acids, mol/100 mol								
Acetate[3]	62.0	60.2	57.9	54.5	0.80	<0.01	0.11	0.74
Propionate[3]	21.6	23.6	24.9	27.7	0.80	<0.01	0.48	0.41
Butyrate[3]	12.6	12.3	12.8	12.6	0.56	0.83	0.95	0.42

[1]Treatment diets offered based on dry matter intake of 45/100 treatment intake that was offered for ad libitum intakes. First number = Mcal net energy for gain/100 lb dry matter. Second number = % of 45/100 treatment offered on dry matter basis.
[2]Largest value among treatments reported.
[3]Average of values collected at 0, 2, 4, 6, 8, 12, 18, and 24 hours after feeding expressed as a percentage of total volatile fatty acids.

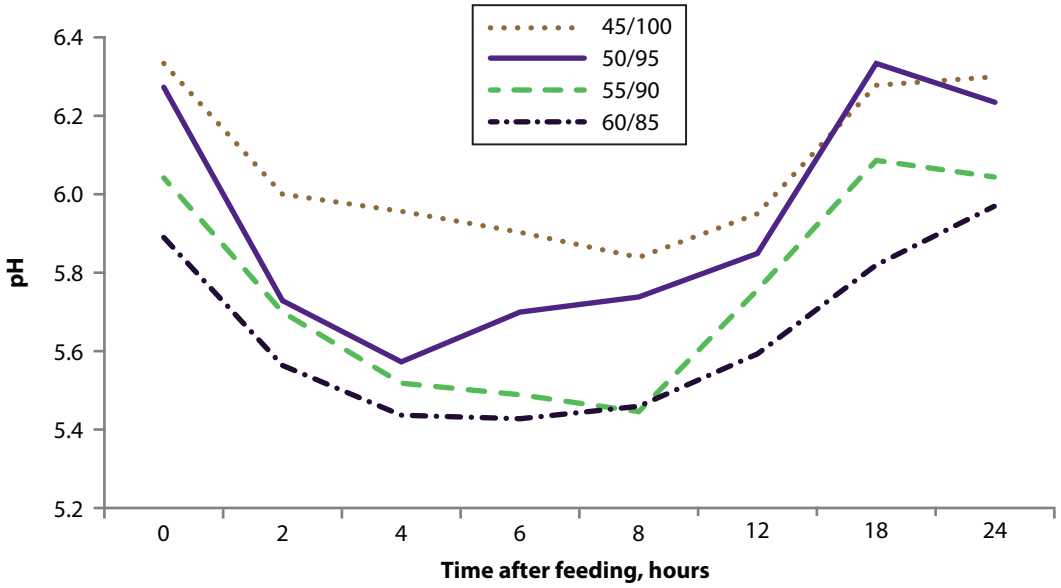

Figure 1. Ruminal pH measured continuously over 24 hours after feeding using indwelling pH monitoring bolus (SmaXtec; Graz, Austria).