INFLUENCE OF SUPPLEMENTAL BRANCHED CHAIN FATTY ACIDS ON FORAGE INTAKE AND UTILIZATION BY STEERS

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Story in Brief

The effects of supplemental branched chain volatile fatty acids on utilization of prairie hay were tested using steers in two trials. In trial 1, branched chain acids did not influence ruminal pH or concentrations of ammonia and volatile fatty acids. Ruminal proportions of isobutyrate and isovalerate were increased by the supplement, but the other major acids were not affected. In addition, digestibility of dry matter, fiber and nitrogen were not changed by supplementation. Microbial nitrogen flow to the small intestine and efficiency of growth tended to be reduced when the branched chain acids were added. Addition of the acids to urea-based supplements in trial 2 did not influence voluntary hay intake or the digestibility of dry matter and fiber. In these trials, a deficiency of branched chain fatty acids in the rumen did not limit digestion and intake of prairie hay. These results do not exclude the possibility that acids have postabsorptive effects on metabolism.

(Key Words: Urea, Branched Chain VFA, Low Quality Forage, Intake, Rumen Fermentation)

Introduction

Calcium salts of branched chain volatile fatty acids (BCVFA) are being added to many commercial diets for lactating cows based on research indicating that they increase milk production. In a previous trial with growing steers (D.R. Gill, unpubl. data), ammonium salts of BCVFA had no effect on rate or efficiency of gain. Few tests of BCVFA have involved low quality forages. BCVFA are produced in the rumen by fermentation of amino acids and are required for growth by rumen microbes, especially those which digest cellulose. Since BCVFA are produced from protein, their concentration in the rumen is low if protein intake is low. Levels are particularly low when urea replaces natural proteins in the diet. Some workers have speculated that a ruminal deficiency of BCVFA could limit the value of NPN. If so, supplementing with BCVFA should increase fermentation rate, cellulose digestion and intake of forage. The objective of the following trials was to evaluate the influence of added BCVFA on digestion of low quality prairie hay supplemented with urea.

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Materials and Methods

Trial 1

Four steers (282 kg) fitted with ruminal and duodenal cannulas were used in a crossover experiment. Approximately 18 g dry matter/kg body weight of chopped, prairie hay (max. particle length = 1 in.; Table 1) was fed each day at 0800 h. At 1000 h, steers were fed 365 g/head of a urea-based supplement with 0 or 30 g of a branched chain volatile fatty acid product (BCVFA; Table 1). Chromic oxide was fed as an indigestible marker.

Each of the two feeding periods lasted 21 days. Rumen, duodenal and fecal samples were collected simultaneously at specific time intervals during the last 3 days of each period. The pH of each sample was determined immediately. Rumen samples were frozen and later analyzed for volatile fatty acids and ammonia nitrogen (NH_3-N). Duodenal and fecal samples were analyzed for dry matter, ash, acid insoluble ash (AIA), nitrogen (N), acid detergent fiber (ADF), chromium and nucleic acid N.

Trial 2

Twelve Hereford steers (336 kg) in individual pens had free access to prairie hay in a crossover experiment. Chopped prairie hay (max. particle length 1 in.; Table 1) was offered daily at 0800 h. Voluntary hay intake was recorded over the last 7 days of each 21 day feeding period. Steers received 500 g/head of a urea-based supplement with or without 30 g of BCVFA added. Supplement was fed at 1000 h daily. Fecal samples were collected from each steer six times during days 19 and 20 of each period and analyzed for AIA.

Results and Discussion

Trial 1

Addition of BCVFA to the supplements had little impact on rumen fermentation products (Table 2). Rumen NH_3-N was consistently below 2 mg/100 ml and may have limited ruminal fermentation and microbial protein synthesis. Previous studies with high roughage rations found that BCVFA had no effect on ruminal NH_3-N (Unmunna et al., 1975; Hefner et al., 1985). Ruminal VFA concentrations were similar for both treatments. Likewise, there were no differences in the relative proportions of acetate, propionate and butyrate in rumen contents. Cook (1985) reviewed several studies in which isoacids have increased acetate production. Our results neither support our refute this point since relative rates of acid removal from the rumen could have masked any differences in total production. Ruminal proportions of isobutyrate and isovalerate were increased (P .05) 7.6 and 3.2 fold, respectively, by BCVFA supplementation. These increases were expected since these acids are components of the BCVFA supplement. Valerate levels tended (P .05) be higher with BCVFA additions.

Total tract digestibilities were calculated using both Cr and AIA as indigestible markers. No effect of BCVFA on total tract DM and ADF digestion was detected. Cook (1985) cited studies showing improved feed digestion with isoacid supplementation, however, in studies by Cline et al. (1966), Unmunna et al. (1975) and Hefner et al. (1985), isoacid

Table 1. Composition of prairie grass hay and supplement[a].

	Hay		Urea
	Trial 1	Trial 2	Supplement
Dry matter, %	94.2	93.1	90.0
Crude protein, % of dry matter	3.6	4.1	34.3
Acid detergent fiber, % of dry matter	41.8	40.4	9.4
	----------% As Fed----------		
Urea			6.4
Corn			42.0
Cottonseed meal			33.5
Alfalfa			5.4
Molasses			2.7
Sodium sulfate			1.1
Potassium chloride			2.0
Dicalcium phosphate			4.3
Trace mineralized salt			2.1
Vitamin A			.5

[a]Branched chain VFA product contained 90% DM, .01% N, min. 89% Ca-salts of isobutyric and 5-carbon acids, min. 15.3% total Ca. Product of Eastman Kodak, Kingsport,TN.

Table 2. Rumen pH, ammonia and volatile fatty acids Trial 1.

	Urea	Urea+BCVFA
pH	6.9	7.0
Ammonia, mg/100 ml	1.7	1.9
Total VFA, mmoles/liter	89.7	91.6
	---------moles/100 moles-------	
Acetate	76.9	76.8
Propionate	14.3	12.5
Butyrate	7.9	8.2
Isobutyrate	.11[a]	.84[b]
Isovalerate	.32[a]	1.01[b]
Valerate	.47[c]	.66[d]

[ab]Row means with different superscripts are different (P<.05).
[cd]Row means with different superscripts are different (P<.07).

Table 3. Intake, digestion and intestinal flow measurements, Trial 1.

Item	Supplement	
	Urea	Urea+BCVFA
Organic matter intake, kg	4.8	4.7
Organic matter digestion		
Ruminal %[a]	30.3[c]	31.4[d]
Total tract %[a]	53.7[c]	51.9[d]
Total tract %[b]	47.8	47.6
Acid detergent fiber digestion		
Ruminal %[a]	47.4	40.8
Total tract %[a]	47.9	46.8
Total tract %[b]	42.2	41.3
Nitrogen		
Passage, g/day		
Intake	48.5	48.5
Entering duodenum		
Total	87.2	79.3
Microbial	59.3	51.1
Feed and NH_3-N	27.9	28.2
Feces	34.8	32.8
Microbial efficiency, g MN/g apparently FOM	.41	.34
Digestion, %		
Ruminal	-78.7	-63.4
Total tract	32.5	28.2

[a] Calculated with Cr marker
[b] Calculated with AIA marker
[cd] Means are different P<.10

supplementation did not alter digestion of dry matter or fiber. Similarly, total tract N digestibility was not altered by BCVFA. This agrees with the results of Cline et al. (1966), Unmunna et al. (1975) and Hefner et al. (1985). Flow of N to the small intestine and total tract digestion of N tended to be reduced by BCVFA supplementation. Efficiency of microbial growth was not increased by BCVFA supplementation. This conflicts with a number of in vitro trials which have suggested that microbial growth is enhanced by BCVFA. In vitro conditions limit crossfeeding and microbial adaptation that can occur in the rumen.

Past studies (Unmunna et al., 1975; Hefner et al., 1985; Cook, 1985) suggested that feeding of isoacids may improve retention of N by cattle and sheep. If BCVFA do not alter ruminal synthesis or digestibility of protein, such responses must be occurring after absorption from the gastrointestinal tract.

Table 4. Hay intake and digestibility, Trial 2.

Item	Supplement	
	Urea	Urea+BCVFA
Steer wt., kg	336	336
Voluntary intake, g/kg BW		
Dry Matter	19.5	19.4
Acid Detergent Fiber	7.9	7.8
Digestibility, %		
Dry Matter	47.5	47.8
Acid Detergent Fiber	42.0	42.4

Trial 2

Adding 30 g BCVFA product to the protein supplement did not increase voluntary hay intake or digestibility of DM and ADF. This supports the results of trial 1.

Intakes of protein supplement were lower than planned. Hence, total protein intake was marginal in both trials and may have limited the response to supplemental BCVFA. Other studies with protein supplemented high roughage diets, have generally failed to show any response to BCVFA in urea-based supplements. If intake and digestiblity are not increased but N retention is, BCVFA supplementation must exert its effects after digestion and absorption. Cook (1985) indicated that BCVFA increased serum growth hormone levels in lactating Holstein cows. This could redirect N flow. Eventually, feed intake would need to increase to meet the increased energy demand.

The factors that limit the value of urea-based supplements for cattle grazing low quality forage remain a mystery. Results of this study would suggest that a ruminal deficiency of BCVFA is not the primary factor limiting the value of urea-based supplements. If responses to BCVFA are metabolic rather than digestive, further performance and N balance studies are needed.

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