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Abstract
Previous research at Kansas State University has shown that providing supplemental energy when protein is deficient will cause a decrease in digestion of low-quality forage. Our project examined the effects of supplemental glucose on low-quality forage intake and digestion. Urea recycling is a mechanism by which cattle preserve nitrogen when faced with a deficiency. Young, growing cattle receiving sufficient protein recycle large amounts of nitrogen to the rumen. Our goal was to explore the effects of providing supplemental energy and protein to cattle that are on the downward side of their growth curve. Specifically, we measured intake, digestion, and urea kinetics in these animals.

Keywords
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Effects of Supplemental Protein and Energy on Digestion and Urea Kinetics in Beef Cattle[1]

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Introduction

Previous research at Kansas State University has shown that providing supplemental energy when protein is deficient will cause a decrease in digestion of low-quality forage. Our project examined the effects of supplemental glucose on low-quality forage intake and digestion. Urea recycling is a mechanism by which cattle preserve nitrogen when faced with a deficiency. Young, growing cattle receiving sufficient protein recycle large amounts of nitrogen to the rumen. Our goal was to explore the effects of providing supplemental energy and protein to cattle that are on the downward side of their growth curve. Specifically, we measured intake, digestion, and urea kinetics in these animals.

Experimental Procedures

Six Angus-cross steers (initial body weight = 908 lb) were used in a metabolism trial to measure the effect of supplemental energy and protein on intake, digestion, and urea kinetics. The animals were ruminally and duodenally cannulated. The trial was conducted as a 4 × 4 Latin square with two extra steers per period. Supplemental energy treatments were a control (no supplemental energy) or 1,200 g glucose dosed ruminally once daily. Casein (240 or 480 g) was dosed once daily as a degradable intake protein supplement. The steers were given ad libitum access to low-quality prairie hay (4.7% crude protein). Each 14-day period consisted 9 days for adaptation to treatments, 4 days for fecal and urine collection, and 1 day for ruminal and duodenal sample collection. Doubly labeled urea was infused intravenously from day 10 through day 14 of each period to allow measurement of urea kinetics.

Results and Discussion

Forage intake, digestion, and urea kinetics are shown in Table 1. Glucose reduced forage intake by 18% ($P<0.01$), but casein supplementation did not change ($P=0.69$) forage intake. Glucose depressed ($P<0.01$) total tract digestion of neutral detergent fiber. Providing supplemental energy to cattle without sufficient dietary protein had detrimental effects on forage digestion. When a large amount of a readily useable substrate (glucose) was provided, glucose-digesting microbes grew quickly and consumed large amounts of ruminally available nitrogen. Thus, energy supplementation can exacerbate protein deficiencies, limit productivity of fiber-digesting microbes, and depress fiber digestion. To avoid depressing forage digestion, producers should be conscious of the protein content of the diet before providing supplemental energy.

The amount of urea produced by the body increased 50% ($P=0.03$) as casein increased from 240 to 480 g/day. The amount of urea recycled to the gut numerically increased by

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25% as casein increased (P=0.30). The proportion of urea production that was recycled to the gut decreased (P<0.01) as casein increased. When more nitrogen was available in the rumen, the animal was less reliant on urea recycling to optimize performance of ruminal microbes. Glucose supplementation did not change (P=0.70) urea production or the amount of urea recycled to the gut (P=0.91); however, the proportion of urea production recycled to the gut numerically increased (P=0.25) when glucose was supplemented.

Total nitrogen flow to the duodenum increased as casein increased in glucose-supplemented steers but not in control steers. A similar pattern was observed for microbial nitrogen flow to the duodenum. The amount of recycled urea captured by ruminal microbes was less (P=0.07) for the treatment providing no supplemental energy and 480 g of casein. This likely occurred because ruminal microbes were receiving an excess of available nitrogen. Increasing casein decreased (P=0.02) the percentage of total microbial nitrogen derived from recycled urea. In contrast, supplemental glucose tended to increase (P=0.18) the percentage of microbial nitrogen derived from recycled urea. This reflected an increased need for nitrogen in the ruminal environment when energy supply was increased.

Implications

Supplemental glucose decreased forage intake and digestibility. Increasing casein altered urea kinetics by increasing urea production, but the proportion of urea nitrogen recycled to the gut decreased. Cattle continue to recycle urea even when they receive sufficient amounts of nitrogen to meet their requirements.

Table 1. Effects of degradable intake protein (DIP) and glucose supplementation (1.2 kg/day) on intake, digestion, urea kinetics, and microbial flow in mature steers fed low-quality forage

	240 g/day DIP		480 g/day DIP			P-value		
Item	Control	Glucose	Control	Glucose	SEM	DIP	Energy	DIP × Energy
Organic matter intake, lb/day								
Forage	9.7	7.5	9.0	7.9	0.7	0.69	0.01	0.19
Total	10.1	10.6	10.1	11.2	0.7	0.39	0.08	0.19
Total tract digestibility, %								
Organic matter	55.7	60.0	55.6	60.9	1.6	0.78	0.01	0.70
Neutral detergent fiber	53.9	43.4	48.8	43.1	2.1	0.09	0.01	0.12
Urea kinetics, g/day of nitrogen								
Production	88	86	137	125	21	0.03	0.70	0.77
Gut entry (Recycled)	74	76	94	93	21	0.30	0.91	0.99
% of total production	81	85	67	73	5	0.01	0.25	0.84
Duodenal flow, g/day of nitrogen								
Total nitrogen	73	56	70	79	6	0.06	0.43	0.02
Microbial nitrogen	49	40	55	59	5	0.01	0.55	0.11
Microbial nitrogen from recycled urea	18.7	18.0	7.3	18.3	3.1	0.06	0.10	0.05
% of total microbial nitrogen	39.3	46.2	13.7	29.4	7.7	0.02	0.18	0.54