COMPARISON OF ILEAL WITH RUMINAL UREA INFUSIONS ON FEED INTAKE AND DIGESTIBILITY OF PRAIRIE HAY BY BEEF STEERS

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Story in Brief

Urea was infused either into the rumen or into the intestines (ileum) to evaluate responses in feed intake, forage digestion and site of nitrogen utilization in beef cattle. Eight crossbred steers (451 kg body weight) had ad libitum access to a prairie hay diet (4.3% crude protein) during the 42-day crossover experiment. Each steer received a total of 50 g of urea daily split into three ruminal or ileal doses (100 ml/dose). Dry matter intake was similar (7.0 vs 6.9 kg) for urea infusions at both sites but greater than during the control period. Duodenal dry matter flow (4.6 vs 4.5 kg dry matter/day) and fecal output were slightly greater (2.5 vs 2.3 kg dry matter/day) for the steers with urea infused into the ileum. Total tract dry matter digestibility was greater (64.4 vs 61.0%) when urea was infused into the rumen. The fact that hay intakes were nearly similar for both sites of urea infusion, indicates that urea dosed into the ileum improved nitrogen status of the steers, either through nitrogen recycling to the rumen or through meeting tissue needs for non-specific nitrogen. To supply protein in supplements for low quality forages, extent appears more important than site of digestion.

(Key Words: Beef Cattle, Prairie Hay, Urea, Rumen, Ileum, Infusions.)

Introduction

Beef cattle consuming low quality forages often lose weight because of low voluntary feed intake associated with a low nitrogen content and poor digestibility. Under such conditions, supplemental nitrogen can improve animal performance. However, responses in forage intake vary according to the source of supplemented nitrogen. Intake is increased more consistently by supplementation with natural protein than by supplemental urea; reasons for this difference include the lack or excess of specific nitrogen compounds

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either in the rumen or available to the animal. In contrast, under controlled conditions, intake increases were similar whether protein came from post-ruminal infusions of urea or casein (an intact natural protein). Nitrogen recycling to the rumen was high and presumably enhanced forage intake by stimulating ruminal bacterial activity and rate of ruminal digestion. Another possibility is that intake was increased by cycling of nitrogen to the large intestine to increase digestion there. Relative responses to ruminal vs intestinal infusions of nitrogen in steers fed low quality forages have not been tested. This study examined the effect of ruminal or ileal urea infusions twice daily on feed intake and utilization of prairie hay available free choice to beef steers.

Materials and Methods

Eight crossbred Angus x Hereford steers (451 kg) equipped with ruminal, duodenal and ileal (T-type) cannulas had free choice access to prairie hay (4.3% crude protein) during a 42-day crossover experiment. Animals were housed individually, adapted to their diet for a minimum of 14 days and fed once daily (8:30 am) throughout the study. During each 14 day period, steers received three (8:30 am, 2:30 pm and 8:30 pm) daily doses (100 ml/dose) of a urea solution (50 g/day) either into the rumen or into the ileum. Chromic oxide was dosed twice daily (3 g/dose) intraruminally during the last week of each period. Ruminal fluid, duodenal digesta and fecal grab samples were collected 3 times per day (8:30 am, 2:30 pm and 8:30 pm) the last two days of each experimental period. Duplicate jugular blood samples were collected at 4 hours post-feeding the last day of each period for plasma-urea and osmolality determinations. Ammonia-nitrogen (NH_3-N) concentration and osmolality were determined in ruminal liquid samples. Duodenal digesta and fecal grab samples were composited (within animal and period), dried and analyzed for chromium oxide concentration, in order to calculate duodenal flow, digestibility and total fecal output. Ruminal microbial protein synthesis was calculated using purine concentrations in duodenal samples.

Data for this crossover experiment were analyzed statistically (GLM procedure). Ammonia-nitrogen and osmolality in ruminal fluid were treated as repeated measurements, using the animal x treatment x period interaction as the main plot error term. Means were compared using the least squares procedure.

Results and Discussion

Compared with the control period, urea infusions at either site increased (6.9 vs 5.5 kg DM/day) feed intake (Figure 1) suggesting that nitrogen supply of the hay limited intake. Ruminal or ileal urea infusions, however, produced similar hay intakes (7.0 vs 6.9 kg DM/day) indicating that site of urea infusion did not alter the ability of nitrogen to increase intake (Table 1).

Steers dosed into the ileum consumed more water (32.2 vs 30.2 liters/day; $P<.08$) than animals infused intraruminally. Consequently, the ratio of daily water intake to dry matter consumed per day (Table 1) was increased (4.7 vs 4.4 liters/kg DM; $P<.04$). Daily duodenal dry matter flow (4.5 vs 4.6 kg DM/day) was similar for both treatments, but fecal output and fecal moisture content (81.6 vs 79.0%; $P<.01$) were greater in steers dosed with urea in the ileum (2.5 vs 2.3 kg DM/day; $P<.01$). Whether or not water intake differences were due to fecal moisture output is not clear. Site of urea infusion influenced total tract dry matter digestibility; values were higher (64.4 vs 61%; $P<.01$) for steers infused intraruminally (Table 2). Plasma urea-nitrogen (19.3 vs 20.8 mg/dl) and ammonia-nitrogen (0.8 vs 0.7 mg/dl) concentrations in ruminal fluid were not altered by urea infusions (Table 3). These values are higher than those reported earlier (Garza et al., 1991a) for beef steers receiving intestinal bicarbonate buffer solutions and fed prairie

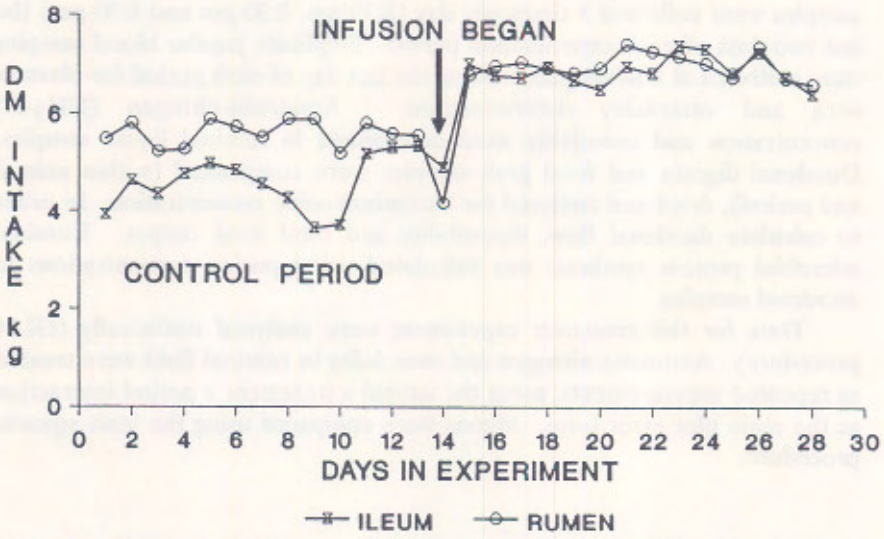

Figure 1. Effect of ileal or ruminal urea infusions on daily feed intake in steers fed low quality hay.

Table 1. Effect of ruminal or ileal urea infusions on feed and water intake in steers fed prairie hay ad libitum (n=8).

	Urea infusion sites		
	Rumen	Ileum	SE
Intake:			
Feed, kg DM/day	7.0	6.9	.04
Water, liter/day	30.2[a]	32.2[b]	.66
Water/DM, liter/kg	4.4[c]	4.7[d]	.09

[a,b]Means in the same row with different superscripts differ (P<.08).
[c,d]Means in the same row with different superscripts differ (P<.04).

Table 2. Effect of ruminal or ileal urea infusions on site and extent of DM digestion in steers fed prairie hay ad libitum (n=8).

	Urea infusion sites		
	Rumen	Ileum	SE
Duodenal flow, kg DM/d	4.5	4.6	.11
Fecal output, kg DM/d	2.3[a]	2.5[b]	.03
DM digestibility:			
Ruminal, %	29.6	29.7	2.00
Intestinal, % of diet	34.7	31.3	2.20
% of duodenal flow	48.1	42.7	2.62
Total tract, %	64.4[a]	61.0[b]	.64
Fraction of total in rumen, %	45.6	48.4	3.23
Postruminal, %	54.4	51.6	3.23

[a,b] Means in the same row with different superscripts differ (P<.01).

hay of a similar origin and a similar nitrogen content. Osmolality of plasma (284 vs 283 mOsm/kg) and ruminal fluid (240 vs 258 mOsm/kg) were similar for both treatments (Table 3). These values are consistent with previous results with beef heifers fed low quality hay (Garza et al., 1989). Nitrogen digestibility was greater (34.3 vs 30.2%) with the intraruminal urea infusion, but efficiency of microbial protein synthesis (17.1 vs 17.4 g/100 g of organic matter truly fermented in the rumen) was not different (Table 4).

Daily ileal urea infusions improved nitrogen status of steers. This can be ascribed either to providing non-specific nitrogen for tissue needs or to increased recycling of nitrogen to the rumen. In this study, net N recycling with ileal infusion at 50 g/day exceeded N intake; this estimate is higher than most past estimates of N recycling to the rumen. Ruminal ammonia-nitrogen concentrations were much lower than optimum for microbial growth (Satter and Slyter, 1974). Yet, values for efficiency of microbial protein synthesis appear similar to those values indicated by Owens and Goetsch (1988). Methods to enhance nitrogen recycling in cattle grazing low quality forage may enhance forage intake.

Considering the high capacity for nitrogen recycling to the rumen, total tract nitrogen availability rather than ruminal digestion alone should prove superior as an index of the protein value of a supplement. Some proteins with high ruminal bypass have a low total tract digestibility. Low total tract protein digestibility, by reducing N recycling, will limit the value of a protein supplement for cattle fed a low quality forage.

Table 3. Effect of ruminal or ileal urea infusions on plasma urea-N, ruminal ammonia-N and osmolalities in steers fed a low quality hay (n=8).

	Urea infusion sites		
	Rumen	Ileum	SE
Plasma:			
Urea-N, mg/dl	19.3	20.8	.57
Osmolality, mOsm/kg	284.0	283.3	1.81
Ruminal fluid:			
Ammonia-N, mg/dl	.8	.7	.03
Osmolality, mOsm/kg	240.3	258.3	7.85

Table 4. Effect of ruminal or ileal infusions on site and extent of nitrogen digestion in steers fed prairie hay.

	Urea infusion sites		
	Rumen	Ileum	SE
Steers	8	8	---
N consumed, g/d	47.9	47.3	0.74
N infused, g/d			
Rumen	21.0	0	---
Ileum	0.0	21.0	---
N passing to duodenum from rumen, g/d	104.3[a]	97.3[b]	1.57
N from food origin, g/d	64.6[a]	52.4[b]	2.94
Microbial nitrogen, g/d	39.7	45.3	3.36
Ruminal gain in N, g/d	56.4[c]	50.4[d]	1.92
Bypass N, %	139.8[a]	114.5[b]	6.7
Efficiency of microbial protein synthesis, g/100 g TFOM	17.1	17.4	1.93
Total tract protein digestibility, %	34.3	30.2	1.29

[a,b]Means in the same row with different superscripts differ (P<.03).
[c,d]Means in the same row with different superscripts differ (P<.07).

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