FREQUENCY OF UREA DOSING FOR BEEF STEERS FED LOW PROTEIN HAY

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Story in Brief

Urea was dosed at different time intervals into the rumen to simulate frequent or infrequent urea consumption so as to determine if rapid release of ammonia in the rumen decreases efficiency of nitrogen utilization. Eight cannulated crossbred steers (448 kg body weight) were given free choice access to prairie hay (5.3% crude protein). Feed and water intake were recorded daily during the 56-day experiment. Steers were infused intraruminally with either A) water (200 ml/day, control); B) urea twice a day (20 g in each/100 ml); C) urea once a day (40 g in 200 ml water) or D) urea every other day (80 g in 200 ml water). Hay and water intakes, duodenal dry matter flow and total tract digestibility were increased by urea infusions; responses were best for steers receiving urea once a day or urea every other day. Feed intakes were similar for treatments C and D, but greater than for treatment B. Synchronous ammonia release in the rumen of steers fed low quality hay did not limit efficiency of nitrogen utilization.

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

Introduction

Low levels and rapid rates of ammonia release in the rumen have been proposed as key factors limiting microbial protein production. The concept that rapid release of ammonia from urea limits bacterial growth in forage-fed cattle has been the focus of several studies. Frequently feeding urea (Kropp et al., 1977; Mizwicki et al, 1980); periodic versus continual intraruminal urea infusions (Romero et al., 1976) and slow-release non-protein compounds (Owens at al, 1980) have been tested. Results from these experiments have indicated that urea dosed periodically was used as well as urea dosed continuously. However, these trials have not all measured feed intake

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responses or efficiency of nitrogen utilization. The objectives of this study were to determine the effect of frequent intraruminal urea infusions on feed intake, site and extent of forage digestion and efficiency of nitrogen utilization in steers given free choice access to low quality prairie hay.

Materials and Methods

Eight crossbred Angus x Hereford steers (448 kg body weight) were used in two simultaneous 4x4 latin square experiments. Steers had free choice access to prairie hay (5.3% crude protein), and received 50 g of a mineral premix[5] previous to each morning feeding. Feed and water intake were recorded daily during the 56-day experiment. Each experimental period of the latin square lasted 12 days, with daily ruminal urea infusions consisting of: A) Water (100 ml water dosed at 8:30 am and 2:30 pm, control); B) urea twice a day (20 g in 100 ml water/dosed as treatment A); C) urea once a day (40 g in 200 ml water/dosed at 8:30 am) and D) urea every other day (80 g in 200 ml water /dosed at 8:30 am).

Chromic oxide was dosed intraruminally (3 g/dose) twice daily (8:30 am and 4:30 pm) during the last week of each experimental period; this was used to estimate digestibility. On day 11 and 12 of each period, ruminal liquid samples were collected sequentially (8:30 am; 10:30 am; 2:30 pm; 6:30 pm; 10:30 pm). The pH was recorded immediately. Samples were acidified and frozen for ammonia-nitrogen analysis. Duodenal contents and fecal grab samples were taken 3 times daily on day 11 and 12 and composited within animal and period.

Sampling, pH measurements, and chemical analysis procedures for chromium, ruminal liquid ammonia-N (NH_3-N), and purine analyses were discussed elsewhere (Garza et al., 1992).

Data were analyzed using a general linear models procedure. Animal, period and treatments were the classes in the statistical model.

Results and Discussion

Frequent intraruminal urea infusions influenced intake of hay and water (Table 1). Compared with control steers, animals dosed with urea consumed more hay (7.3 versus 5.8 kg DM/day; $P<.01$) and drank more

[5]Contained: Dicalcium Phosphate 42.3%, KCL 17.9% trace mineral salt 28.1% (.25% Mn, .2% Fe, .033% Cu, .0025% Co, .007% I, .005 % Zn), Na_2SO_4 11.2% and vit A .57% (30,000 UI/g).

Table 1. Influence of frequent intraruminal urea infusions on intake and digestion in steers fed prairie hay.

Item	Frequency of urea infusions				SE
	Control	Twice	Once	Every other day	
Intake:					
Feed, kg DM/day	5.8[a]	6.6[b]	7.7[c]	7.5[c]	.23
Water, liters/day	24.6[a]	27.0[b]	30.7[c]	30.1[c]	.96
Water/DM, liters/kg DM	4.5	4.3	4.1	4.2	.18
Duodenal flow:					
kg wet matter/day	113.3	117.7	124.5	129.0	9.91
kg dry matter/day	4.9[a]	5.4[b]	6.2[c]	6.3[c]	.17
Duodenal DM, %	4.6	4.8	5.1	4.9	.31
Fecal output:					
kg wet matter/day	19.8[a]	21.0[a]	23.8[b]	24.3[b]	.73
kg dry matter/day	3.9[a]	4.1[a]	4.6[c]	4.6[c]	.13
Fecal DM, %	19.7[d]	19.5[d]	19.3[d]	18.8[f]	.31
DM digestibility:					
Ruminal, %	14.5	17.4	20.2	16.5	3.36
Intestinal, % of diet	17.9	21.1	20.0	22.3	3.52
% of duodenal flow	20.8	24.8	23.9	25.8	3.21
Total tract, %	32.4[a]	38.6[b]	40.1[b]	38.8[b]	1.93
Fraction of total tract:					
Rumen, %	41.4	42.6	52.8	43.7	9.60
Postruminally, %	58.6	57.4	47.2	56.3	9.60

[a,b,c] Means in the same row with different superscripts are different ($P<.01$).
[d,f] Means in the same row with different superscripts are different ($P<.05$).

water (29.3 versus 24.6 liters/day; P<.01, Table 1). Feed and water intakes also differed with frequency of urea infusion. Steers receiving urea once daily or every other day had greater feed (7.6 vs 6.6 kg DM/day; P<.02) and water (30.4 vs 27.0 liters/day; P<.01) intakes than animals infused twice daily. Fecal DM output was similar for the control steers and the steers dosed twice per day, but lower (P<.01) than from animals infused with urea once daily or every other day. Regardless of the frequency of urea dosing, duodenal dry matter flow was increased (P<.001) with nitrogen infusion. Dry matter flow differences also were apparent between frequencies of urea infusions. Steers dosed once or every other day had greater (P<.01) duodenal flow than steers receiving urea twice daily or steers dosed with water (control).

Dosing urea at different intervals did not affect ruminal or intestinal digestibilities, but it increased total tract digestion (39.2 vs 32.4%; P.<03). Diurnal changes in ruminal liquid ammonia-nitrogen concentrations are presented in Figure 1. Ammonia concentrations were maximum for the samples taken 2 hours after urea infusion, with the greatest increase for the steers dosed every other day. The maximum concentration of ruminal ammonia paralleled the amount of urea infused. Although these patterns were expected, increases were transitory (2 to 3 hours) for steers dosed urea once or twice daily, and 4 to 6 hours for steers dosed urea every two days. Figure 1 shows concentration of ammonia in the ruminal liquid was below

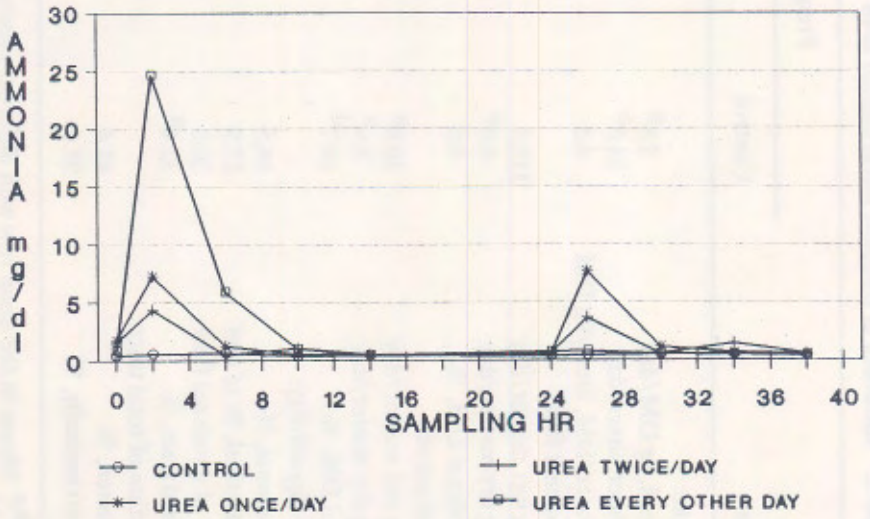

Figure 1. Ruminal fluid ammonia concentrations in steers dosed with urea at different time intervals.

Table 2. Influence of frequent intraruminal urea infusions on nitrogen utilization in steers fed prairie hay.

Item	Frequency of urea infusions				SE
	Control	Twice	Once	Every other day	
N consumed, g/day	49.9[a]	56.8[b]	65.9[c]	64.6[c]	1.98
N infused, g/day	0.0	16.8	16.8	16.8[d]	-----
N passing to duodenum from rumen, g/day	89.5[a]	111.9[b]	113.5[b]	124.4[b]	5.10
N from food origin, g/day	39.2[a]	57.6[b]	52.5[b]	62.4[b]	5.32
Microbial nitrogen, g/day	50.2[a]	54.4[a]	61.0[b]	62.0[b]	2.71
Ruminal gain in N, g/day	39.5[a]	55.1[b]	47.5[ab]	59.7[b]	6.15
Bypass N, %	79.1	106.6	80.8	98.8	11.78
Efficiency of microbial protein synthesis, g/100 g TFOM	33.0	27.5	25.0	30.0	4.38
Total tract protein digestibility, %	25.9[a]	24.4[a]	34.2[b]	29.8[ab]	2.73

[a,b,c]Means in the same row with different superscript are different ($P<.05$).
[d]Dosed on alternate days.

the suggested levels (Satter and Slyter, 1974) for adequate microbial growth during most of the day.

Total microbial nitrogen passing to the small intestine was greater ($P<.01$) with once per day or every other day (61.5 vs 52.2 g/day) urea infusions (Table 2). Efficiency of bacterial protein synthesis was similar for all treatments, but total tract N digestion tended to be greater for the steers dosed with urea once daily.

Results indicate that transient but high peaks of ruminal ammonia did not adversely affect forage intake nor utilization. The fact that feed intake was greater for animals dosed once daily or every other day, and that ammonia levels in the rumen remained below 1 mg/dl for most part of the day, suggests that N recycling to the rumen can compensate for rapid absorption of ammonia from the rumen. Higher intakes with infrequent urea dosing suggests that greater recycling may increase forage intake through increasing saliva flow.

Efficiency of microbial protein synthesis was not depressed by a deficiency of nitrogen that reduced digestibility and intake. This indicates that energy expenditure and heat loss by microbes through futile cycle activity was not enhanced by inadequate ammonia.

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