EFFECT OF POST-RUMINAL PROTEIN INFUSIONS ON FEED INTAKE AND UTILIZATION OF LOW QUALITY HAY BY BEEF STEERS

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Story in Brief

Two experiments studied the effect of daily duodenal nitrogen infusions on feed and water intake. Crossbred cannulated steers (936 lb) were fed free choice a low quality (4.5%) prairie hay diet. Steers were infused (750 ml) four times (8:30 am, 12:30 pm, 4:30 pm and 8:30 pm) daily with either sodium bicarbonate buffer (control), methionine-supplemented casein or urea-glucose solutions (Experiment 1). In the second trial, urea or urea-glucose mixtures were infused as in Experiment 1. Dry matter feed intake and water consumption were increased by nitrogen infusions in both studies. Steers dosed with the urea-glucose solution tended to eat more DM (6.7%) and drink more water (12.5%) than the animals infused with casein. Duodenal dry matter flow, ruminal and total tract digestibilities also were increased by postruminal nitrogen infusion. The increase in ruminal ammonia and plasma urea concentrations of steers dosed with urea-glucose, suggest that a high percentage of the infused material was recycled to the rumen to enhance rate of ruminal digestion. However the increase in duodenal flow but constant fecal output suggests that ruminal fill was not the factor limiting hay intake.

(Key Words: Beef Cattle, Hay, Duodenal Infusions, Protein.)

Introduction

Low voluntary feed intake and low digestibility limit performance of animals fed poor quality forages. Deficiencies of protein or B-vitamins reduce feed intake in most animals. Duodenal infusions of intact proteins or non-protein nitrogen, such as urea have increased both voluntary feed intake and digestibility of low quality forages in sheep (Egan and Moir, 1965).

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More recently, Garza et al., (1991) found that feed intake and ruminal digestibilities in beef steers fed a high concentrate diet were increased by daily duodenal infusions of urea-glucose solutions. Whether these responses were due to an increased post-ruminal supply of nitrogen or glucogenic compounds to the small intestine is not clear. These two trials were designed to examine the effects of daily duodenal infusions of sodium bicarbonate buffer, methionine-supplemented casein, urea-glucose or urea solutions on voluntary feed and water intake, ruminal contents and site of DM digestion in beef steers fed a prairie hay diet.

Materials and Methods

Experiment 1

Nine crossbred Angus x Hereford steers (950 lb) housed in individual slatted-floor pens were used in three simultaneous Latin square experiments. Animals had ad libitum access to a prairie hay diet (4.5% CP). Previous to the daily feeding and throughout the study, animals received 50 g of a mineral premix[3]. During the experimental periods, each lasting 16 days, daily duodenal infusions (treatments) were provided consisting of either sodium bicarbonate buffer (control); methionine-supplemented casein or a urea-glucose solution, prepared and dosed as outlined by Garza et al., (1991). Chromic oxide was dosed (3 g/dose) twice daily (8:00 am and 8:00 pm) during the last week of each experimental period, to estimate digestibility. Ruminal liquid, duodenal contents and fecal grab samples were taken three times daily on day 14 and 15 of each period. Steers had a minimum of 10 days with no infusion between experimental periods to avoid any carry-over effect. During this period, daily feed and water intakes were recorded.

Sampling, pH measurements, ruminal content calculations and chemical analysis procedures for chromium, and ruminal fluid ammonia-N (NH_3-N) were similar to Garza et al., (1991).

Data were analyzed using a general linear models procedure. Animal, period and treatment were the classes in the statistical model. Orthogonal contrasts were used to compare treatment effects of control versus others and casein versus glucose-urea infusion.

[3]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% (100,000 IU/g).

Experiment 2

Eight Angus x Hereford steers (923 lb) housed in individual slatted-floor pens were fed as in Experiment 1 in a crossover experiment with two 7-day experimental periods. Steers received daily duodenal infusions of either urea (85 g) or urea (85 g) plus glucose (285 g) solution; all steers also received a duodenal B-vitamin premix. Daily infusions, schedule and doses were similar to those used in Experiment 1. Jugular blood samples (30 ml) were collected sequentially during the last day of each period at 8:00 am, 10:00 am and 12:00 pm. Immediately after withdrawal, blood samples were centrifuged and the remaining plasma was transferred to plastic tubes and frozen for later plasma urea analysis.

Data were analyzed using animal, period and treatment in the statistical model. Repeated measurements (blood samples) were analyzed using the animal x period x treatment interaction as the main plot error term.

Results and Discussion

Experiment 1

Voluntary feed and water intake increased ($P<.001$) with supplemental duodenal nitrogen; responses tended to be higher (14.3 lb/day and 5.4 gallons/day) for the urea-glucose treatment than for the casein infusion (13.4 lb/day and 4.8 gallons/day; Table 1). Increased feed intake has been observed with sheep fed low quality forages and duodenally infused with casein or urea (Egan and Moir, 1965). However, their doses were transitory and intake returned to pre-treatment levels within 3 to 5 days following each dose. In our study, feed intake returned to pretreatment levels after the infusions were stopped. In some cases intakes were slightly depressed during the post-infusion compared to the infusion period.

Total ruminal liquid volume was similar for the control and the urea-glucose treatment; however, animals duodenally infused with the casein solution had larger (14.2 vs 12.7 and 12.1 gallons) rumen liquid volume and had more ($P<.02$) free ruminal liquid than urea-glucose infused steers.

Daily duodenal dry matter flow ($P<.002$), ruminal dry matter digestibility ($P<.06$) and total tract dry matter digestibility ($P<.001$) all were enhanced by postruminal infusion of urea-glucose or casein solutions (Table 2). Ammonia nitrogen (NH_3-N) concentrations in ruminal liquid and total blood urea levels are presented in Table 2. Steers receiving the urea-glucose mixture had higher levels ($P<.001$; .82 mg/dl and 15.5 mg/dl) than steers receiving the casein (.28 mg/dl and 7.64 mg/dl) or the control (.16 mg/dl and

Table 1. Effect of duodenally nitrogen infusions on feed intake, water consumption and ruminal parameters in beef steers fed low quality hay (Experiment 1).

	Treatments				Orthogonal contrast	
Item	Buffer	Casein	Urea-glucose	SE	B vs C, U [a]	C vs U
Feed intake, lb	10.8	13.4	14.3	.36	.001	.09
Water intake, gallons	3.5	4.8	5.4	.20	.001	.07
Rumen contents:						
Total weight, lb	123.0	135.4	115.8	4.07	NS	.004
Ruminal DM, %	13.4	12.3	12.6	.60	NS	NS
pH	7.0	6.8	6.9	.02	.001	.05
Liquid:						
Total volume, gallons	12.7	14.2	12.1	.40	NS	.002
Free, gallons	6.4	7.5	6.1	.38	NS	.02
Bound to feed, gallons	6.3	6.7	5.9	.44	NS	NS
Solids:						
Total DM, lb	16.4	16.7	14.8	1.0	NS	NS

[a] B= buffer (control); C= casein; U= Urea-glucose solutions.

Table 2. Effect of duodenally nitrogen infusions on site and extent of digestion in beef steers fed low quality hay (Experiment 1).

Item	Treatments				Orthogonal contrast	
	Buffer	Casein	Urea-glucose	SE	B vs C, U [a]	C vs U
Duodenal pH	2.5	2.6	2.7	.04	NS	NS
Duodenal flow, DM lb/day	7.1	9.0	8.8	.36	.002	NS
Fecal output, DM lb/day	6.4	6.8	6.7	.43	NS	NS
Digestibility :						
Ruminal, %	23.5	31.8	36.7	4.47	.06	NS
Intestinal, %	8.8	16.1	13.2	4.24	NS	NS
Percent of flow, %	9.6	22.6	19.0	5.53	NS	NS
Total tract, %	32.3	48.0	50.7	4.71	.001	NS
Ammonia-N and Urea-N, mg/dl						
Ruminal NH_3-N	.16	.28	.82	.03	.001	.001
Plasma urea-N	3.96	7.64	15.50	1.57	.006	.01

[a] B= buffer (control); C= casein; U= Urea-glucose solutions.

3.96 mg/dl) treatments. These results suggest that nitrogen recycling to the rumen of those steers receiving the urea-glucose treatment was high and may have influenced feed intake by stimulating ruminal bacterial activity and increasing the rate of ruminal digestion. It is not possible to determine from this experiment the percentage of nitrogen from infused materials that was recycled to the rumen. Data from blood urea and ruminal NH_3-N suggest that casein may have altered feed intake in a manner different from urea. Casein may have had a more localized effect within the small intestine and based on blood urea levels, was not all deaminated. The increase in daily duodenal flow with infusions make one question the idea that ruminal fill and output limit forage intake. The 25% increase in duodenal flow but only a 10% increase in fecal output with nutrient infusions suggest that with this low quality forage, N supply to and fermentation in the large intestine responded to infusions. Thus, fecal output, not ruminal output probably limited feed intake with this diet. The fact that intake response was equal to or greater than the response from casein indicated that the effect was not due directly to the added amino acids.

Experiment 2

The increase in forage intake in Experiment 1 could be ascribed to either the supplemental N or the supplemental energy provided. In this experiment, we measured which was more important. Because N is definitely deficient we compared urea to urea-glucose infusions. Daily DM intake (16.2 vs 15.3 lb/day; $P<.03$) water consumption (5.9 vs 5.2 gallons/day) and total plasma urea concentrations (13.0 vs 12.1 mg/dl) were greater for the steers infused the urea than the urea-glucose solution (Table 3). Regardless of

Table 3. Effect of post-ruminal urea or glucose-urea infusions on feed and water intake of steers fed a low quality hay diet (Experiment 2).

	Treatments		
	Urea	Urea-glucose	SE
Intake :			
Feed, lb DM/day	16.2^a	15.3^b	.24
Water, gallons/day	5.9^c	5.2^d	.24
Plasma urea-N, mg/dl	13.0	12.1	.97

[a,b] Means in the same row with different superscript differ ($P<.02$).
[c,d] Means in the same row with different superscript differ ($P<.10$).

treatment, plasma urea concentration peaked approximately two hours postfeeding (P < .05) and tended to decline thereafter (Figure 1).

Results indicated that under the feeding conditions of this experiment, additional duodenal energy in the form of glucose failed to enhance feed intake. This finding is in agreement with other studies (Rogers et al., 1979) where abomasal infusions of glucose in dairy cows fed silage did not affect feed intake; however mixtures of casein plus glucose infused similarly increased feed intake and milk yield.

In summary, feed and water intake were increased by both casein or urea. An additional glucose supply did not increase intake. Providing non-protein sources post-ruminally may prove useful and economical to promote feed intake and animal performance of cattle fed low quality forage. Relative responses to ruminal vs postruminal infusion need to be tested.

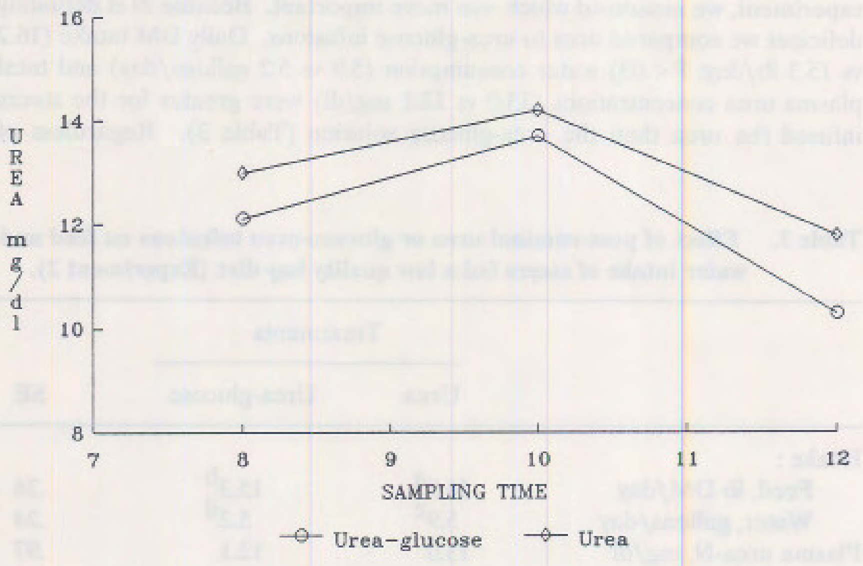

Figure 1. Effect of post-ruminal urea or urea-glucose infusions on plasma urea levels in steers fed a prairie hay diet.

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