EFFECTS OF POST-RUMINAL CASEIN ON VOLUNTARY ALFALFA HAY INTAKE BY STEERS

J.D. Garza-F[1], F.N. Owens[2], S. Welty[3] and J. Summers[4]

Story in Brief

Effects of supplemental duodenal protein on voluntary intake of alfalfa hay and water, ruminal volume and site of nitrogen digestion were studied in a crossover experiment with 8 Angus x Hereford steers (443 kg initial body weight). Steers had ad libitum access to alfalfa hay (17.5% crude protein) and received either no infusion (control) or four daily (8:30 am, 12:30 pm, 4:30 pm and 8:30 pm) doses (750 ml/dose) of casein (300 g + 3 g methionine daily). Digesta and fecal grab samples were collected 3 times/day on two consecutive days; ruminal contents were evacuated on day 15 of each period. Infused duodenal casein did not influence intake of either hay or water. Animals dosed with casein tended to have larger ruminal liquid volume (47.5 vs 43.5 liters) and more free liquid volume (17.8 vs 17.5 liters) than the control steers. Casein infusions depressed daily duodenal DM flow (7%) and fecal output (11%), but casein enhanced ruminal dry matter digestibility (50.3 vs 45.7%). Regardless of treatment, ruminal ammonia-nitrogen concentration peaked at 4 h postfeeding. Total tract protein digestibility tended to be increased (67.7 vs 64.4%) by infused casein. Additional duodenal protein appeared to reduce ruminal outflow to the small intestine and increase the extent of ruminal and total tract digestion of the alfalfa hay. Results suggest that protein levels above 17.5% may increase the extent of ruminal and total tract digestion of alfalfa without increasing feed intake. A high supply of postruminal protein, by reducing ruminal outflow rate may shift site of digestion from the intestines toward the rumen.

(Key Words: Beef Cattle, Alfalfa Hay, Duodenum, Casein Infusions.)

---

[1]Research Associate [2]Regents Professor [3]Herd Manager [4]Laboratory Technician

Introduction

Voluntary feed intake is an important factor determining animal productivity. Major changes in intake will markedly influence animal performance and profitability of production. In practice, composition and nutrient characteristics (protein, energy, vitamins, etc.) of a feed or a supplement can alter feed intake. But the factor limiting intake seldom is apparent. In past studies, feed intake responses have been attributed to ruminal changes (ammonia levels, pH or microbial activity) or to post-ruminal supply of nutrients. With beef cattle fed concentrate diets (12.2% crude protein), voluntary feed intake and ruminal dry matter digestibilities were increased by daily duodenal infusions of urea-glucose or casein, with higher intake from urea-glucose (Garza et al., 1991a). Hence, post-ruminal supply of amino acids was not limiting intake with that diet. Other studies (Garza et al., 1991b) have indicated that addition of glucose to post-ruminal infusions of urea in steers fed low quality hay did not improve voluntary feed intake or dry matter digestibility. This study evaluated the effect of daily duodenal casein infusions on voluntary feed and water intake, ruminal volume, and site and extent of dry matter and crude protein digestion in beef steers fed alfalfa hay.

Materials and Methods

Eight crossbred Angus x Hereford steers (443 kg initial BW) with ruminal, duodenal and ileal (T-type) cannulas were housed individually in slatted-floor pens. Animals had free choice access to water and alfalfa hay (17.2% CP) with fresh alfalfa hay added once daily (8:30 am) during the 45-day crossover experiment. Each experimental period lasted 15 days. Duodenal infusions given 4 times each day consisted of methionine-supplemented casein or no infusion (control) as described by Garza et al. (1991a). Feed and water intake were recorded daily. A 5% excess over the previous day's intake was provided. Alfalfa hay samples were collected weekly throughout the study and composited for dry matter and crude protein determinations. During the last week of each period, chromic oxide was dosed (3 g/dose) intraruminally twice each day. Ruminal, duodenal and fecal grab samples were taken three times per day (8:30 am, 2:30 pm and 8:30 pm) on days 13 and 14 of each period. Individual ruminal liquid samples were frozen after collection for ammonia-nitrogen analysis. Duodenal, fecal grab samples and aliquots of ruminal fluid were composited on a wet basis, dried and ground prior to chromic oxide analysis. Ruminal, intestinal, total tract dry matter digestibility, dry matter duodenal flow and daily fecal output,

were calculated based on chromic oxide concentrations. Purine content of intestinal digesta was measured to estimate net microbial protein synthesis in the rumen. On day 15 of each period, total ruminal contents were removed mechanically to determine ruminal liquid volume as suggested by Garza et al. (1991b).

Animal, period and treatments were included as variables in the data analysis. Repeated measurements (NH_3-N) were analyzed 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

Duodenal infusions of methionine-supplemented casein did not influence voluntary alfalfa hay or water intake by steers (Table 1). These data are consistent with earlier reports by Egan (1966) who indicated that

Table 1. Effect of post-ruminal casein infusions on feed intake, water consumption and ruminal parameters in steers fed alfalfa hay diet.

	Treatments		
	Control	Casein	SE
Steers	8	8	---
Intake :			
Feed, kg DM/d	10.3	10.1	.35
Water, liter/d	44.1	44.0	1.81
Water/DM, liter/kg	4.8	4.6	.18
Rumen contents:			
Total weight, kg	51.7	55.3	2.14
Ruminal DM, %	14.0	13.9	.36
Liquid:			
Total vol, liter	44.3	47.5	1.80
Free, liter	17.1	17.8	1.45
Bound to feed, liter	27.3	29.8	1.45
Solids:			
Total solids, kg	7.2	7.6	.39

intestinal casein infusions in sheep fed high protein forage did not alter feed intake. Total ruminal contents (55.3 vs 51.7 kg), ruminal liquid volume (47.5 vs 44.3 liters) and liquid in the rumen (total and bound liquid) tended to be greater in steers dosed with casein (Table 1); but dry matter (DM) percentage of ruminal contents was not different. Values are similar to those reported by Garza et al. (1991a) with beef steers consuming low quality prairie hay. Daily casein infusion tended to depress duodenal DM flow (7%) and fecal output (11%; Table 2). Ruminal (50.3 vs 45.8%) and total tract (62.7 vs 58.6%) dry matter digestibilities were enhanced by protein infusion (Table 2). These results suggest that casein infusion reduced ruminal outflow rate so that residence time of alfalfa in the rumen, and ruminal digestion were increased. Ammonia levels in ruminal fluid were similar (13.7 vs 14.6 mg/dl) for the two treatments, but concentrations varied ($P<.001$) during the day (Figure 1). Ammonia-nitrogen concentrations peaked at 4 hours post-feeding (Figure 1).

In spite of the additional 39 g of nitrogen provided by casein, no effect of duodenal infusions on site and extent of nitrogen utilization were apparent (Table 3). Net loss of nitrogen in the rumen (96.0 vs 87.5 g N/day) and total tract protein digestibility (68.0 vs 64.0%) tended to be greater for those steers receiving casein. But, efficiency of microbial protein synthesis (g N/100 g

Table 2. Effect of post-ruminal casein infusions on site and extent of DM digestion in steers fed alfalfa hay.

	Treatments		
	Control	Casein	SE
Steers	8	8	---
Duodenal flow, kg DM/d	5.6	5.0	.46
Fecal output, kg DM/d	4.2	3.7	.22
DM Digestibility:			
Ruminal, %	45.8	50.3	3.08
Intestinal, % of diet	12.8	12.4	.93
% of duodenal flow	19.2	21.6	7.08
Total tract, %	58.6	62.7	1.65
Ruminal, % of total tract	79.7	81.4	5.84
Postruminal, % of total tract	20.3	18.6	5.84
Ammonia-N :			
Ruminal fluid, mg/dl	13.7	14.6	.40

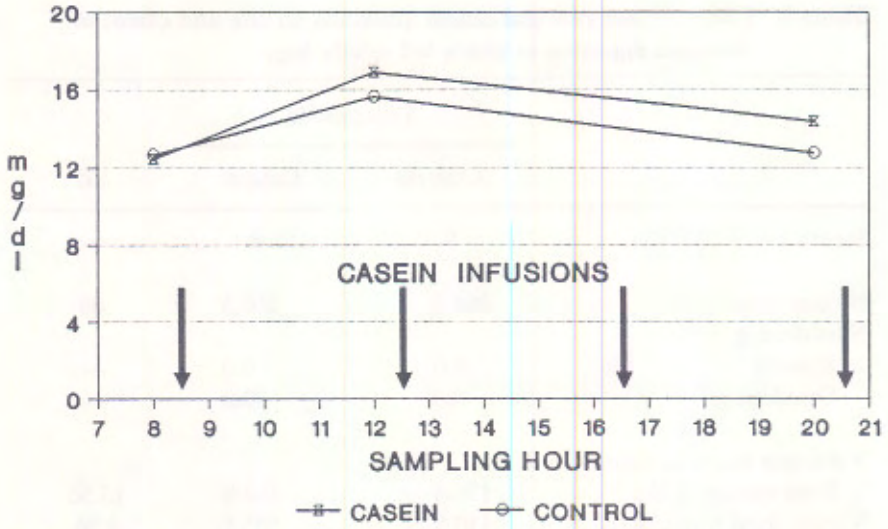

Figure 1. Effect of pos-ruminal casein infusion on ruminal liquid ammonia concentration in steers fed alfalfa hay.

truly fermented organic matter in the rumen) tended to be greater for the control steers. These differences in microbial yields may reflect the differences observed in ruminal turnover of dry matter. The fact that ruminal NH_3-N levels tended to increase with casein but crude protein content of feces was similar (13%) for both treatments, indicates that surplus nitrogen was absorbed and used or excreted. Body weight records suggest that casein was used also to meet tissue needs; steers given casein had greater (1.6 vs 1.1 kg/day) daily gains than the steers receiving alfalfa hay alone. In summary, supplemental intestinal protein did not increase intake of high quality alfalfa hay, but it appeared to increase extent of ruminal digestion and total tract digestibility. Contrasted with responses in feed intake to additional post-ruminal protein with low quality roughages, these results indicate that responses to casein depend on the type and quality of the forage.

Table 3. Effect of post-ruminal casein infusions on site and extent of nitrogen digestion in steers fed alfalfa hay.

	Treatments		
	Control	Casein	SE
Steers	8	8	---
N consumed, g/d	264.3	260.5	.05
N infused, g/d			
Rumen	0.0	0.0	---
Duodenum	0.0	39.0	---
N passing to duodenum from rumen, g/d	176.8	164.8	15.56
N from food origin, g/d	110.5	105.1	8.26
Bypass N, %	43.1	41.0	1.94
Microbial nitrogen, g/d	66.3	59.7	11.40
Efficiency of microbial protein synthesis, g/100 g TFOM	15.1	14.3	3.56
Ruminal loss in N, g/d	87.5	95.7	---
Total tract protein digestibility, %	64.4	67.7	1.63

Literature Cited

Egan, A.R. 1966. Nutritional status and intake regulation in sheep. V. Effect of intraruminal infusions of volatile fatty acids upon voluntary intake of roughage by sheep. Aust. J. Agric. Res. 17:741-755.

Garza-F, J.D. et al. 1991a. Effect of post-ruminal protein infusions on feed intake and utilization of low quality hay by steers. Okla. Agr. Exp. Sta. Res. Rep. MP-134:106.

Garza-F, J.D. et al. 1991b. Duodenally infused casein or urea-glucose for steers fed a high concentrate diet. Okla. Agr. Exp. Sta. Res. Rep. MP-134:215.