Effect of Degradable or Undegradable Intake Protein on Forage Intake and Digestibility in Steers Consuming Low Quality Forage

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Story in Brief

To determine the effect of undegradable intake protein or degradable intake protein on forage intake and digestion in cattle fed *ad libitum* coarsely chopped prairie hay (PH), eight ruminal cannulated Angus steers received continuously iso-nitrogenous (55 g N d^{-1}) infusions of casein into rumen (DIP), or casein into abomasum (UIP), or urea into rumen (UDIP). Casein and urea were dissolved in 3.6 L in tap water. Control animals (CON) received continuous infusions of tap water (3.6 L) into abomasum. A peristaltic pump was used to infuse each solution at a rate of 2.5 ml/min^{-1}. Nitrogen supplementation significantly increased forage intake and digestible organic matter intake compared to CON, but no differences were detected among supplemental N treatments. DM, OM, NDF and, ADF digestibilities were similar among treatments. These data suggest that forage intake of prairie hay is limited by its low nitrogen content. When continuously infused, urea was a good N source to improve intake of low quality forage as protein sources. Additionally, undegradable intake protein can improve forage intake possibly through an increase in N recycling.

Key Words: Forage, Voluntary Intake, Digestion, Protein Supplementation.

Introduction

One of the main factors that limits consumption of low quality forage by ruminants is nitrogen availability in the rumen (NRC, 1985). Therefore, it is common practice to supplement cattle with N when they consume low quality forage. Non-protein nitrogen sources (NPN) can be an inexpensive way to overcome a nitrogen deficiency. However, the rapid release of nitrogen decreases the efficiency of N utilization by bacteria and could possibly lead to ammonia toxicity (Owens *et al*., 1980). In contrast, true protein sources are degraded slower in the rumen compared to NPN, extending N availability for longer periods of time. Also, it is thought that true protein sources improve microbial protein production by supplying amino acids, peptides and some branched chain amino acids. Additionally, transfer of urea from blood into the gastro-intestinal tract is an important mechanism to save nitrogen and maintain microbial fermentation for cattle consuming low quality forages. When fed at high levels, undegradable intake protein via urea transference can supply N to rumen if a N deficiency exists in the rumen.

Material and Methods

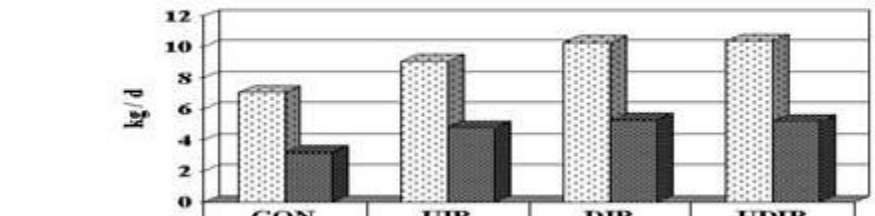
Eight mature Angus steers (545 ± 50 kg) with rumen, duodenum and abomasum (via rumen cannulae) cannula were used in a replicated Latin square design (Steel *et al*., 1997). Animals were individually housed in 3 x 4 m pens in an environment-controlled room. Each experimental period consisted of an adaptation phase (10 d) and a sample collection phase (6 d). The basal diet consisted of coarsely chopped prairie hay (5.0% CP) offered *ad libitum* daily at 10% above previous day's hay intake. Experimental treatments were: 1) CON: prairie hay + continuous

infusion of 3.6 L of water, 2) UIP: prairie hay + continuous infusion of 400 g casein dissolved in 3.6 L of water infused directly in abomasum through an infusion line from ruminal cannula, 3) DIP: prairie hay + continuous infusion 400 g casein dissolved in 3.6 L of water infused directly in rumen and, 4) *ad libitum* prairie hay + continuous infusion: 123 g urea dissolved in 3.6 L of water infused in rumen. From day 11 to 15, forage intake was recorded. Forage intake was calculated by subtracting weight of refusal from hay offered. A daily sample of offered feed and the previous day's refusal was dried at 55C for 72 h in an air-forced oven. At the end of each period, a composite sample was made for each animal. Total fecal output on day 11 to 15 was weighed daily, sampled (approx. 500 g) and dried at 55 ºC for 72 h. At the end of each experimental period, samples were individually ground and then pooled by weight within steer-period. To collect total urinary output, jugs with capacity of 20 L containing enough 6 N HCl (200 to 600 ml per jug) to keep urinary pH below 3 were used. Form d 12 to 15, total urine production was weighed, sampled (1% of total urine output), stored, and frozen until analysis in laboratory. In order to estimate total urine volume, urinary density was determined by weighing 1000 ml of urine at room temperature. Then, volume was estimated as total urine weight divided by density. Data were analyzed using a model that included square, pen nested in square, period nested in square, and treatment effects with the GLM procedure of SAS. When the F-test was significant, means comparison were carried out with a Bonforroni test, considering significant level at P<.05.

Results and discussion

Independent of N source infused in the rumen (DIP vs UDIP; Figure 1) or infusion site, N infusion increased (P<.05) forage DM intake. Undegradable intake protein increased forage intake by 28% and, DIP and UDIP increased forage intake by 46% compared to CON.

Figure 1. The effect of continuous infusion of UIP or DIP on forage intake (FI) and digestible OM intake (DOMI) of steers consuming prairie hay



	CON	UIP	DIP	UDIP
FI, kg d-1	7.1 a	9.1 b	10.3 b	10.4 b
DMOI, kg -1	3.2 a	4.8 b	5.3 b	5.2 b

a, b, c means within rows with uncommon superscripts differ P<.05

No differences were detected (P>.05) for the digestibility coefficients for: DM, OM, NDF and ADF of prairie high by nitrogen supplementation (Table 1). However, digestibility coefficients of animals receiving supplemental nitrogen were greater numerically to those of CON animals.

Table 1. Digestibility coefficients in steers fed *ad libitum* fed prairie hay with continuous infusion of DIP from casein or urea into rumen or, continuous infusion of UIP from casein into abomasum

	Tretaments [1]				
	CON	UIP	DIP	UDIP	√MSE [2]
Digestibility, %[3]					
Dry matter	45.5	51.4	50.0	49.6	3.3
Organic matter	48.3	51.4	50.0	49.6	3.2
NDF	47.0	51.9	51.0	51.7	3.8
ADF	39.3	45.1	44.3	44.6	3.7

[1] CON: *ad libitum* prairie hay; UIP: CON + continuous infusion of casein (400 g) into abomasum; DIP: CON + continuous infusion of casein (400 g) into rumen and UDIP: CON + continuous infusion of urea (123 g) into rumen

[2] √Mean Square Error

[3] Percentage of intake that disappeared apparently in total intestinal tract

In previous studies, digestibility of low quality forage has not been consistently increased by N supplementation. The increase in forage intake resulted in higher (P<.05) intake of digestible OM (DMOI; figure 1), being 50% higher for UIP and 64% for DIP and UDIP, compared to CON animals. This increase in DMOI will improve the animal's energy status and possibly performance. Under the conditions of this study, urea increased forage intake to similar rate than casein in rumen did. It is not clear how UIP increased forage intake, however N recycling and metabolic effects may be involved.

Implications

Nutrient consumption from low quality forage can be increased by nitrogen supplementation through an increase in forage intake. In addition, under the conditions of this study, NPN and DIP increase forage intake at similar level.

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