MICROBIAL USE OF RECYCLED UREA IS DEPENDENT ON THE LEVEL AND FREQUENCY OF DEGRADABLE INTAKE PROTEIN SUPPLEMENTATION

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Introduction

Protein supplementation increases utilization (intake and digestion) of low-quality forage and ultimately animal performance. Despite its effectiveness, protein supplementation is often expensive. One strategy to reduce the cost of supplementation is to supplement less frequently than daily, generally every other day or every third day. By reducing the frequency of supplementation, the cost of delivering the supplement is reduced. Reducing the frequency of supplementation is an effective strategy for reducing cost, and it only minimally impacts animal performance, with less frequent supplementation resulting in slightly greater losses of body condition score and body weight during the winter supplementation period.

Urea recycling, the transfer of urea from the animal's body to the gastrointestinal tract, has been suggested as a mechanism that allows infrequently supplemented cattle to perform similarly to cattle supplemented daily. However, little data is available to substantiate this claim, and such data would be useful in helping nutritionists better understand nitrogen metabolism in infrequently supplemented ruminants. Our objective was determine the role of urea recycling in meeting ruminal nitrogen requirements in infrequently supplemented cattle fed low-quality forage.

Experimental Procedures

Five duodenally and ruminally fistulated Angus × Hereford steers (average initial body weight 807 pounds) were used to evaluate the effect of increasing amounts of supplemental degradable intake protein on forage utilization and recycled urea use by ruminal microbes in cattle consuming low-quality forage. All cattle were given *ad libitum* access to prairie hay (4.7% crude protein and 73% NDF). Two levels of supplemental protein were provided daily: 0.31 pounds (low) and 0.93 pounds (high), and two levels were provided every third day: 0.93 pounds (low) or 2.79 pounds (high) per supplementation event. Steers supplemented with the low amount of protein, either daily or every third day, received the same amount of supplement per week; the frequency of delivery was the only difference. Similarly, steers supplemented with the high amount of protein, either daily or every third day, received the same amount of supplement per week, with frequency being the only difference. Supplemental protein was provided as casein pulse-dosed into the rumen. Casein was used because it is a protein source that is highly available to ruminal microbes and it has a high protein content, which allowed researchers to study only the effects of supplemental protein.

Calculations of intake, digestion, and nitrogen balance were made using observations of hay intake and total collections of feces and urine. Duodenal samples were used to determine microbial flow from the rumen and ruminal digestion. Additionally, labeled urea was infused intravenously, allowing measurement of urea metabolism by the animal and the contribution of urea recycling to meeting microbial nitrogen requirements in the rumen.

Results and Discussion

Frequency of supplementation had no impact on forage intake, and only modest increases in forage intake were observed as the amount of supplemental protein increased from low to high (Table 1). At the low level of supplementation, less frequent supplementation resulted in greater total tract digestion.

Urea production and gut entry (recycling) of urea were greater for steers supplemented every third day as compared to those supplemented daily at the high level. Additionally, the contribution of urea recycling to meeting the nitrogen requirements of ruminal microbes was greater for infrequently supplemented steers at the high level of supplementation. This greater dependency on urea recycling in infrequently supplemented animals is in contrast to the effects on urea recycling to the gut and the contribution of urea recycling to ruminal microbes when steers were on the low level of supplementation. In the latter case, less frequent supplementation resulted in a numeric reduction in both gut entry and microbial incorporation of recycled urea nitrogen. When the high level of supplementation was provided infrequently, the amount of nitrogen in the rumen exceeded what the ruminal microbes could use and excess nitrogen was absorbed from the rumen as ammonia. Ammonia is not useful to the animal and is detoxified to urea, which can then be recycled to the gut and used by the ruminal microbes. In contrast, at the low level of supplementation, infrequent provision of supplemental protein provided a small enough amount of nitrogen at each feeding that the ruminal microbes were able to capture most of the nitrogen and utilize it directly for the synthesis of microbial protein. There was not an excessive amount of nitrogen lost from the rumen when the steers were supplemented at a low level every third day. Urea recycling was not needed under those conditions to capture most of the benefits from the supplemental protein.

Implications

At levels of protein supplementation near the requirement for degradable intake protein (the high treatment in this study), animals supplemented infrequently were more dependent on urea recycling as a means of capturing benefit from supplemental protein than animals supplemented more frequently or supplemented a lesser amount at the same frequency.

Table 1. Effects of Frequency and Level of Degradable Intake Protein Supplementation on Intake, Digestion, Urea Metabolism and Microbial Flow in Steers Fed Low-quality Forage

	Level of Supplementation			
	Low		High	
	Frequency of Supplementation			
Item	Daily	Every 3rd day	Daily	Every 3rd day
Organic matter intake, pounds/day				
Forage	14.1	16.1	16.7	16.7
Total	14.3	16.3	17.6	17.8
Digestible	7.9	10.1	10.1	10.1
Total tract digestibility, %				
Organic matter	54.8	61.4	57.6	54.8
Neutral detergent fiber	55.1[c]	61.7[d]	58.1	54.2
Urea kinetics, g nitrogen/d				
Production	58.3	45.5	86.6 [c]	126.5 [d]
Gut entry (recycled)	57.3	47.7	68.1 [c]	106.1 [d]
Duodenal flows, g nitrogen/d				
Total	135.5	130.4	165.0	148.4
Microbial nitrogen	96.4	95.8	133.3 [c]	114.7 [d]
Undegradable intake protein	39.1	34.7	31.7	33.9
Recycled urea nitrogen in microbes				
Nitrogen, g/d	35.2	31.8	30.8[a]	47.4[b]
% of total microbial nitrogen	34.1	33.2	22.8 [a]	42.1[b]
% of urea production	65.7	67.5	35.2	38.5

[a,b]Means in the same row and same level of supplementation with different superscripts differ ($P<0.05$).
[c,d]Means in the same row and same level of supplementation with different superscripts differ ($P<0.10$).