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D.W. Drake

M.L. Jones

David E. Anderson

See next page for additional authors

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Effect of nitrogen supplementation on urea recycling in steers consuming corn-based diets

Authors

D.W. Drake, M.L. Jones, David E. Anderson, and Evan C. Titgemeyer

Effect of Nitrogen Supplementation on Urea Recycling in Steers Consuming Corn-Based Diets[1]

D.W. Brake, E.C. Titgemeyer, M.L. Jones, and D.E. Anderson

Introduction

Nitrogen absorbed in the small intestine of cattle can be recycled to the rumen and incorporated into microbially synthesized amino acids. This is an advantage when dietary protein is low or when ruminally available nitrogen is limited by poor ruminal protein degradation.

In a survey, consulting feedlot nutritionists reported that 83% of their clients used ethanol coproducts in finishing diets. Ruminal availability of nitrogen in dried distillers grains with solubles is low (i.e., 25% of total nitrogen). Thus, urea recycling may be of greater relative importance when distillers grains are used to supplement protein to cattle.

The goals of our study were to better predict the amount of urea recycled by growing cattle fed corn-based diets supplemented with dried distillers grains with solubles or urea and quantify use of recycled urea by ruminal microbes.

Materials and Methods

Six ruminally and duodenally fistulated steers of British breeding were used in two concurrent 3 × 3 Latin squares. Treatments were three corn-based diets: control (10.2% crude protein), urea (13.3% crude protein), and dried distillers grains with solubles (14.9% crude protein). Treatments delivered dried distillers grains with solubles and urea at inclusion rates similar to those used commonly in corn-based diets fed to finishing cattle. Dried distillers grains with solubles was selected as a supplemental protein source because of its relatively high undegradable intake protein content. Urea was selected as a supplemental nitrogen source that is completely ruminally degradable.

Steers were housed in metabolism crates to allow total collection of urine and feces. Steers were fed twice daily in equal amounts. A temporary indwelling catheter was placed into an ear vein for infusion of $^{15}N^{15}N$-urea to allow measurement of urea recycling.

Results and Discussion

Intake, Digestibility, and Nutrient Flow

Dry matter intake did not differ among treatments ($P \geq 0.18$) but was numerically less when steers consumed urea.

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Total tract dry matter digestibility tended (P=0.11) to be greatest for urea, least for the control, and intermediate for dried distillers grains with solubles. Increased dry matter digestibility may be explained by urea stimulating microbial fermentation, although ruminal digestion of dry matter was not different among treatments (P=0.81). Numerically lower dry matter intake for the urea treatment may have contributed to its greater total tract dry matter digestibility compared with other treatments.

As expected, protein intake increased with increasing crude protein concentration in the diet (P<0.01). Steers consumed the greatest amount of protein when fed dried distillers grains with solubles, the least amount of protein when fed the control diet, and an intermediate amount when fed urea. Ruminally undegraded intake protein was numerically greatest for dried distillers grains with solubles, although microbial crude protein flowing to the intestine did not differ (P=0.81) among treatments.

Nitrogen retention (i.e., lean tissue deposition) was greater (P=0.02) for steers fed dried distillers grains with solubles than for steers fed the control diet or urea. This treatment effect may have been a response to an increasing metabolizable protein supply. Other researchers have observed that young cattle benefit from increases in metabolizable protein.

Urea Recycling

Urea production was greater (P=0.09) for dried distillers grains with solubles than for the control, but urea production in the urea treatment was not different from that in the dried distillers grains with solubles or control treatments. Urea recycling to the digestive tract did not differ among treatments (P=0.25), but there were large numerical differences that corresponded to the pattern of urea production. The dried distillers grains with solubles treatment yielded the numerically greatest microbial capture of endogenously produced (83 g/day), the control treatment produced the least (39 g/day), and the urea treatment was intermediate (57 g/day).

The percentage of microbial crude protein derived from urea recycling was greater (P=0.10) for dried distillers grains with solubles than for urea or the control. As the proportion of ruminally undegraded dietary protein increased, ruminal microbes may have incorporated more nitrogen from recycled urea. Previous research reported that urea recycling increased when intake of ruminally undegraded intake protein increased.

Microbial Capture of Endogenously Produced Urea

Urea production (percentage of protein intake) was numerically greater for dried distillers grains with solubles (83%) than for urea (73%). Steers fed dried distillers grains with solubles captured (P=0.10) a greater proportion of their microbial crude protein from recycled urea (35%) than steers fed urea (22%) or the control (17%). Ruminal microbes are more dependent on urea recycling to meet their needs for nitrogen when ruminally undegraded intake protein is provided to cattle. Previous research at Kansas State University reported similar increases in the amount of recycled urea captured by ruminal microbes when ruminally undegraded protein was supplemented.

Implications

Improved estimates of urea recycling by cattle consuming corn-based diets will lead to more precise diet formulation and less nitrogen excretion.

Table 1. Effect of nitrogen supplementation on urea recycling in steers consuming corn-based diets supplemented with no protein (Control), dried distillers grains with solubles (DDGS), or urea

	Diets				
Item	Control	DDGS	Urea	SEM	P-value
Dry matter intake, lb/day	13.6	13.6	12.7	1.3	0.18
Ruminal dry matter digestion, %	40.6	37.5	42.7	8.4	0.81
Total tract dry matter digestion, %	78.8	79.1	80.5	1.6	0.11
Nitrogen intake, g/day	99[a]	151[b]	123[c]	12	<0.01
Nitrogen retained, g/day	41[a]	67[b]	47[a]	7	0.02
Undegraded intake protein, g/day	51	97	67	18	0.12
Urea production, g/day of nitrogen	52[a]	118[b]	86[ab]	17	0.09
Urea recycling, g/day of nitrogen	39	83	57	17.1	0.25
Microbial nitrogen, g/day of nitrogen	95	84	83	16	0.81
Ruminal microbial capture of recycled urea					
grams of nitrogen/day	17	30	18	6.4	0.28
% of total microbial nitrogen	17[a]	35[b]	22[a]	5.3	0.10

Means in the same row with common superscript letters are not different (P>0.05).