RUMINAL DEGRADATION OF DIETARY PROTEIN IN STEERS FED LASALOCID

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Summary

A trial was conducted to investigate the effect of lasalocid (Bovatec®) on ruminal degradation of dietary protein in Holstein steers. Five ruminally and duodenally cannulated steers (305 kg) were fed a corn-alfalfa-soybean meal diet (17% CP), with or without lasalocid, in a three period, switch-back experiment. Ruminal pH, ammonia, volatile fatty acids, and amino acid and peptide concentrations were unaffected by lasalocid. Lasalocid reduced (P<.05) ruminal protease activity by 15%, but did not change deaminase activity. Digestibilities of dry matter, organic matter, fiber, and crude protein were similar between treatments. Intestinal flows of microbial and feed crude protein fractions, as well as amino acids, remained unchanged when lasalocid was fed. Thus, in this experiment, lasalocid failed to decrease feed protein degradation in the rumen and, therefore, was unable to increase the supply of crude protein or amino acids to the small intestine.

(Key Words: Ionophore, Lasalocid, Protein Degradation, Microbial Protein, Amino Acids, Ruminants, Dairy Cattle.)

Introduction

Much of the feed protein ingested by cattle is degraded by the microbial population of the rumen to peptides, amino acids, and ammonia. Ammonia not utilized by the microbes is absorbed into the blood, converted to urea, and largely excreted in the urine. This constitutes a loss to the animal, and, therefore, it is of interest to investigate ways to decrease ruminal protein degradation and increase feed protein reaching the small intestine where it can be digested and absorbed by the animal. Especially in high milk-producing dairy cows, postruminal amino acid supply may limit performance. Ionophores, like lasalocid (Bovatec®), potentially can decrease ruminal protein breakdown because of their antimicrobial properties. Therefore, our objective was to evaluate the effect of lasalocid on ruminal protein degradation and on supply of amino acids to the small intestine of cattle, with the experiment serving as a model for the dairy cow.

Procedures

Five ruminally and duodenally cannulated Holstein steers (305 kg) were used in a switch-back experiment with three periods, to evaluate two experimental treatments, a basal diet with or without lasalocid. Three steers received the control diet in periods 1 and 3 and lasalocid in period 2, whereas the reverse order of treatments was applied to the other two steers. One observation was missing for the control treatment in period 1 because of excessive feed refusals by one steer.

The basal diet was high in protein and moderate in roughage (Table 1). Chromic oxide was included to serve as a digesta flow marker. Steers were fed twice daily at levels just below ad libitum intake. Each period consisted of a 10-day adaptation phase followed by a 4-day sample-collection phase. On the last day of adaptation, ruminal fluid samples were collected for measurements of deaminase and protease activity. Collections of ruminal fluid, duodenal digesta, and feces were made three times daily at 4-hr intervals with times moved forward 1 hr daily such that each hour between feedings was represented. Ruminal fluid samples were analyzed for pH, ammonia, volatile fatty acids, and free amino

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Table 1. Diets Fed to Steers

	Treatment	
Ingredient	Control	Lasalocid
	---- % as fed ----	
Dry rolled corn	44.4	44.4
Alfalfa hay	43.9	43.9
48% Soybean meal	10.0	10.0
Dicalcium phosphate	.6	.6
Trace-mineral salt	.5	.5
Molasses	.5	.5
Vitamin ADE	.1	.1
Lasalocid (45 ppm)		.03
Cellulose	.03	
Nutrient	--- % of DM ----	
Organic matter	92.4	92.5
NDF	29.6	29.9
Crude protein	16.6	16.8

acid and peptide concentrations. Duodenal and fecal samples were used to measure ruminal and total tract digestion of organic matter, fiber, and protein. Whole ruminal content samples were taken once a day, mixed in a blender, and strained through cheesecloth, with the subsequent ruminal fluid being pooled to obtain a representative sample of rumen bacteria.

Results and Discussion

Ruminal pH, ammonia, volatile fatty acids, and amino acid and peptide concentrations were unaffected by the presence of lasalocid in the diet; the values in Table 2 represent the averages across all of the collection times. Ruminal protease activity, a measure of the rumen's microbial capacity to degrade feed proteins, was reduced ($P<.05$) by 15% when lasalocid was fed, but deaminase activity, a measure of the rumen's microbial capacity to degrade free amino acids, did not change (Table 2). The decreased protease activity, however, did not appear to be large enough to affect intestinal crude protein (Table 4) or amino acid supply (Table 5).

Intake and digestion of dry matter, organic matter, and fiber remained unchanged when lasalocid was fed (Table 3), although ruminal digestibilities were numerically higher for lasalocid. The apparent ruminal digestibilities of organic matter appear somewhat low, but this may relate to a relatively rapid passage of corn particles that is often observed when mixed diets are fed.

Data for crude protein intake and digestion are presented in Table 4. If lasalocid, in fact, had decreased protein degradation in the rumen, we would have expected to see an increase in duodenal crude protein and amino acid supplies. However, these measures were not different between treatments. Partitioning intestinal crude protein supply between microbial and nonmicrobial fractions also showed no differences. Thus, lasalocid apparently affected neither the escape of dietary protein from ruminal degradation nor the quantity of bacterial protein that reached the small intestine. Although total tract digestion of crude protein is often less than ideal for assessing small intestinal digestion, the similarities between treatments for duodenal crude protein supply and fecal crude protein output would lead to the assumption that small intestinal digestion of crude protein was probably similar between treatments.

Flow of amino acids to the small intestine is shown in Table 5. Given the general lack of effect of lasalocid on total crude protein supply to the intestine, it is not surprising that intestinal amino acid supplies also were unaffected by lasalocid.

In conclusion, lasalocid decreased ($P<.05$) ruminal protease activity, but the decrease was of insufficient magnitude to alter either feed or bacterial crude protein supply to the small intestine. Thus, in this experiment, decreasing feed crude protein degradation in the rumen and increasing feed crude protein supply to the small intestine were not among the potentially beneficial effects of feeding lasalocid.

Table 2. Ruminal Measurements

	Treatment		
Parameter	Control	Lasalocid	SEM
pH	6.59	6.53	.05
Ammonia, mM	11.8	12.3	.77
Total VFA, mM	90.4	91.3	3.2
Acetate, mM	59.9	61.9	1.6
Propionate, mM	17.2	15.7	1.0
Butyrate, mM	9.0	9.0	.6
Isobutyrate, mM	1.4	1.4	.03
Valerate, mM	1.2	1.2	.04
Isovalerate, mM	1.9	1.8	.05
Amino acids, mg N/liter	1.88	1.83	.11
Peptides, mg N/liter	1.92	1.99	.09
Protease activity[1]	.477	.405[a]	.017
Deaminase activity[2]	.070	.066	.004

[a]Different ($P<.05$) from control.
[1]mg nonprotein-N produced per mL of rumen fluid per hr.
[2]mg ammonia-N produced per mL of rumen fluid per hr.

Table 3. Intake and Digestion of Dry Matter, Organic Matter, and Fiber

	Treatment		
Intake	Control	Lasalocid	SEM
	------------------- g/day -------------------		
Dry matter	5924	6138	216
Organic matter	5474	5680	201
NDF	1755	1838	65
Ruminal digestibility	--------------------- % ---------------------		
Dry matter, apparent	14.4	22.2	3.1
Organic matter, apparent	19.9	29.1	2.6
NDF	31.3	38.5	3.3
Total tract digestibility	--------------------- % ---------------------		
Dry matter	66.3	64.2	1.5
Organic matter	67.6	66.1	1.4
NDF	50.0	50.7	1.3

Table 4. Crude Protein Intake and Digestion

Crude protein	Treatment		SEM
	Control	Lasalocid	
	--------------- g/day ---------------		
Intake	985.6	1034.4	39.4
Duodenal flow	877.5	868.8	51.3
Microbial	469.4	450.0	51.3
Nonmicrobial	408.1	418.8	21.3
Total tract digestibility, %	67.2	67.1	1.0
MOEFF[1]	193.1	187.5	49.4

[1]Microbial efficiency, g microbial CP/kg organic matter truly fermented in the rumen.

Table 5. Duodenal Amino Acid Flows

Amino acid	Treatment		SEM
	Control	Lasalocid	
	------------- g/day ------------		
Aspartate	69.3	68.0	4.2
Threonine	40.8	39.1	2.4
Serine	44.6	43.0	2.6
Glutamate	118.1	112.4	6.8
Glycine	49.2	47.0	2.6
Alanine	59.6	56.4	3.7
Valine	45.6	42.7	2.9
Methionine	15.2	14.7	.9
Isoleucine	42.9	40.9	2.9
Leucine	79.1	75.8	5.2
Tyrosine	31.9	32.7	2.3
Phenylalanine	42.7	40.8	2.7
Lysine	48.5	49.4	3.1
Histidine	20.7	19.0	1.1
Arginine	42.1	40.8	2.2
Total amino acids	750.3	722.7	44.3