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MODERATION OF RUMINAL FERMENTATION BY PROTOZOA IN CATTLE FED HIGH-GRAIN DIETS

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Summary

Ruminal protozoa in cattle fed high-grain diets appear to contribute to the maintenance of a stable ruminal fermentation. This was evidenced by higher ruminal pH's and lower volatile fatty acid concentrations in faunated (with protozoa) than defaunated (without protozoa) cattle. The moderation of fermentation was likely due to reduced bacterial numbers associated with the presence of protozoa.

(Key Words: Acidosis, Fermentation, Protozoa, Rumen.)

Introduction

Ciliated protozoa constitute an important fraction of the total microbial population in the rumen of cattle fed high-grain diets. Although the overall value of protozoa to the ruminant host is a subject of considerable debate, many researchers believe that in animals fed high-grain diets, protozoa play a beneficial role, primarily because of their ability to regulate ruminal lactic acid metabolism. The presence of ruminal protozoa in animals on high-grain diets is associated with decreased accumulation and increased fermentation of lactic acid, suggesting that protozoa contribute to the maintenance of a stable ruminal fermentation. However, evidence to support this theory is lacking. Our study determined the influence of protozoa on ruminal pH, fermentation products, and bacterial numbers in steers fed a high-grain diet.

Experimental Procedures

Six ruminally cannulated steers were assigned randomly to two treatment groups — defaunated (devoid of ruminal protozoa) and faunated (with ruminal protozoa). Cattle were adapted to a high-grain diet (85% corn and 15% alfalfa hay) and fed at 12-hr intervals. All six steers were defaunated by ruminal emptying, omasal flushing, and treatment with an antiprotozoal compound, sodium sulfosuccinate. Then three steers received ruminal fluid inoculum from a faunated donor animal to re-establish protozoa. After 2 wk of adaptation, ruminal contents were sampled just before feeding and at 1, 2, 4, 6, 8, and 12 hr postfeeding and samples were analyzed for pH; fermentation products (lactate, ammonia, and volatile fatty acids); and numbers of total, lactic acid-producing, and lactic acid-fermenting bacteria.

Results and Discussion

Ruminal pH was lower ($P<.01$) in defaunated than faunated steers (5.97 vs 6.45). In both groups, ruminal pH declined following feeding and returned to the prefeeding level at 12 hr. Although there was no treatment × time interaction, the extent of postfeeding decline in ruminal pH tended to be greater in defaunated than faunated steers (Figure 6.1). Ruminal lactic acid concentrations were extremely low in both groups and were not affected by the absence or presence of protozoa (.12 vs .05 mM). Similarly, ruminal ammonia concentrations were not influenced by the protozoa (10.2 vs 9.1 mM). Ruminal volatile fatty acid (VFA) concentrations were significantly higher in the defaunated than faunated steers, and there was a significant treatment × time interaction (Figure 6.2). Therefore, assuming buffering was constant, the difference in total VFA and not lactic acid concentration was responsible for the difference in ruminal pH. Ruminal propionate concentrations were significantly higher in the defaunated than the faunated steers (27.2 vs 12.2 mM). However, ruminal butyrate concentrations were unaffected by the protozoa (8.3 vs 7.4 mM). Total bacterial numbers were about fourfold higher in the defaunated than the faunated steers (Table 6.1), probably because protozoa act as predators of bacteria. Although numbers of lactic acid-producing bacteria (*Streptococcus bovis*, lactobacilli, and starch-fermenters) and lactic acid-fermenting bacteria were not statistically different between the two groups, there was a trend for higher numbers in the defaunated than the faunated group (Table 6.1).

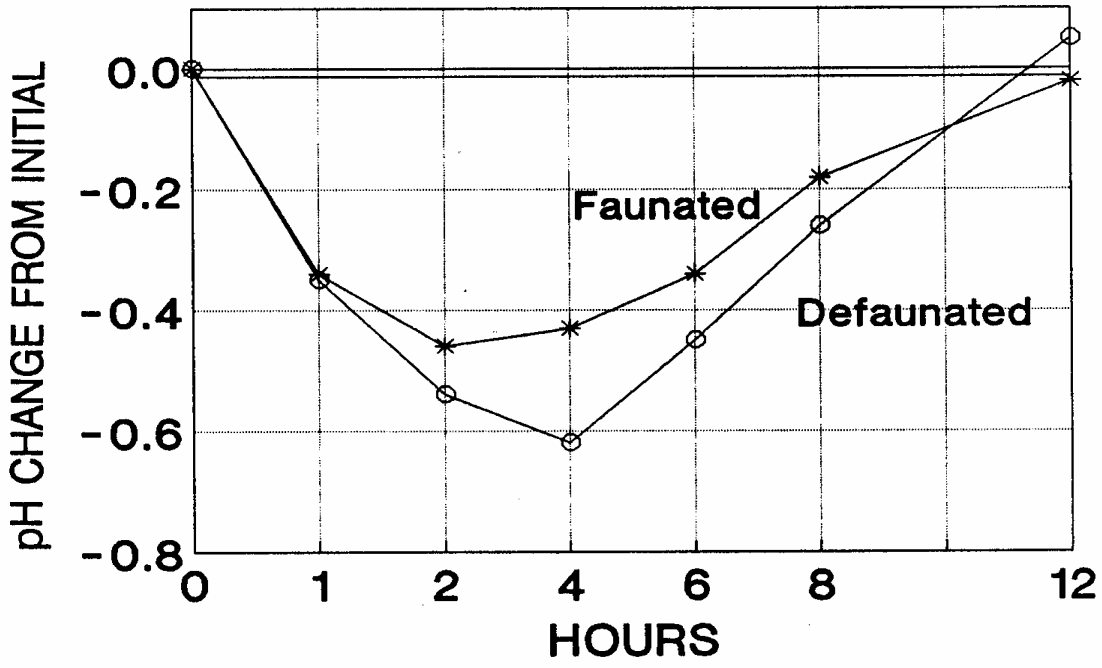

Figure 6.1. Postfeeding Ruminal pH Changes in Defaunated and Faunated Steers Fed a High-Grain Diet

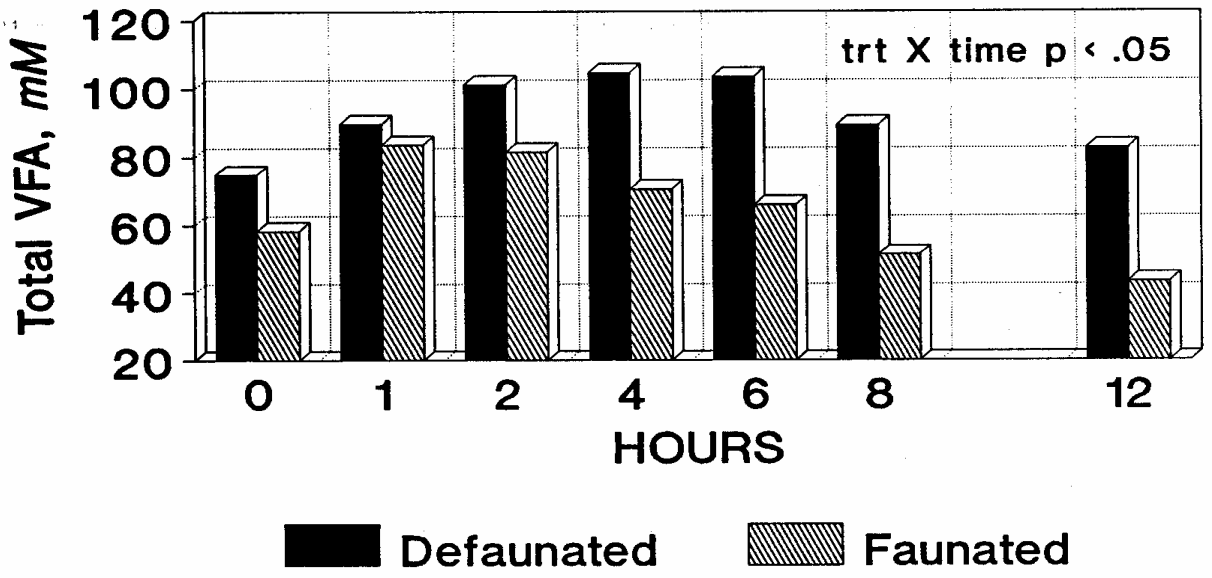

Figure 6.2. **Ruminal Volatile Fatty Acid Concentrations in Defaunated and Faunated Steers Fed a High-grain Diet**

Table 6.1. **Total, Lactic Acid-producing, and Fermenting Bacterial Numbers in Defaunated and Faunated Steers Fed a High-grain Diet**

Bacteria, per g DM	Defaunated	Faunated	P value[a]
Total bacteria, $\times 10^{10}$	13.0	2.9	.10
Streptococcus bovis, $\times 10^{7}$	36.9	23.7	.58
Lactobacillus, $\times 10^{8}$	27.7	8.4	.28
Starch-fermenting, $\times 10^{10}$	10.3	2.3	.11
Lactate-fermenting, $\times 10^{9}$	33.5	14.0	.25

[a]Probability that treatments are statistically similar.

It appears that ruminal protozoa help maintain higher ruminal pH by moderating ruminal fermentation, probably because of decreased bacterial numbers. The effect of protozoa on ruminal pH could have significant impact on overall ruminal metabolism because low pH inhibits bacterial activity.