A Summary of Recent Kansas State University Research on the Metabolism of Supplemental Niacin in the Rumen of Cattle

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Introduction

Benefits have been shown under certain conditions when niacin is added to the diets of beef cattle, dairy cattle or sheep. We attempted to find out what effects added niacin has on the rumen fermentation, and conversely, how the rumen metabolizes niacin.

Effect of Niacin on the Rumen Fermentation. We found that feeding niacin to rumen fistulated cattle increased rumen bacterial protein production and increased the percentage of rumen propionate. In a later study, we found that niacin increased microbial protein synthesis *in vitro* more when soybean meal rather than urea was the nitrogen source. Because niacin is involved intimately in energy metabolism, we had expected the opposite. Bacteria can synthesize niacin from tryptophan. Because rumen ciliate protozoa cannot synthesize niacin and must obtain it from bacteria or from feed, we thought the heating that occurs in commercial soybean meal processing might reduce the availability of either niacin or tryptophan for bacteria, thus reducing the supply of niacin to protozoa. To test that, we compared the effect of heated (conventionally processed) or unheated soybean meal, with or without niacin, on rumen protozoal numbers. Rumen protozoal numbers increased when niacin was added to diets containing heated soybean meal but not in diets containing unheated soybean meal. In a companion study we found that rumen bacterial protein synthesis was higher in cattle fed unheated than heated soybean meal (738 vs 554 mg bacterial N per gm total N). Niacin supplementation of cattle fed heated soybean meal increased bacterial N synthesis by 10.9%. Microbial protein in duodenal samples was increased in cattle fed heated soybean meal (22.2 vs 16.6 g bacterial-N per kg dry matter). Thus, niacin may be a limiting nutrient for rumen microorganisms when cattle are fed diets containing heated (conventionally processed) soybean meal.

Synthesis and Degradation of Niacin in the Rumen. Although rumen bacteria can synthesize niacin, there is little information as to how supplementary niacin affects ruminal niacin, and to what extent dietary niacin is degraded in the rumen. We studied these effects *in vitro*. Niacin synthesis was greatest when no niacin was added. Small quantities of supplemental niacin (.5 ppm) decreased niacin synthesis, and large quantities (2-8 ppm) were partially degraded. We believe there is an optimum rumen niacin concentration below which synthesis will occur and above which either no net synthesis, or degradation occurs.

Supplementing duodenal cannulated cattle with 2 gm niacin per feeding (30 ppm) resulted in higher niacin concentrations in both ruminal and duodenal digesta. Niacin flow to the small intestine and niacin absorption from the small intestine increased with niacin supplementation. Thus, while supplemental niacin may affect ruminal niacin synthesis and some may be degraded, considerable supplementary niacin reaches the duodenum and is absorbed. Furthermore, we found that blood niacin increased when the diet was supplemented with 6gm niacin per head per day, confirming the fact that supplemental niacin was absorbed.

Recommended levels of supplementary niacin for ruminant diets are 100 ppm for feedlot cattle and 200 ppm for fresh dairy cows.

FISTULAS AND CANNULAS

Rumen fistulas and duodenal cannulas are two basic tools for the rumen nutritionist. A fistula is simply an opening -- in our case, an opening in the rumen. Through that opening, samples can be taken to measure how foodstuffs are digested and how fast they pass out of the rumen. Often, the entire rumen contents are removed, measured, and replaced to find out how much feed is in the rumen at a given time. Rumen fluid can also be removed through the fistula to innoculate "artifical rumens." Duodenal cannulas are tubes installed in the small intestine, just below the outlet of the true stomach. They are useful in understanding the material that leaves the rumen. Using the duodenal cannula, the amount of material flowing into the duodenum per day can be measured. Suppose we measure the niacin concentration in duodenal contents and know how much material flows into the duodenum per day. Then we can calculate how much niacin per day leaves the rumen. That amount will probably be greater than the amount of niacin in the feed. The difference represents the niacin synthesized by rumen microorganisms. With proper care, these fistulated or cannulated animals have a normal life expectancy, and contribute greatly to our understanding of rumen nutrition.