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B.D. Lambert

C.A. Löest

Evan C. Titgemeyer

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Abstract

Methionine is often the first limiting amino acid for growing cattle. This study was conducted to determine how methionine metabolism is regulated in the liver of growing steers. Six ruminally cannulated steers were used in a replicated 3 x 3 Latin square experiment. Either 0, 5, or 10 g/day L-methionine was infused into the abomasum. These treatments were designed to be deficient, adequate, and in excess of the steers' requirements for methionine. Methionine supplementation linearly increased protein deposition and decreased the activity of methionine synthase (a methionine conserving enzyme). However, it had little effect on activity of cystathionine synthase (an enzyme that produces cysteine from methionine). Our results suggest that methionine metabolism and regulation in cattle may vary from that in monogastrics.

Keywords

Cattlemen's Day, 2002; Kansas Agricultural Experiment Station contribution; no. 02-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 890; Beef; Methionine; Amino acids; Growth

EFFECT OF METHIONINE SUPPLEMENTATION ON METHIONINE METABOLISM IN GROWING CATTLE

B. D. Lambert, E. C. Titgemeyer and C. A. Löest

Summary

Methionine is often the first limiting amino acid for growing cattle. This study was conducted to determine how methionine metabolism is regulated in the liver of growing steers. Six ruminally cannulated steers were used in a replicated 3 × 3 Latin square experiment. Either 0, 5, or 10 g/day L-methionine was infused into the abomasum. These treatments were designed to be deficient, adequate, and in excess of the steers' requirements for methionine. Methionine supplementation linearly increased protein deposition and decreased the activity of methionine synthase (a methionine conserving enzyme). However, it had little effect on activity of cystathionine synthase (an enzyme that produces cysteine from methionine). Our results suggest that methionine metabolism and regulation in cattle may vary from that in monogastrics.

(Key Words: Methionine, Amino Acids, Growth.)

Introduction

Methionine is often the first limiting amino acid for growing cattle. We have previously evaluated methionine requirements in growing cattle and assessed some factors that impact how efficiently it is utilized. In species such as pigs and chickens, cysteine can reduce the requirement for methionine by about one-half under the appropriate conditions. However, we have been unable to observe this sparing effect in growing cattle. This study was conducted to determine how methionine metabolism is regulated in the liver of growing steers, with the ultimate goal of determining why cysteine has not been shown to spare methionine in cattle.

Experimental Procedures

Six ruminally cannulated steers (452 lb initial body weight) were used in a replicated 3 × 3 Latin square experiment. Steers were maintained in individual metabolism crates to allow for full collection of feces and urine. Nitrogen retention was used as an indicator of lean protein deposition, and liver biopsies were obtained to measure liver enzyme activities at different methionine intakes. Methionine was infused into the abomasum at either 0, 5, or 10 g/day L-methionine; levels designed to be deficient, adequate, and in excess of the steers' requirements for methionine, respectively. However, the nitrogen retention data suggested that the highest level did not greatly exceed the animals' needs.

Steers were fed 5.7 lb/day (dry matter basis) of a soybean hull-based diet (83% soyhulls, 8% wheat straw) twice daily. Steers received ruminal infusions of volatile fatty acids (180 g/day acetate, 180 g/day propionate, and 45 g/day butyrate) and abomasal infusions of 300 g/day dextrose to provide supplemental energy. In order to insure that methionine was the first limiting amino acid for lean tissue deposition, a supplemental mixture containing 300 g/day of essential and nonessential amino acids was infused into the abomasum.

Results and Discussion

Nitrogen balance data are presented in Figure 1. Nitrogen retention increased linearly ($P<0.01$) with methionine supplementation, which indicated that the steers were deficient in methionine when either 0 or 5 g/day was supplemented. Based on previous trials, we expected the steers' requirement to be near 5 g/day.

Methionine supplementation decreased the activity of liver methionine synthase (a methionine-conserving enzyme) (Figure 2). At low methionine levels, this enzyme prevents the conversion of methionine to cysteine. However, either 5 or 10 g/day of supplemental methionine reduced the activity of the enzyme, which would allow for conversion of methionine to cysteine.

Activity of cystathionine synthase (an enzyme that produces cysteine from methionine) in the liver of steers is shown in Figure 3. Based on other species, we expected that cystathionine synthase activity would increase as methionine supply increased, facilitating both the production of cysteine and the removal of excess methionine. Because we may not have supplied a true excess in methionine, it is not surprising that the activity of this enzyme was not altered.

The activities of these enzymes in our steers appear to be different than those measured in monogastric animals. Methionine synthase activity was higher than in rats, whereas cystathionine synthase was lower. This suggests that cattle may be more efficient in conserving methionine than rats, which appear to metabolize methionine similar to pigs and chickens.

Our results suggest that the regulation of methionine metabolism in the liver of cattle may be different than in other species. However, we are not able to definitively answer our initial question as to why cysteine did not spare methionine in cattle.

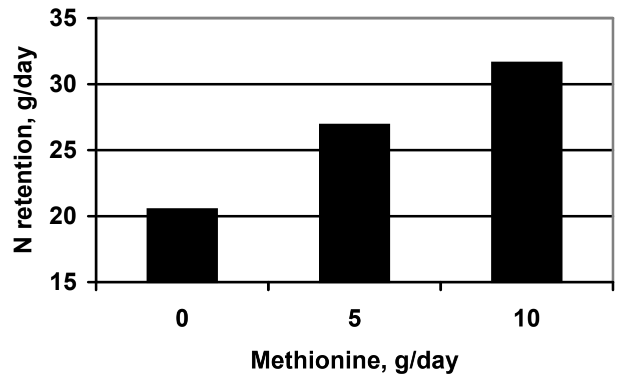

Figure 1. Effect of Methionine Supplementation on Nitrogen Retention of Growing Steers.

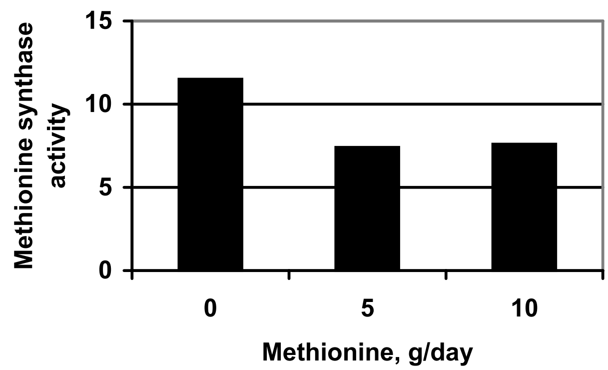

Figure 2. Effect of Methionine Supplementation on Methionine Synthase Activity in Liver of Growing Steers.

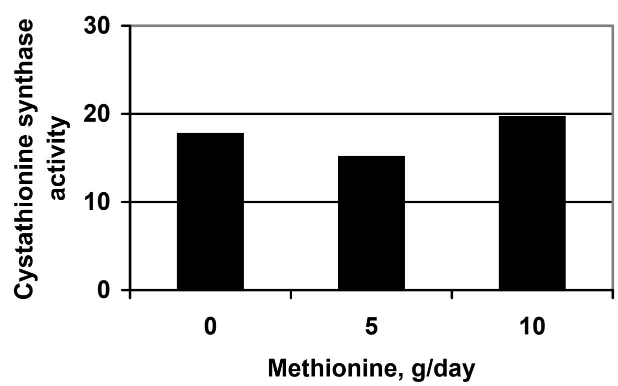

Figure 3. Effect of Methionine Supplementation on Cystathionine Synthase Activity in Liver of Growing Steers.