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Abstract

Previous research has suggested the possibility that the supply of glycine, a nonessential amino acid, might affect how efficiently cattle use methionine. This study was conducted to determine the role of glycine on methionine utilization in growing steers as well as how glycine might impact utilization of cysteine, an amino acid produced in the body from methionine. In Exp. 1, treatments were abomasal infusion of 2 or 5 g/day L-methionine and 0 or 50 g/day glycine in a factorial arrangement. Efficiency of methionine use was 27% in the absence of supplemental glycine, but 66% in its presence. Glycine supplementation by itself had little effect on protein deposition. In Exp. 2, treatments were abomasal infusions of 0 or 2.4 g/day L-cysteine and 0 or 40 g/day glycine in a factorial arrangement. Supplementation with cysteine in the absence of supplemental glycine did not change nitrogen balance. In fact, when glycine was supplemented alone, nitrogen retention decreased. However, when glycine and cysteine were supplemented together, nitrogen retention was increased. Thus, in the presence of supplemental glycine, it appears that cysteine can improve protein deposition, presumably by sparing methionine. Comparison of this and earlier studies suggests that B-vitamin status may play an important role in this response.

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; Glycine; Methionine; Growth

EFFECT OF GLYCINE SUPPLEMENTATION ON SULFUR AMINO ACID USE IN GROWING CATTLE

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Summary

Previous research has suggested the possibility that the supply of glycine, a nonessential amino acid, might affect how efficiently cattle use methionine. This study was conducted to determine the role of glycine on methionine utilization in growing steers as well as how glycine might impact utilization of cysteine, an amino acid produced in the body from methionine. In Exp. 1, treatments were abomasal infusion of 2 or 5 g/day L-methionine and 0 or 50 g/day glycine in a factorial arrangement. Efficiency of methionine use was 27% in the absence of supplemental glycine, but 66% in its presence. Glycine supplementation by itself had little effect on protein deposition. In Exp. 2, treatments were abomasal infusions of 0 or 2.4 g/day L-cysteine and 0 or 40 g/day glycine in a factorial arrangement. Supplementation with cysteine in the absence of supplemental glycine did not change nitrogen balance. In fact, when glycine was supplemented alone, nitrogen retention decreased. However, when glycine and cysteine were supplemented together, nitrogen retention was increased. Thus, in the presence of supplemental glycine, it appears that cysteine can improve protein deposition, presumably by sparing methionine. Comparison of this and earlier studies suggests that B-vitamin status may play an important role in this response.

(Key Words: Glycine, Methionine, Growth.)

Introduction

Methionine is often the first limiting amino acid for growing cattle. Previous research has suggested that the supply of glycine, a nonessential amino acid, might affect how efficiently cattle use methionine. Methionine utilization is intertwined with metabolism of methyl groups because it serves as a primary methyl group donor as well as being an amino acid that is necessary for protein deposition. Glycine has the potential to either serve as a source of methyl groups or to deplete the supply of methyl groups available in the body. This study was conducted to determine the role of glycine on methionine utilization in growing steers as well as how glycine might impact utilization of cysteine, an amino acid that is produced in the body from methionine.

Experimental Procedures

Two separate experiments were conducted. In Exp. 1, four ruminally cannulated steers (290 lb initial body weight) were allotted for use in a 4 × 4 Latin square experiment, although only three actually completed the study. Steers were maintained in individual metabolism crates to allow for complete collection of feces and urine. Nitrogen retention was used as an indicator of lean protein deposition.

Treatments were infused directly into the abomasum and were either 2 or 5 g/day L-methionine and 0 or 50 g/day glycine in a factorial arrangement. Previous research shown that for cattle maintained under similar conditions, 2 g/day methionine was deficient and that steers would increase protein deposition when given additional methionine. By providing two levels of methionine both in the absence and presence of supplemental glycine, we could determine if the steers' response to methionine was impacted by glycine supply.

Steers received continuous abomasal supplements of folic acid, vitamin B_6, and vitamin B_{12} so that deficiencies would not confound results. Steers were fed 5.1 lb/day (dry matter basis) of a soybean hull-based diet (83% soyhulls, 8% wheat straw) twice daily. They 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. To ensure that methionine was the first limiting amino acid for lean tissue deposition, a supplemental mixture containing 350 g/day of essential and nonessential amino acids was infused into the abomasum.

In Exp. 2, four ruminally cannulated steers (505 lb initial body weight) were used in a 4 × 4 Latin square design. Experimental conditions were similar to Exp. 1, except that the steers were fed 6.0 lb/day of diet and the supplemental amino acid mixture was reduced to 260 g/day. Treatments consisted of 0 or 2.4 g/day L-cysteine and 0 or 40 g/day glycine in a factorial arrangement. All steers received 2 g/day methionine in order to ensure that methionine was more limiting than cysteine, a prerequisite for response to cysteine supplementation. By evaluating responses to cysteine both in the presence and absence of supplemental glycine, we were able to determine if glycine impacted the ability of cysteine to spare methionine.

Results and Discussion

In Exp. 1, methionine supplementation increased N retention (Figure 1). When methionine was supplemented in the absence of glycine, N balance increased from 34.4 g/day to 40.9 g/day. This change would indicate an efficiency of methionine use of 27%. However, when methionine was supplemented in the presence of 50 g/day supplemental glycine, the methionine response was an increase from 33.6 to 49.5 g/day, an efficiency of methionine use of 66%. Thus, it appears that supplemental glycine led to improvements in the efficiency of methionine use. This suggests that glycine served as a source of methyl groups. Interestingly, glycine supplementation by itself had little effect on protein deposition by our steers.

In Exp. 2, supplementation with cysteine in the absence of supplemental glycine did not change nitrogen balance (Figure 2). In fact, when glycine was supplemented alone, nitrogen retention decreased ($P<0.05$). However, when glycine and cysteine were supplemented together, nitrogen retention increased (cysteine × glycine interaction; $P=0.01$). Thus, in the presence of supplemental glycine, it appears that cysteine can improve protein deposition, presumably by sparing methionine. The fact that responses to glycine supplementation alone were different between the two studies suggests that caution should be used in interpreting the data. Previously, we have observed responses to cysteine supplementation in the presence of supplemental glycine; all similar studies have been conducted with supplemental glycine. The only clear difference is that B-vitamin supplements were provided in this study but not in the previous work. Further work is needed to determine if vitamin status was responsible for the differing results. In any case, our results suggest that the nonessential amino acid, glycine, may be important in methionine metabolism.

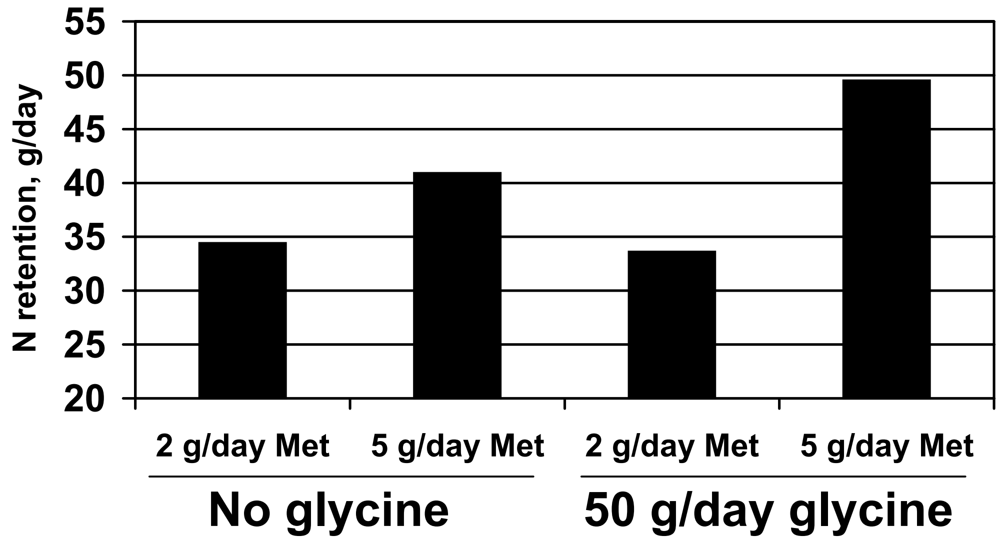

Figure 1. Effect of Methionine (Met) and Glycine Supplementation on Nitrogen Retention of Growing Steers (Exp. 1).

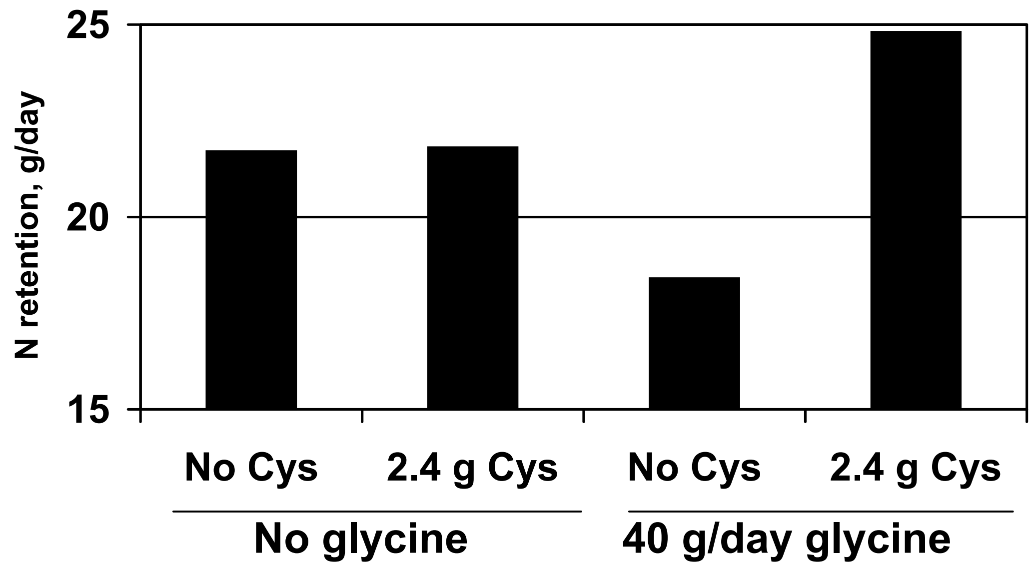

Figure 2. Effect of Cysteine and Glycine Supplementation on Nitrogen Balance of Growing Steers (Exp. 2).