Leucine Supplementation Did Not Improve Protein Deposition or Lysine Utilization in Growing Steers

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Introduction

Amino acids are used for a wide variety of biological processes, one of which is to build muscle. Though there are requirements for each amino acid, the requirement for optimal efficiency to meet the animals' genetic potential has yet to be identified. Protein can be the most expensive portion of the diet. By feeding the optimal amount of limiting amino acids, producers may be able to better feed animals to their genetic potential while saving money by not feeding excess protein. In addition, by determining the proper requirements of these amino acids, producers may be able to reduce nitrogen losses in urine and feces by increasing protein deposition by the animal. Lysine is generally one of the most limiting amino acids in cattle, making its delivery important. In addition, there is evidence that leucine is a key regulator of protein synthesis, and therefore it might increase performance by playing a regulatory role in muscle. Thus, providing leucine in amounts greater than the animal's requirement has the potential to increase growth and improve the efficiency of lysine utilization. This study was conducted to determine if leucine supplementation could improve protein deposition and lysine utilization in growing steers.

Experimental Procedures

Seven ruminally cannulated Holstein steers (initial body weight 380 ± 8.1 lb) were used in a 6 × 6 Latin square design and randomly assigned to one of 6 treatments in each of 6 periods. Each treatment period lasted one week, for a total of 6 weeks. Treatments consisted of 2 levels of lysine (0 or 0.212 oz/day) and 3 levels of leucine (0, 0.529, or 1.058 oz/day) infused abomasally; all 6 possible combinations of these two factors were tested. All steers received abomasal infusions of all essential amino acids, except lysine, to ensure that lysine was the only limiting amino acid. In addition, all steers received constant ruminal infusions of 12.35 oz/day of volatile fatty acids and abomasal infusions of 10.58 oz/day of glucose to provide additional energy to the steers.

The basal supply of leucine was designed to be adequate to meet the animals' needs for protein deposition, and supplemental infusions of leucine were used to investigate the regulatory effects of leucine on protein deposition. Leucine, in some animal models, is able to regulate protein synthesis by intracellular signaling pathways.

Steers were housed in metabolism crates in an environmentally-controlled room to allow for complete urine and fecal collection, which allowed measurement of nitrogen retention (an estimate of protein deposition). Feed (Table 1) was delivered twice daily at 6.2 lb/day, with the remaining nutrients being infused ruminally and abomasally. This was accomplished using a central pump to infuse nutrients into the rumen cannula with one infusion line placed in the abomasum and the other in the rumen. Treatments were constantly infused throughout the study. The first two days of each period were used for treatment adaptation. Diet samples were collected on days 2 through 5, and fecal and urine outputs from days 3 through 6 of each period were collected. Samples were frozen until time of analysis, and each sample was analyzed for nitrogen content. Nitrogen retention was calculated as the difference between total nitrogen input and total nitrogen output. Data were analyzed using the MIXED procedure of SAS version 9.4 (SAS Inst. Inc., Cary, NC) as a 6 × 6 Latin square design. Treatment, treatment interactions, and period were all considered fixed effects. Animal was considered to be the random effect. Significance was declared at a P-value less than 0.05.

Results and Discussion

Nitrogen retention increased when supplemental lysine was infused postruminally ($P<0.0001$, Figure 1). This response was expected because the model was designed to be limiting in lysine. No differences were observed in response to leucine infusion ($P=0.46$), and no interactions between leucine and lysine treatments were observed ($P=0.72$). These data suggest that, at the levels included in this study, leucine had no effect on lysine utilization in terms of nitrogen retention. However, in conditions in which lysine is not limiting, it is possible that leucine could yield a benefit.

Plasma concentrations of lysine increased ($P<0.0001$, Figure 2) with lysine supplementation, and leucine increased linearly ($P<0.0001$, Figure 3) with postruminal supplementation of leucine. This suggests that the model was successful in delivering these amino acids to the steers.

Implications

Supplementing growing cattle with post-ruminal leucine had no effect on nitrogen retention when lysine was limiting. However, supplemental lysine increased nitrogen retention when 0.212 oz/day was supplemented.

Table 1. Diet composition

Item	% of diet dry matter
Soy hulls	82
Wheat straw	8
Molasses	5
Premix[1]	4

[1]Premix contained on a dry matter basis 38.3% calcium phosphate, 24.3% sodium bicarbonate, 20.1% calcium carbonate, 7.9% magnesium oxide, 4.3% trace mineralized salt, 0.3% vitamin A premix (30,000 IU/g), 0.2% vitamin D premix (30,000 IU/g), 2% vitamin E premix (20,000 IU/lb), 0.2% selenium premix (600 ppm selenium), 2% sulfur, and 0.3% Bovatec-91 (Zoetis, Parsippany, NJ).

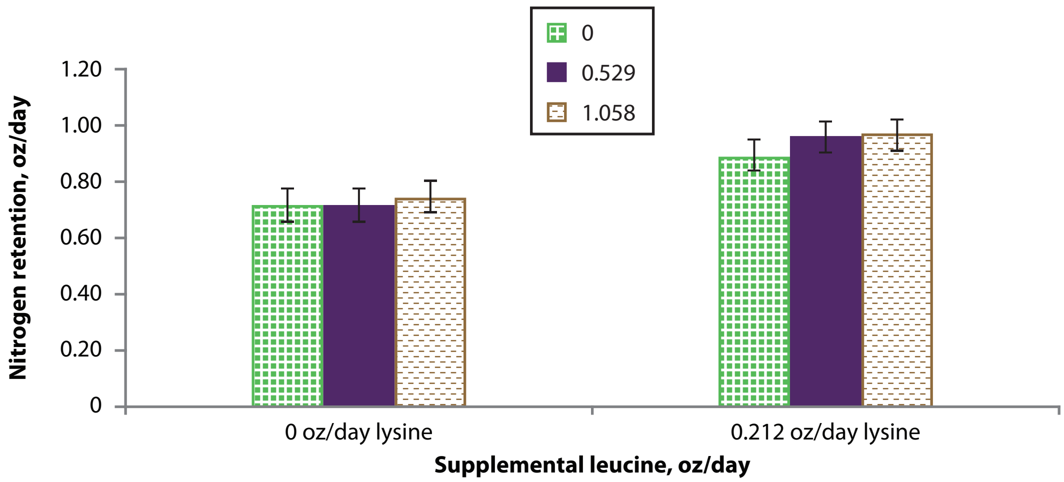

Figure 1. Nitrogen retention in response to postruminal lysine and leucine supplementation in growing steers fed a lysine-limiting diet. Nitrogen retention increased (P<0.0001) when lysine was increased from 0 to 0.212 oz/day, but no differences (P=0.46) were observed in response to supplemental leucine.

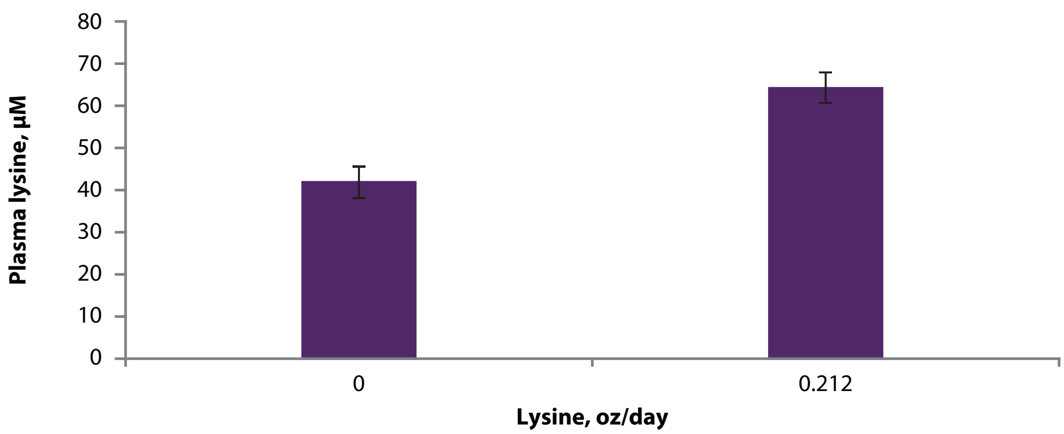

Figure 2. Plasma lysine increased when supplemental lysine was increased from 0 to 0.212 oz/day (P<0.0001).

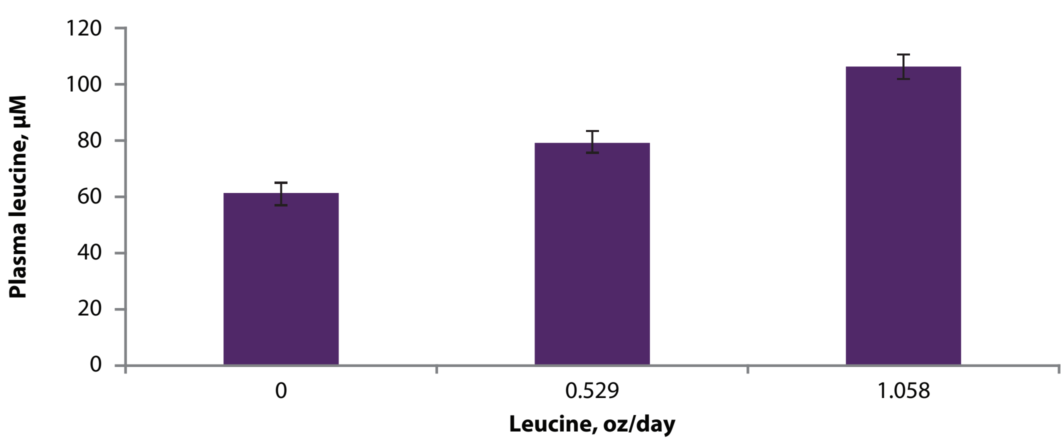

Figure 3. Plasma leucine increased linearly with leucine supplementation (P<0.0001).