RESPONSE OF HOLSTEIN STEERS FED A SOYBEAN HULL-BASED DIET TO AMINO ACID SUPPLEMENTATION WHEN THE METHIONINE REQUIREMENT WAS MET

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Summary

A study was conducted to determine the response to amino acid supplementation when the first limiting amino acid (methionine) was provided in excess. Three ruminally cannulated Holstein steer calves (281 lb) were fed 4.8 lb of a soybean hull-based diet (87% soyhulls and 8% wheat straw) daily. Methionine is the first limiting amino acid on diets of this type, and all steers were abomasally infused with 10 g/day of methionine to ensure that this requirement was met. Treatments consisted of increasing amounts (100, 250, or 400 g/day) of an amino acid mixture supplied abomasally. Calves received decreasing amounts of supplemental energy in the form of volatile fatty acids and dextrose as amino acid infusion increased in order for treatments to remain isoenergetic. Nitrogen balance increased as amino acid supply increased, indicating that amino acids other than methionine limited protein deposition. The nitrogen balance change between the 100 and 250 g/day amino acid treatments was greater than that from 250 to 400 g/d, suggesting that 250 g/day supplied amounts of amino acids near the requirement.

(Key Words: Amino Acids, Requirements, Steers.)

Introduction

Methionine is often the first limiting amino acid for growing cattle. We have previously evaluated the methionine requirement of growing steers. However, little research has been conducted to quantify the requirement of growing cattle for other amino acids. The current study was conducted to determine the optimal level of inclusion of a supplemental amino acid mixture. Our results allow some initial conclusions about the magnitude of the deficiencies of amino acids other than methionine, and will serve as a starting point for further work investigating amino acid needs of growing cattle.

Experimental Procedures

Three ruminally cannulated Holstein steer calves (281 lb initial weight) were used in a 3 × 3 Latin square design. Steers were maintained in individual metabolism crates to allow for collection of feces and urine. We used nitrogen retention as an indicator of lean protein deposition. Treatments consisted of abomasal infusion of three graded amounts (100, 250, or 400 g/day) of an amino acid mixture (Table 2). Steers were fed 4.84 lb/day (dry matter basis) of a soybean hull-based diet (Table 1) twice daily. All steers received 10 g/day L-methionine in their infusate, which meets their requirement for this first growth-limiting amino acid. Across treatments, the ratio of amino acids remained constant (except for methionine). As supplemental energy, steers received acetate, propionate, and butyrate intraruminally. Steers also received supplemental energy abomasally in the form of glucose (Table 2). Glucose and volatile fatty acids decreased as the amount of amino acids increased to maintain constant energy supply across treatments.

Results and Discussion

Urinary nitrogen increased linearly ($P=0.05$) as infused amino acids increased. The magnitude of change in urinary nitrogen was greater between the 250 and 400 g/day treatments than between 100 and 250 g/d, which indicates that amino acid requirements have been met, and excess amino acid nitrogen was being wasted in the urine. Likewise, nitrogen retention tended to increase linearly (P=0.08) as amino acid infusion increased. The observed changes in nitrogen retention correspond to increases in lean tissue deposition of 0.92 lb/day between the 100 and 250 g/day treatments and of 0.30 lb/day between the 250 and 400 g/day treatments. The increase in nitrogen retention between the 100 and 250 g/day treatments indicates that, at the 100 g/day amount, the supply of at least one of the supplemental amino acids was limiting. The smaller increase between 250 and 400 g/day treatments indicates that, even though 250 g/day did not fully meet the steers needs, it was very close.

Our results suggest that the amino acid supplement of 250 g/day was near to meeting the steers amino acid needs when the first limiting amino acid (methionine) was supplied in excess. Although this research was not conducted under normal production conditions, our results offer useful information toward the goal of balancing cattle diets on the basis of amino acids rather than crude protein.

Table 1. Diet Composition

Ingredient	% of DM
Soybean hulls, pelleted	83.3
Wheat straw	7.6
Molasses, cane	3.7
Dicalcium phosphate	2.0
Sodium bicarbonate	1.0
Calcium carbonate	1.0
Urea	0.49
Magnesium oxide	0.40
Trace mineralized salt[a]	0.29
Vitamin A, D, E[b]	0.10
Sulfur	0.10
Bovatec-68[c]	0.02

[a]Composition (%): NaCl (95 to 99), Mn (>0.24), Cu (>0.032), Zn (>0.032, I (>0.007), and Co (>0.004).
[b]Supplied per lb of DM: 4090 IU vitamin A, 682 IU vitamin D and 18 IU vitamin E.
[c]Supplied 15 mg lasalocid per lb of DM.

Table 2. Amino Acid, Volatile Fatty Acid, and Dextrose Infusates for Steer Calves

	Amino acid supply (g/day)		
Infusate	100	250	400
L-Glutamate	37	92.5	148
Glycine	12.5	31.25	50
L-Valine	5	12.5	20
L-Leucine	7.5	18.75	30
L-Isoleucine	5	12.5	20
L-Lysine-HCl (feed grade; 78.8%)[a]	10	25	40
L-Histidine-HCl-H_2O (74.0%)[b]	2.5	6.25	10
L-Arginine	5	12.5	20
L-Threonine (feed grade; 98%)[c]	5	12.5	20
L-Phenylalanine	8.75	21.875	35
L-Tryptophan (feed grade; 98%)[d]	1.75	4.375	7
L-Methionine	10	10	10
Glucose	400	350	300
Acetate	276	228	180
Propionate	248	214	180
Butyrate	53	46	40

[a]To provide 31.5, 19.7 and 7.9 g/day L-Lysine.
[b]To provide 7.4, 4.6, and 1.9 g/day L-Histidine.
[c]To provide 19.6, 12.3 and 4.9 g/day L-Threonine.
[d]To provide 6.9, 4.3 and 1.7 g/day L-Tryptophan.

Table 3. Nitrogen Balance Data for Steer Calves Receiving Graded Levels of Amino Acid Mixtures

	Amino acids (g/day)				Contrast P value[a]	
Item	100	250	400	SEM	Linear	Quadratic
n	3	3	3			
Nitrogen, g/day						
Infused	13.7	33.0	52.2	-	-	-
Dietary	45.0	45.0	45.0	-	-	-
Total Intake	58.8	78.0	97.2	-	-	-
Fecal	19.8	22.1	19.7	2.0	0.97	0.43
Urinary	13.4	16.8	34.1	3.3	0.05	0.23
Retained	25.6	39.0	43.4	3.9	0.08	0.44

[a]Probability of obtaining a difference of the observed magnitude by chance.