Lysine Requirements for Feedlot Cattle

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Feedlot diets low in ruminal escape protein may be deficient in metabolizable lysine, especially early in the feeding period. Addition of rumen-protected lysine can improve feedlot gain and efficiency.

Summary

Sixty steer calves individually fed incremental levels of rumen-protected lysine were used to determine the lysine requirement for feedlot cattle. Treatments contained either rumen-protected lysine and methionine, or methionine alone. Addition of lysine and methionine improved gains, intakes and efficiency ($P < .1$) during the first 56 days. There was no response to methionine alone ($P > .3$), suggesting that lysine was the first limiting amino acid. The predicted lysine flow for the control diet was 55.4 g/day. Steers supplemented with 3-4 g/day lysine had the greatest gains, predicting a requirement of 58.4 g/day or 5.58 percent of the metabolizable protein.

Introduction

Many large frame calves are being fed high concentrate finishing diets immediately after weaning without a growing period. These calves are commonly fed for 160 to 200 days before being slaughtered. During this time calves make rapid gains, depositing a high percentage of protein, especially early in the feeding period. Protein requirements early in the feeding period would be expected to be high.

Feeding wet corn gluten feed (WCGF) has markedly increased in the Midwest as corn syrup and ethanol production have increased. Although a good source of crude protein, most is degradable, making WCGF a poor source of escape protein. While the escape value of dry corn protein is high, high moisture corn protein is more degradable, having only two-thirds the escape value of dry corn.

Because of their lower escape protein values, we hypothesize that calves finished on WCGF and/or high moisture corn would be deficient in metabolizable protein. Furthermore, because of the low lysine content in corn protein, we predict lysine to be the first limiting amino acid. Supplementing WCGF/high moisture corn diets with rumen-protected lysine should improve finishing performance of large-framed calves.

Procedure

A calf growth trial was conducted using 60 large frame size crossbred steer calves (522 lb) with a high potential for growth. Calves were individually fed ad libitum once daily using Calan electronic gates. The diet consisted of (DM basis) 45% WCGF, 22.5% high moisture corn, 20% dry rolled corn, 5% corn silage, 5% alfalfa hay, and 2.5% supplement (Table 1). Diets were formulated to contain a minimum of 12% crude protein, 0.7% calcium, 0.35% phosphorus, 0.7% potassium and 7.5% roughage.

Supplements were combined at feeding to achieve our ten treatments, which varied in amount of supplemental rumen-protected lysine and methionine fed. Supplements were fed to supply 0, 1, 2, 3, 4, 6, 8, 10, and 12 grams per day of rumen-protected lysine hydrochloride. The protected lysine, supplied as Smartamine ML™, contained both lysine and methionine. To determine the response due to lysine, a rumen-protected methionine control was

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Table 1. Supplement composition (% dry matter basis).

Ingredient	0 g lysine, 0 g methionine[a]	12 g lysine, 3.6 g methionine[a]	0 g lysine, 3.6 g methionine
Limestone	59.52	59.52	59.52
Ground corn	23.72	12.28	21.27
Salt	12.00	12.00	12.00
Trace mineral premix	.80	.80	.80
Vitamin premix	.40	.40	.40
Monensin	.64	.64	.64
Tylosin	.44	.44	.44
Thiamin premix	.24	.24	.24
Copper oxide	.24	.24	.24
Tallow	2.00	2.00	2.00
Smartamine ML™		11.44	
Smartamine M™			2.45

[a]Supplements mixed to supply 0, 1, 2, 3, 4, 6, 8, 10, and 12 of lysine with 0, .3, .6, .9, 1.2, 1.8, 2.4, 3.0, and 3.6 g of methionine, respectively.

Table 2. Performance of finishing steer calves, days 0 - 56

Lysine level	Daily gain, lb[a]	Dry matter intake, lb/day[a]	Feed/gain
0 (control)	4.58	22.0	4.8
1	4.95	21.6	4.4
2	4.80	21.8	4.5
3	5.21	22.9	4.4
4	5.26	24.0	4.6
6	5.10	22.4	4.4
8	5.06	23.1	4.6
10	5.21	23.1	4.4
12	4.51	21.8	4.8
0 (methionine)	4.58	21.3	4.7

[a]Quadratic response to supplemental lysine, $P < .10$.

Table 3. Performance of finishing steer calves, days 0 - 161.

Lysine level	Daily gain, lb[a]	Dry matter intake, lb/day	Feed/gain
0 (control)	3.85	20.3	5.3
1	3.86	19.6	5.1
2	3.81	19.0	5.0
3	4.23	21.1	5.0
4	4.34	21.9	5.1
6	3.99	21.2	5.3
8	4.04	21.0	5.2
10	4.16	21.5	5.2
12	3.73	19.8	5.3
0 (methionine)	3.82	20.1	5.3

[a]Quadratic response to supplemental lysine, $P < .10$.

Table 4. Amino acids in abomasal contents, predicted dietary supply and predicted NRC requirements.

Amino acid	Abomasal, % of CP	Supply, g/day[a]	Predicted NRC requirement (g/day)
ARG	5.43	56.7	62.4
HIS	2.27	23.8	23.4
ILE	3.76	39.3	26.9
LEU	9.34	97.6	63.4
LYS	5.30	55.4	60.3
MET	1.54	16.1	18.6
PHE	4.37	45.7	33.4
VAL	4.88	51.0	38.1
THR	4.68	48.9	36.9

[a]Based on a calculated metabolizable protein flow of 1045 g/day.

included. Supplements also supplied 240 mg Rumensin, 80 mg Tylan and 50 mg thiamine daily.

Steers were randomly assigned to treatment, with ten steers assigned to the zero lysine control, ten steers assigned to the methionine control, and five steers assigned to each of the other eight treatments. Before the start of the trial, steers were limit fed 12 lb (dry-matter) daily of a 50% corn silage, 50% alfalfa hay diet to reduce weight differences due to fill. Steers were implanted with Revalor-S at the start of trial and on day 84 of the 161-day trial. Steers were fed the final finishing diet from day 1 of the trial by limit feeding 12 lb/day (dry-matter) of the final diet and increasing the amount offered by 1 lb (dry-matter) daily until animals were offered ad libitum amounts of feed. Feed refusals were collected and weighed every three days to keep feed fresh and bunks clean.

Animals were weighed before feeding on three consecutive days at the beginning of the trial and on days 56, 84, 112, and 161. Average daily gain, dry matter intake and feed/gain were calculated for all periods of the trial and plotted using the slope ratio technique. At the conclusion of the trial animals were slaughtered. Carcass characteristics including fat depth, quality grade, and yield grade were measured.

Metabolizable protein flow for steers on the finishing diet was predicted using the NRC model (1996 Nutrient Requirements of Beef Cattle) for ruminant protein metabolism. Amino acid composition of the metabolizable protein was determined in a separate metabolism trial. Abomasal contents were collected following slaughter of four steers fed the control finishing diet for 14 days. Contents were freeze dried and analyzed for amino acid composition. Flow of metabolizable amino acids was calculated by multiplying the abomasal amino acid composition as a percentage of the protein by the predicted metabolizable protein flow. These calculated supplies of amino acids were compared to requirements estimated using level 2 of the NRC model (1996 Nutrient Requirements of Beef Cattle).

Results

Steers responded to rumen-protected lysine during the first 56 days on feed (Table 2). However, gains, intakes, and feed conversions were equal for the control and the methionine supplemented cattle, suggesting that the response was due to lysine, not methionine. Gains, intakes and feed conversions were all improved in a quadratic manner ($P < .10$). Gains were maximized at the three and four gram supplementation level. Steers supplemented with three grams of lysine had an increased gain above the control of .63 lb per day, or an improvement of 13.7 percent. Higher levels of lysine supplementation were less effective at improving gain and feed efficiency, suggesting a true quadratic response. Non-linear analysis comparing gain to supplemental lysine intake predicted a supplemental lysine requirement of 2.9 g/day to achieve a maximum gain of 5.1 lb.

During no periods following the first 56 days did lysine supplementation improve animal performance. However, for the entire trial, lysine supplementation quadratically improved gain ($P < .10$) over the control (Table 3). Cattle supplemented with three and four grams of lysine gained 37 lb more than the controls during the first 56 days. By the end of the trial, these steers had a weight advantage of 68 lb or a ten percent improvement in gain compared to the controls. Any weight advantage obtained during the first 56 days was more than maintained throughout the feeding period. Carcass characteristics were similar ($P > .3$) for treatments.

The NRC model predicted a daily metabolizable protein flow of 1045 g for steers consuming the control diet and gaining 5.1 lb, the maximum gain determined using non-linear analysis. Based on an abomasal lysine content of 5.30% (Table 4), our predicted lysine flow for the control diet was 55.4 g. Three g of supplemental lysine would increase the lysine flow to 58.4 g which is similar to the NRC calculated requirement of 60.3 g. A lysine flow of 58.4 g would correspond to 5.58 percent of the metabolizable protein. While the predicted flow of lysine, methionine, and arginine was less than their calculated requirement (Table 4), a response to lysine would suggest lysine to be first limiting, and the animals requirement for the other amino acids to be met.

Feedlot diets containing high levels of WCGF and high moisture corn may be deficient in metabolizable lysine. Supplementing rumen escape lysine can improve performance of feedlot cattle, especially early in the feeding period. Our predicted metabolizable lysine requirement for steer calves gaining 5.1 lb/day would be 58.4 g/day or 5.58 percent of the metabolizable protein requirement.

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