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Phase-feeding metabolizable protein can reduce nitrogen excretion to the environment while maintaining equal performance. In this trial, performance was lower than projected causing metabolizable protein requirements to be overpredicted.

Summary

A finishing trial was conducted to evaluate phase-feeding of metabolizable protein in order to match requirements. Treatments were: 1) one finishing diet which matched requirements at initial weight; 2) one finishing diet which matched requirements at mid-weight; and 3) six finishing diets fed in sequential order which matched requirements throughout the feeding period. The 1996 Beef NRC was used to determine metabolizable protein requirements. No performance differences were observed. Gains and efficiencies were lower than projected, likely due to mud, causing protein requirements to be overpredicted. Phase-feeding metabolizable protein maintained equal performance and reduced nitrogen excretion compared to treatment 1.

Introduction

Typical feedlot diets often contain higher crude protein levels than predicted by the 1984 NRC. This is primarily because the factorial system (1984 NRC) does not account for the microbial nitrogen requirement. Therefore, typical feedlot diets are formulated with excessive crude protein levels in order to ensure maximum performance.

The 1996 NRC uses a metabolizable protein (MP) system which accounts for both the protein requirement for the animal as well as for the rumen microbial population. Because the metabolizable protein system more accurately predicts protein requirements, it may be efficacious to feed protein levels at or near the predicted requirement and still ensure maximum performance.

The primary reason for feeding protein levels at, but not above, the requirement is pending environmental regulations. In trials conducted at the University of Nebraska (1999 Nebraska Beef Report, pp. 60-63), yearling steers were fed finishing diets containing 13.5% crude protein, which was approximately 123% of the predicted requirement. During the 137-day feeding period from May to September, each steer excreted approximately 65 pounds of nitrogen onto the pen surface, of which about 71% volatilized into the air. In 192-day calf-finishing trials conducted from October to May, steers excreted approximately 71 lb of nitrogen onto the pen surface, of which, approximately 41% volatilized into the air.

The metabolizable protein system (1996 NRC) predicts large changes in the protein requirement throughout the feeding period due to changes in intake, body weight and composition of gain. The overall MP requirement does not change significantly; however, the composition or type of protein required does. The degradable intake protein (DIP) requirement increases due to a gradual increase in intake. The undegradable intake protein (UIP) requirement decreases due to both a larger supply of microbial protein and from a lower requirement because the composition of gain is increasingly more fat and less lean. Therefore, because the requirements are changing, a series of finishing diets fed in sequential order in order to meet, but not exceed both the DIP and UIP requirements throughout the feeding period (phase-feeding), should be beneficial. Therefore, objectives of the current trial were to evaluate phase-feeding of metabolizable protein in order to match requirements of finishing calves.

Procedure

One hundred and fifty crossbred steer calves (average initial weight = 585 lb) were used in a completely randomized design to evaluate phase-feeding of metabolizable protein. Steers were stratified by initial weight into one of 15 pens (10 steers per pen). Pens were randomly assigned to one of three treatments (five pens per treatment). Treatments consisted of: 1) one finishing diet fed throughout the feeding period which was formulated to match MP requirements at 700 lb body weight; 2) one finishing diet fed throughout the feeding period which was formulated to match MP requirements at 950 lb body weight; and 3) six finishing diets fed in sequential order to match MP requirements for every 100 lb increment in body weight change throughout the feeding period.

The 1996 NRC was used to determine the appropriate MP requirements. In order to use the 1996 NRC model to predict requirements throughout the feeding period, accurate projections of body weight, intake and gain are needed. We summarized all appropriate calf finishing trials conducted at the University of Nebraska ARDC Feedlot. Using intermediate weights, performance parameters for each 100 lb increment in body weight were calculated and shown in Table 1. These parameters were used as inputs in the NRC model to formulate the appropriate diets. Treatment 1 was formulated for 700 lb which was the initial weight of the steers when they reached the finishing diet. Treatment 2 was formulated for 950 lb body weight because it was the mid-weight of the feeding period. Because the UIP requirement decreases during the feeding period, treatment 1 should match the UIP requirement initially, but then

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overfeed UIP increasingly throughout the feeding period. Treatment 2 should be deficient in UIP up to the midpoint (950 lb), then become excessive for the remainder of the feeding period. Treatment 3 should match the UIP requirement throughout the feeding period. Our hypothesis was that treatments 1 and 3 would perform similarly, and both would perform greater than treatment 2. Treatment 3 would be the most economical because of less UIP supplementation compared to treatment 1, and improved performance compared to treatment 2.

Finishing diet compositions are shown in Table 2. In treatment 3, because dry rolled corn (60% UIP) and high moisture corn (40% UIP) have opposite DIP and UIP profiles, we altered the combination of these two ingredients in the six finishing diets in order to match the predicted requirements. Feathermeal and bloodmeal were added in order to meet UIP requirements beyond what dry rolled corn could provide in diets A, B, and C. The average dry matter percentages of dry rolled and high moisture corn in the six finishing diets of treatment 3, were about the same as those used in the finishing diets of treatments 1 and 2. All finishing diets were formulated to contain a minimum of .7% calcium, .3% phosphorus, .8% potassium, 27 g/ton Rumensin, and 10 g/ton Tylan (DM basis). Steers were brought up to full-feed in 21 days using four step-up diets containing 45, 35, 25, 15% alfalfa (DM basis).

Steers were weighed initially after being limit-fed at 2% of body weight for five days to minimize differences in gut fill. Steers were implanted with Revalor S on days 1 and 85 and fed for a total of 203 days. Final weights were calculated using hot carcass weight adjusted to a common dressing percentage (62%).

Table 1. University of Nebraska-Lincoln Feedlot performance parameters for finishing calves.

	Body weight lb	DM intake lb/d	DM intake % of body weight	Daily gain lb/d	Feed/Gain
	600	18.0	3.00	3.6	5.0
	700	19.0	2.71	3.6	5.3
	800	20.0	2.50	3.6	5.6
	900	21.0	2.33	3.6	5.8
	1000	21.5	2.15	3.6	6.0
	1100	22.0	2.00	3.6	6.1
	1200	22.5	1.88	3.6	6.3
	1300	23.0	1.77	3.6	6.4
Average	950	20.9	2.29	3.6	5.8

Table 2. Composition of finishing diets (% of diet DM).

	Treatment[a]							
	1	2	3					
			A	B	C	D	E	F
Dry rolled corn	46	46	67	67	67	29	20	14
High moisture corn	21	21	—	—	—	38	47	55
Wet corn gluten feed	20	20	20	20	20	20	20	20
Alfalfa	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Dry supplement	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Feathermeal	1.32	.12	1.04	.96	.20	—	—	—
Bloodmeal	.33	.03	.26	.24	.05	—	—	—
Crude protein	12.7	11.7	12.7	12.6	12.0	11.4	11.3	11.2

[a]Treatment 1 was balanced for initial weight, Treatment 2 was balanced for the mid-weight, and diets in Treatment 3 were fed in sequential order and balanced for every 100 lb increment in body weight.

Table 3. Performance, carcass, and nitrogen balance results.

	Treatment			
	1	2	3	P =
DM intake, lb	21.2	20.9	21.0	.69
Daily gain, lb	3.29	3.20	3.21	.21
Feed/gain	6.45	6.54	6.54	.30
Fat depth, in.	.49	.50	.48	.79
Marbling score[b]	505	506	503	.98
Yield grade	2.4	2.2	2.2	.27
Nitrogen intake, lb/head	87.2[c]	79.4[d]	80.5[d]	.0001
Nitrogen retention[f], lb/head	10.7[c]	10.5[d]	10.5[d]	.03
Nitrogen excretion[g], lb/head	76.6[c]	68.9[d]	70.0[d]	.0001

[a]Treatment 1 was balanced for initial weight, Treatment 2 was balanced for the mid-weight, and diets in Treatment 3 were fed in sequential order and balanced for every 100 lb increment in body weight.
[b]Marbling score of 500 = Small 0, 600 = Modest 0.
[cd]Means in a row not bearing a common superscript differ ($P < .05$).
[f]Nitrogen retention based on ADG, NRC equation for retained energy and retained protein.
[g]Nitrogen excretion calculated as intake minus retention.

Results

Results are shown in Table 3. No differences were observed ($P > .10$) for any performance or carcass parameters for treatments 1, 2, or 3. Based on past feeding experience with similar calves and diets, we projected these steers to consume 21 lb of feed and gain about 3.6 lb/day (Table 1). The steers in this trial consumed the amount we projected, but only gained about 3.2 lb/day. This trial was conducted during the winter and spring of 97-98. During this period, we experienced very poor feeding conditions with a lot of mud. It is our conclusion that the mud increased the steers' NEm requirement, increasing feed required per lb of gain by approximately 12%. Because gains were lower than expected, MP requirements were overpredicted. Treatment 2 provided the lowest level of supplemental UIP and should have been deficient during the first half of the feeding period, based on our projections. However, the actual UIP balance was positive during the entire feeding period for treatment 2, as well as for the treatments 1 and 3. Therefore, no performance differences would be expected.

Due to performance lower than projected, the results of this study do not properly evaluate phase-feeding of MP. Analysis with the 1996 NRC model agrees with the performance data in that the model predicts no response because all treatments were excessive in UIP and MP. However, there was a treatment difference in nitrogen excretion onto the pen surface. Treatment 1 consumed and excreted more nitrogen ($P < .05$) than treatments 2 or 3 (Table 3). As a result, treatment 1 not only had the highest ration cost, but also poses the greatest environmental concern. In this trial, treatment 2 was optimal because of lowest protein supplementation cost with equal performance. However, we would project under good feeding conditions, the performance of treatment 2 would be reduced compared to treatments 1 and 3.

This trial emphasizes the need for accurate predictions of performance in order to match MP requirements. Optimizing protein supplementation in order to minimize excretion and maintain maximum performance will become a very important issue for cattle feeding. Phase-feeding of MP throughout the feeding period may be efficacious; however, additional research is needed to validate this concept.

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