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BEEF REPORT

HIGH-MOISTURE EAR CORN AND CORN SILAGE IN BACKGROUNDING CATTLE DIETS

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Summary

One hundred ninety-two Angus x Limousin steer calves (560 lb) were used in an 85-day backgrounding trial. Dietary crude protein levels of 90, 100, 110 and 120% of the NRC factorial equation recommendation were used within ad libitum-fed corn silage diets (CS) and limit-fed chopped high-moisture ear corn (HMEC) diets. The objective was to determine if optimum dietary crude protein levels differed between these two basal diets when fed at similar levels of a net energy of gain. By design of the experiment, daily dry matter intake of HMEC diets was lower than CS diets (P<.001). ADG was similar across basal diets and feed conversion was improved (P<.001) with HMEC diets. Dietary crude protein level did not affect ADG. Quadratic decreases in the protein efficiency ratio occurred as dietary crude protein level increased (P<.01). Plasma urea N (PUN) levels were higher in calves fed HMEC diets (P<.05) and increased quadratically with increasing dietary crude protein level on day 56 (P<.05). This study suggests the NRC factorial equation estimates the gram daily crude protein requirement and can be used without modification to predict dietary crude protein needs of limit-fed feeder calves.

(Key Words: Steer Calves, Crude Protein, Limit-feeding, ADG, Feed Conversion.)

Introduction

Roughage-based backgrounding programs can provide economical gains and are an important crop marketing mechanism for farmer-feeder operations in South Dakota. High variability in the energy content of roughages yielding poor prediction of average daily gain (ADG) and, frequently, a relatively expensive unit cost of net energy of gain compared to concentrates suggest alternate feeding systems may benefit feeding operations which rely on substantial amounts of purchased feedstuffs.

An alternate backgrounding management scheme may involve the use of high-concentrate diets. Use of high-concentrate diets during the backgrounding phase would allow more accurate prediction of marketing dates. Intakes of high-concentrate diets may have to be limited to small or medium framed calves to prevent excessive subcutaneous fat deposition. Excess condition may limit subsequent pasture gains or reduce slaughter weight.

Use of limit-fed high-concentrate (LFHC) diets may create management problems. Limit-feeding may cause greater ruminal proteolysis of dietary crude protein and reductions in microbial growth that may result in reduced intestinal amino acid supplies available to support gains. Ad libitum feeding is believed to be necessary for acceptable cattle performance to occur during the winter. Ad libitum feeding allows ruminal conditions to be more stable and maximizes the heat of fermentation which aids in maintaining body temperature during the winter. Interrupted consumption of highly fermentable feed occurs with limit-feeding programs. The calf's rumen buffering capabilities may be exceeded because of this situation.

The present study had two objectives: (1) to determine if optimal dietary crude protein levels differed between ad libitum-fed corn silage diets (CS) and limit-fed chopped high-moisture ear corn diets (HMEC) and (2) to determine if calves limit-fed HMEC diets would perform similarly to contemporaries fed CS diets ad libitum during cold weather conditions.

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Materials and Methods

Steer calves arrived at the feedlot 4 wk prior to initiation of the 85-day backgrounding trial. They were vaccinated for IBR, BVD, PI_3, BRSV, Haemophilus somnus and treated for parasites (Ivermectin) at that time. The steers were fed a corn silage receiving diet until initiation of the trial. Steers were randomly allotted to 24 pens of 8 head each. Two steers were removed from the trial due to causes unrelated to experimental treatment. Shrunk weights were taken on day 85 after a 24-hour feed and water withdrawal.

Predictions for dry matter intake (DMI) and nutrient requirements were based on the estimated mean weights of steers for each of the three 28-day feeding periods. Individual steer weights were taken every 14 days to aid prediction of the mean steer weights within each period.

Ad libitum consumption of CS diets was allowed throughout the trial. Intakes of HMEC diets were limited to provide energy levels sufficient to support ADG's similar to CS diets based on the calculated net energy values of the diets (Table 1). For formulation purposes, ad libitum consumption of CS diets was estimated to be 100 g DMI/kg $wt^{.75}$.

TABLE 1. BASAL DIETS[abc]

Ingredient	CS	HMEC
Corn silage	78.76	
High-moisture ear corn		72.84
Rolled corn	7.50	7.50
Soybean meal	11.78	16.87
Limestone	.48	1.02
Dicalcium phosphate	1.10	.80
Potassium chloride		.47
Trace mineralized salt	.38	.50
NEm, Mcal/lb[d]	.75	.88
NEg, Mcal/lb[d]	.46	.58

[a] All diets provided >17,000 IU of vitamin A/head/day and 210 mg/head/day of monensin.
[b] Percentage dry matter basis.
[c] CS = corn silage, HMEC = chopped high-moisture ear corn.
[d] Calculated values.

Dietary crude protein levels of 90, 100, 110, and 120% of the gram daily crude protein requirement recommended by the NRC factorial equation were used within each basal diet (Table 2). Restricting DMI of HMEC diets resulted in a lower gram daily crude protein requirement for HMEC diets because of a lower estimation of daily metabolic fecal N loss. The NRC factorial equation estimates metabolic fecal N losses as being 3.34% of DMI. All other components of the NRC factorial equation were considered similar across basal diets. Monensin was included in all diets at levels of 210 mg/head/day.

TABLE 2. DIETARY CRUDE PROTEIN CONTENT OF CORN SILAGE AND HIGH-MOISTURE EAR CORN DIETS

Basal diet[b]	Dietary crude protein level[a]			
	CP-90	CP-100	CP-110	CP-120
		Period I (1-28 days)		
CS	9.38	10.02	10.60	11.52
HMEC	11.14	11.76	13.68	14.43
		Period II (29-56 days)		
CS	10.99	12.01	13.16	14.34
HMEC	13.50	14.31	15.97	17.47
		Period III (57-84 days)		
CS	10.95	11.98	13.01	13.98
HMEC	11.87	13.11	13.98	15.29

[a] Percentage of the gram daily crude protein requirement recommended by the NRC factorial equation.
[b] CS = corn silage, HMEC = chopped high-moisture ear corn.

Jugular blood samples were taken from the same four steers per pen before feeding on days 56 and 84 for determination of PUN concentrations.

Variables used to evaluate basal diet and dietary crude protein level effects were ADG, feed conversion, protein efficiency ratio (PER; lb of ADG/lb of crude protein intake, daily) and plasma urea nitrogen (PUN) concentration. Data were analyzed using procedures appropriate for a 2 x 4 factorial model. Dietary crude protein levels of 90, 100, 110, and 120% of the NRC factorial equation recommendation across basal diets are abbreviated CP-90, CP-100, CP-110, and CP-120, respectively. Significant crude protein level effects were tested for linear, quadratic, or cubic responses. Treatment means were separated by contrasts of CP-90 vs CP-100, CP-110 and CP-120; CP-100 vs CP-110 and CP-120; and CP-110 vs CP-120. No interactions existed between basal diet and crude protein level allowing independent discussion of each.

Results and Discussion

This study was conducted from December 12, 1987, to February 26, 1988. The average ambient temperature was 11 ^{o}F. Temperatures of less than -20 ^{o}F were recorded on nine occasions during the study.

Cumulative daily DMI were 15.52 and 13.49 lb/day for CS and HMEC diets, respectively (P<.001). These DMI corresponded to 97.9 and 84.8 g/kg $wt^{.75}$ for CS and HMEC diets, respectively (Table 3).

Gains were similar across basal diets (Table 3), indicating LFHC diets could be used as a management alternative for backgrounding cattle in South Dakota. Reduced feedlot performance would have occurred if an inability to maintain body temperature or higher incidence of digestive upset had occurred for steer calves fed HMEC diets.

Average daily gain was similar across dietary crude protein levels (Table 4), suggesting crude protein needs were satisfied by feeding 90% of the estimated crude protein requirement. Low effective ambient temperatures during the study may have increased energy requirements such that protein was not limiting growth. Canadian research has shown that cold temperatures cause increased gastrointestinal tract motility, resulting in reduced ruminal degradation of dietary crude protein and increased microbial protein production efficiency. This may have enhanced utilization of crude protein for growth.

TABLE 3. EFFECT OF BASAL DIET ON FEEDLOT PERFORMANCE

	Basal diet[a]		
	CS	HMEC	SEM
Initial wt, lb	560	560	1.70
Final wt, lb	763	758	3.77
ADG, lb	2.34	2.38	.04
Dry matter intake, lb/day[b]	15.52	13.49	.11
Feed conversion[b]	6.68	5.69	.11
PER[c]	1.23	1.27	.03
PUN (day 56), mg/dl[d]	11.61	14.20	.83
PUN (day 84), mg/dl	10.84	11.86	1.08

[a] CS = corn silage, HMEC = chopped high-moisture ear corn.
[b] Basal diet effect (P<.001).
[c] Protein efficiency ratio.
[d] Basal diet effect (P<.05).

TABLE 4. EFFECT OF DIETARY CRUDE PROTEIN LEVEL ON FEEDLOT PERFORMANCE

	Dietary crude protein level[a]				
	CP-90	CP-100	CP-110	CP-120	SEM
Initial wt, lb	562	562	558	560	2.40
Final wt, lb	761	767	752	763	5.31
ADG, lb	2.31	2.40	2.29	2.40	.07
Dry matter intake, lb/day	14.57	14.81	14.26	14.40	.13
Feed conversion	6.30	6.16	6.24	6.05	.15
PER[bce]	1.36	1.30	1.23	1.12	.04
PUN (day 56), mg/dl[cdf]	10.85	11.20	12.07	17.48	1.27
PUN (day 84), mg/dl	9.37	10.71	10.42	14.90	1.53

[a] Percentage of the gram daily crude protein requirement based on the NRC factorial equation.
[b] Protein efficiency ratio.
[c] Quadratic effect (P<.05).
[d] CP-100 differs from CP-110 and CP-120 (P<.05).
[e] CP-100 differs from CP-110 and CP-120 (P<.01).
[f] CP-110 differs from CP-120 (P<.01).

Lower DMI of HMEC diets supported ADG similar to CS diets (Table 3), resulting in better feed conversions occurring for HMEC diets (P<.001). Feed conversion was similar across dietary crude protein levels (Table 4).

Similar PER occurred across basal diets (Table 3). Higher gram daily crude protein intakes occurred with HMEC than CS diets during the feeding period (P<.001). This was the result of daily DMI of HMEC diets being a higher percentage of CS diet daily DMI than originally estimated. The NRC estimation for metabolic fecal N loss (3.34% x DMI) suggests more efficient utilization of dietary crude protein should have occurred with HMEC diets.

Steers fed HMEC diets had higher PUN levels on day 56 (Table 3; P<.05) than calves fed corn silage. Ruminal proteolysis rates with HMEC diets may have exceeded bacterial N uptake capabilities. Actual gram daily crude protein intakes were higher (P<.001) for HMEC than CS diets during period II. The average analyzed HMEC dietary crude protein percentage across the four dietary crude protein levels was 15.31%. Once daily feeding and rapid consumption of feed deliveries with HMEC diets may have contributed to elevated PUN levels.

Dietary crude protein level effects on the PER and PUN levels will be discussed simultaneously, as similar factors probably affected each variable. The PER decreased quadratically (P<.05) as dietary crude protein level increased (Table 4). Day 56 PUN concentrations increased quadratically (P<.05) in response to increasing crude protein intake. Lower PER and higher PUN occurred for steers fed CP-110 and CP-120 than CP-100 (P<.05).

Analyzed dietary crude protein percentages of the CP-100 treatment for CS and HMEC diets were 12.01 and 14.31%, respectively. As dietary crude protein percentages increased above these levels, the potential for ruminal N utilization was probably exceeded, resulting in lowered N utilization efficiency. Average daily gain did not increase when crude protein was increased beyond 90% of the estimated requirement. Plasma urea N concentrations and PER suggest crude protein requirements for steers on HMEC diets were probably met with CP-100. These data may be interpreted to indicate that, while limiting feeding may not alter daily N requirements, the mechanism of N metabolism may differ and that recycling may become relatively more important when calves are limit-fed high-concentrate diets.