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PROTEIN REQUIREMENTS OF GROWING STEERS LIMIT-FED CORN-BASED DIETS

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Summary

Seven steers (513 lb) were used in an experiment to investigate optimal levels and sources of protein in diets limit-fed to allow gain of 2.2 lb/day. Treatments were: a negative-control diet (urea; supplemented, 11.7% crude protein) and six diets containing either 13.5, 15.4, or 17.2% crude protein with either solvent-extracted (SSBM) or expeller-processed (ESBM) soybean meal, in which the soybean meal replaced corn in the control diet. Diets provided 75, 87.5, 100, or 112.5% of estimated crude protein requirement for a gain of 2.2 lb/day. The basal diet contained 83% rolled corn, 15% alfalfa, and .2% urea. Nitrogen (N) retention was increased linearly (P<.01) by SBM addition with no differences between sources. Because N retention increased to the highest level offered, the steers apparently required more protein than estimated by the 1984 National Research Council's *Nutrient Requirements of Beef Cattle*.

(Key Words: Protein Requirements, Restricted Feeding, Steers.)

Introduction

Calves can be grown efficiently on high-concentrate diets fed at restricted intakes. Benefits of restrictedly feeding high-grain diets relative to ad libitum feeding of high-roughage diets include more stable intake patterns, more predictable performance, and reductions in cost of gain. Growing programs aim to restrict energy-allowable gain without restricting other nutrients required to support that gain. Thus, compared to a low-energy diet fed at ad libitum intake, a limit-fed high-energy diet requires higher concentrations of dietary protein. However, restricted feeding alters ruminal function, which may influence optimal levels and sources of protein.

Our objectives were to 1) investigate optimum levels of dietary protein, and 2) compare solvent-extracted soybean meal (SSBM) and expeller-processed soybean meal (ESBM) as sources of supplemental protein for limit-fed steers.

Experimental Procedures

Seven Angus-cross steers (513 lb) were used in a nitrogen balance experiment to determine optimal levels of dietary protein and source of supplemental protein in a high-concentrate diet fed at restricted intakes designed to allow gain of 2 2 lb/day. The experiment was a 7 × 4 incomplete Latin square. Treatments consisted of six diets in a 3 × 2 factorial arrangement plus a negative-control diet containing only urea as supplemental crude protein. The two main factors were source of supplemental protein and level of protein in the diet. Protein sources were SSBM and ESBM (Super Soy®, Delavan Processing). These protein sources replaced corn in the basal diet (negative control) at levels of approximately 5, 10, and 15% (as-fed basis). Diets (Table 1) were formulated to provide 75, 87.5 ,100, and 112.5% of the recommendation for protein required by a 513 lb steer gaining 2.2 lb/day, according to the 1984 National Research Council's *Nutrient Requirements of Beef Cattle*.

Steers were implanted with Compudose® 200 and housed in metabolism crates. Each period contained a 9-day adaptation and a 5-day collection phase. Feed allocated to each steer was fed in equal portions twice daily (7 a.m. and 7 p.m.). Feed allocations were adjusted at

the start of each new period for projected changes in body weight.

Feed samples, urine, and feces were collected and analyzed for N in order to calculate the amount of N retained by the steers. Nitrogen retention was used as an indicator of protein accretion (lean growth) in the steers. A jugular blood sample was taken 5 hiyrs after the morning feeding on the last day of each period to measure plasma urea and amino acid concentrations.

Estimates of the undegraded intake protein (escape protein) in SSBM and ESBM were obtained by incubating samples with protease enzymes and measuring the protein resistant to degradation.

Results and Discussion

On average, steers consumed 9.9 lb of dietary dry matter per day. Nitrogen balance data are presented in Table 2. No significant interactions occurred between level and source of protein, and effects on N balance were similar for SSBM and ESBM. Urinary N excretion increased linearly (P<.01), whereas fecal N excretion remained constant with increasing levels of protein. Nitrogen retention was increased linearly (P<.01) by increasing levels of protein up to the highest level of supplementation (112.5% of the 1984 NRC recommendation). This suggests that, under the conditions of our study, the protein requirement of steers was underestimated by the 1984 NRC.

Concentrations of total amino acids (α-amino nitrogen) and urea in plasma increased as protein intake increased (Table 2). The increases in urea concentrations are reflective of the higher dietary protein concentration, whereas the increases in amino acid concentrations are reflective of increased supply of absorbable amino acids to the small intestine.

Enzymatic digestion of SBM samples in vitro estimated undegraded intake protein to be 32% of SSBM-protein and 48% of ESBM-protein. The relatively small difference in ruminal escape between the two protein sources resulted in relatively small differences between sources in the supply of protein to the intestine; this could explain the similarity in N balance responses for SSBM and ESBM. Also, when ESBM with its higher escape value was used instead of SSBM, degradable protein supply may have become marginal for ruminal microbes; this could decrease microbial protein synthesis, thereby eliminating any advantage gained by using a protein source with a higher escape value. The conclusion that total supply of protein to the intestine was not affected markedly by source of protein also is supported by the similar increases in plasma α-amino N (amino acid) concentrations between the SBM sources.

Previous studies that investigated supplemental protein for limit-fed growing cattle have yielded equivocal results. In our study, N retention of limit-fed growing steers was improved when corn-urea diets were supplemented with SBM, and N retention increased up to the highest level of protein supplementation (112.5% of estimated crude protein requirement). This suggests that requirements of limit-fed steers for dietary protein are higher than predicted by the 1984 NRC.

Table 1. Ingredient and Nutrient Composition of Diets

		SSBM[a]			ESBM[b]		
Item	Control	5%	10%	15%	5%	10%	15%
Ingredient:				% of the dry matter			
Rolled corn	82.76	78.37	73.99	69.61	77.74	72.72	67.71
Alfalfa	14.68	14.67	14.66	14.65	14.66	14.63	14.61
SSBM[a]	0	4.40	8.80	13.19	0	0	0
ESBM[b]	0	0	0	0	5.06	10.11	15.14
Urea	.22	.22	.22	.22	.22	.22	.22
Minerals and vitamins [c]	2.31	2.31	2.31	2.31	2.30	2.30	2.30
Rumensin/Tylan [d]	.03	.03	.03	.03	.03	.03	.03
Nutrient:							
Crude protein [e]	11.7	13.5	15.3	17.1	13.5	15.4	17.2

[a]SSBM = solvent-extracted soybean meal.
[b]ESBM = expeller-processed soybean meal.
[c]Contained trace-mineralized salt; vitamins A, D, and E; sulfur; limestone; and dicalcium phosphate.
[d]Provided 30 ppm monensin and 11 ppm tylosin to diets.
[e]Analyzed crude protein content.

Table 2. Nitrogen Balance and Plasma Metabolites of Steers Fed Different Levels of Solvent-Extracted (SSBM) or Expeller-Processed Soybean Meal (ESBM)

		SSBM			ESBM			
Item	Control	5%	10%	15%	5%	10%	15%	SEM
Nitrogen				grams of N/day				
Intake [ab]	85.7	98.3	110.8	124.5	98.9	112.0	125.6	.7
Feces	24.7	26.4	28.4	27.7	26.9	25.6	26.5	1.5
Urine [ab]	30.2	40.7	47.9	59.5	38.4	50.0	60.6	2.1
Retained [ab]	30.8	31.2	34.5	37.3	33.6	36.4	38.6	1.5
Plasma				mmol/liter				
α-amino nitrogen [ac]	2.10	2.16	2.29	2.28	2.46	2.27	2.33	.06
Urea nitrogen	1.69	3.29	3.17	4.41	2.64	3.15	4.11	.24

[a]Linear effect of level of solvent soybean meal (P<.05).
[b]Linear effect of level of expeller soybean meal (P<.05).
[c]A measure of total amino acids in plasma.