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Treated Meat and Bone Meal and Rumen Protected Methionine and Tryptophan for Growing Calves

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Summary

Two calf growth trials determined the effects of feeding meat and bone meal treated by the non-enzymatic browning reaction with sulfite liquor. For both trials, protein efficiencies tended to be greater for treated meat and bone meal relative to the untreated controls. Escape protein, estimated from 24-hour ammonia release, was also greater for treated meat and bone meal. Addition of rumen protected methionine to meat and bone meal resulted in a significant increase in protein efficiency. These data indicate treatment of meat and bone meal by non-enzymatic browning with sulfite liquor is a feasible means of increasing escape protein value and protein efficiency in growing calves. However, methionine still remains the first limiting amino acid.

Introduction

To optimize production in growing calves, escape protein is often supplemented to meet the animal's metabolizable protein requirement. Meat and bone meal (MBM) is a rendered animal byproduct often used as a source of escape protein. However, previous studies have shown a lower protein efficiency for MBM relative to blood meal. This has been attributed to the escape protein and/or amino acid composition of MBM being inadequate to meet the specific needs of the growing calf. Collagen, which can comprise a fraction of MBM protein, contains negligible amounts of the essential amino acids methionine and tryptophan.

Recent research has identified methionine as the first limiting amino acid in MBM. Efficiency of protein utilization was greater in steers consuming MBM plus rumen protected methionine than for MBM alone. Rumen protected methionine and lysine did not improve protein efficiency over methionine alone, suggesting MBM contained adequate lysine.

Two methods for increasing the flow of methionine to the small intestine are supplementation with a rumen protected form of methionine, or increasing the amount of methionine from MBM that escapes ruminal degradation. While non-enzymatic browning of soybean meal with sulfite liquor has been successful in increasing the escape protein value from 30% to 75%, the value of this procedure in increasing the escape protein of MBM remains undetermined.

The objectives of this research were to evaluate MBM treated by non-enzymatic browning with sulfite liquor as a protein source, and the effects of rumen protected methionine on protein efficiency in growing calves.

Procedure

Two calf growth trials were conducted using MBM and MBM treated with sulfite liquor. Trial 1 was conducted using 60 steer calves (535 lb) individually fed diets (DM basis) of 44% corn silage, 44% corncobs, and 12% supplement (Table 1). Steers were assigned randomly to treatment and level of treatment protein. Treatments consisted of: 1) urea (control); 2) MBM; 3) Treated MBM; 4) MBM plus rumen protected methionine; 5) Treated MBM plus rumen protected methionine. Protein sources were fed at 20, 30, 40, and 50% of the supplemental nitrogen, with urea supplying the remainder. Therefore,

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Table 1. Supplement composition for Trial 1 (% DM basis).

	Supplement[a]				
Ingredient	Urea	MBM	Treated MBM	MBM+Met	Treated MBM+Met
Meat and bone meal	—	39.7	—	39.7	-
Treated meat and bone meal	—	-	38.7	—	38.7
Urea	15.8	9.0	9.0	9.0	9.0
Soybean hulls	71.4	46.3	47.3	45.8	46.8
Smartamine M	—	-	—	.5	.5
Dicalcium phosphate	7.8	—	-	—	-
Salt	2.5	2.5	2.5	2.5	2.5
Ammonium sulfate	1.7	1.7	1.7	1.7	1.7
Trace mineral premix	.4	.4	.4	.4	.4
Vitamin premix	.3	.3	.3	.3	.3
Selenium premix	.1	.1	.1	.1	.1

[a]Meat and bone meal, treated meat and bone meal, meat and bone meal plus protected methionine, and treated meat and bone meal plus protected methionine, mixed with urea supplement to supply 20, 30, 40, or 50% of supplemental protein.

Table 2. Supplement composition for Trial 2 (% DM basis).

Ingredient	Supplement[a]		
	Urea	MBM	Treated MBM
Meat and bone meal	—	59.4	—
Treated meat and bone meal	—	—	59.4
Urea	15.7	5.8	5.8
Soybean hulls	71.6	28.8	28.8
Smartamine M	—	.4	.4
Promate T	—	.6	.6
Dicalcium phosphate	7.7	—	—
Salt	2.5	2.5	2.5
Ammonium sulfate	1.7	1.7	1.7
Trace mineral premix	.4	.4	.4
Vitamin premix	.3	.3	.3
Selenium premix	.1	.1	.1

[a]Meat and bone meal and treated meat and bone meal, mixed with urea supplement to supply 30, 40, 50 or 60% of supplemental protein.

regardless of the assigned level, all steers consumed a diet containing 11.5% CP (DM basis). Rumen protected methionine was included by feeding 3.5 grams/day of Smartamine M™ (Rhône-Poulenc Animal Nutrition, Atlanta, GA), which supplied 2.2 grams/day metabolizable methionine at the highest level fed and proportionally less for the other levels.

Trial 2 was conducted using 24 steer calves (606 lb) individually fed diets of 44% sorghum silage, 44% corncobs, and 12% supplement (Table 2). Steers were assigned randomly to treatment and level of treatment protein. Treatments consisted of: 1) urea (control); 2) MBM; 3) Treated MBM. Protein sources were fed at 30, 40, 50, and 60% of the supplemental nitrogen, with urea supplying the remainder. Rumen protected methionine and tryptophan were included in both MBM treatments so that protein efficiency could be evaluated without being limited by methionine or tryptophan content. 2.8 grams/day of Smartamine M™ supplied 1.8 grams/day metabolizable methionine, and 4.0 grams/day of Promate T (Showa Denko, Tokyo, Japan) supplied 1.0 grams/day metabolizable tryptophan at the highest level fed and proportionally less for the other levels.

All steers were implanted with Compudose on day 1. For each trial, steers were individually fed (at an equal percentage of body weight) once daily using Calan electronic gates. Weights were collected before feeding on three consecutive days at the beginning and end of each 84-day trial. Protein efficiency, calculated as gain above the urea control vs natural protein intake, was plotted for each treatment using the slope-ratio technique.

For each trial, material for the treated MBM was collected from the same run of rendered material as the untreated MBM to keep the composition of the products as homogeneous as possible. The MBM products differed between trials, with the treated MBM used in Trial 2 being processed more extensively for a greater escape protein value. The escape protein values of the MBM products were determined by 24-hour in vitro ammonia release. A lamb digestion trial was conducted to determine the true protein digestibility of the MBM products relative to a urea control.

Results

Trial 1

Averaged across level of protein fed, differences in daily gain and feed efficiency approached significance (P=.12 and .15, respectively; Table 3). The urea control steers gained 1.57 lb/day, while maximum gain due to protein supplementation, determined by nonlinear regression, was .78 lb/day above the urea controls (2.35 lb/day).

There was no MBM source x methionine supplement interaction so results were pooled for analysis of protein efficiency. Sulfite liquor treated MBM tended (P=.15) to be used with greater efficiency of protein utilization than untreated MBM (1.35 vs 1.19), suggesting treated MBM was higher in escape protein than untreated MBM. This is consistent with laboratory ammonia release values in which untreated MBM had an escape value of 51.9% while treated MBM had an escape value of 66.0%.

True protein digestibility of untreated MBM in lambs was 93.9%, while treated MBM was 94.8%. Overheating during processing, which has been blamed for reduced N digestibility, did not appear to be a problem for either MBM. This indicates that while non-enzymatic browning with sulfite liquor increased escape protein value of MBM, it did not affect protein digestion.

Methionine supplementation increased (P<.10) protein efficiency

Table 3. Performance of steers fed meat and bone meal[a], Trial 1.

Supplement[b]	Daily gain, lb[c]	Daily DMI, % body weight	Gain/ feed[d]
Urea	1.57	2.08	.130
MBM	1.62	2.08	.133
Treated MBM	1.59	2.08	.130
MBM+Met	1.79	2.08	.145
Treated MBM+Met	1.72	2.08	.139

[a]Averaged across protein levels.
[b]Meat and bone meal, treated meat and bone meal, meat and bone meal plus protected methionine, and treated meat and bone meal plus protected methionine.
[c]P=.12.
[d]P=.15.

Table 4. Performance of steers fed meat and bone meal[a], Trial 2.

Supplement[b]	Daily gain, lb	Daily feed, % body weight	Gain/ feed
Urea	.39[c]	1.84	.034[c]
MBM	.85[d]	1.84	.073[d]
Treated MBM	.98[d]	1.84	.084[d]

[a]Averaged across protein levels.
[b]Meat and bone meal, and treated meat and bone meal.
[c,d]Values in the same column with different superscripts differ (P<.05).

in steers consuming MBM (1.62 vs .86), indicating that methionine is the first limiting amino acid in MBM. Based on protein and amino acid composition of live weight gain, the 2.2 grams of metabolizable methionine supplied at the highest level of protein supplementation is adequate for .50 lb of gain, while the difference in gain was only .23 lb. This would suggest that once the requirement for methionine was met, another amino acid likely limited the potential for growth. Tryptophan, because of its reported low concentration in MBM, may have become limiting.

Trial 2

Steers that received the untreated and treated MBM supplements gained .85 and .98 lb/day, respectively, which were greater (P<.05) than the .39 lb/day gained by the urea control steers (Table 4). The increase in gain was due to additional metabolizable protein (MP) supplied by these MBM supplements. Feed efficiency was also greater (P<.05) for these treatments (Table 4) due to the increase in gain since daily feed intake was equal for all treatments.

Protein efficiency was numerically greater for treated MBM than untreated MBM (2.55 vs 1.58, respectively), however this difference was not statistically significant due to a large standard error. The trend, however, would suggest a greater escape protein value for treated MBM which is consistent with measured escape protein values, determined by ammonia release, of 49.5% and 71.4% for untreated MBM and treated MBM, respectively.

The greater protein efficiency and escape protein values for the treated MBM used in trial 2 relative to trial 1 would suggest the more extensive processing was beneficial. Likewise, the greater protein efficiency of the untreated MBM used in trial 2 relative to trial 1, despite its lower escape protein value, could be due to the addition of both rumen protected methionine and tryptophan.

Results of this research indicate treatment of MBM by non-enzymatic browning with sulfite liquor is a feasible means of increasing escape protein value and protein efficiency in growing calves. The added response to protected methionine suggests methionine is the first limiting amino acid in MBM. It is not possible to determine from this research if tryptophan is the second limiting amino acid.

To make the best use of treated MBM, adequate supplies of methionine or sulfur containing amino acids (SAA) should be assured. Corn protein is a good source of methionine so corn gluten meal or distillers grains would complement treated MBM. Obviously high corn diets would also have good supplies of methionine. Feather meal is a good source of SAA but much is in the form of cystine rather than methionine. Feather meal should complement treated MBM but it is not clear just how effectively cystine can replace the methionine requirement. Finally, protected methionine is an effective means of supplementing treated MBM to assure adequate methionine supplies.

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