Metabolizable Protein Estimates of Treated Soybean Meal Products

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The metabolizable protein concentrations of treated soybean meal products vary more from lot to lot than commodity soybean meal. Differences appear to be due to undegraded intake protein concentration.

Summary

The metabolizable protein (MP, % of CP) concentrations of the following three treated soybean meal (SBM) products and commodity SBM were estimated: nonenzymatically browned SBM (Soy Pass®), expeller SBM (SoyPlus®), and a heated SBM:soyhull mixture (AminoPlus®). Separate lots of each product were measured in two separate trials. Commodity SBM yielded consistent MP values, while treated SBM products differed by 11- 58% in MP. Differences in MP appear to be due to differences in undegraded intake protein (UIP) concentration. The UIP concentrations of treated SBM products merits regular monitoring.

Introduction

Previous University of Nebraska research (1999 Nebraska Beef Cattle Report, pp. 65-66) investigated the metabolizable protein concentrations (MP, % of CP) of treated soybean (SBM) products relative to commodity SBM. We concluded although all three treated SBM's tested had higher MP than commodity SBM, differences in MP existed between the products, because processing conditions designed to increase undegraded intake protein concentration (UIP) of each product may have lowered its true nitrogen digestibility (TND). Each product is sold on the basis of possessing higher UIP than commodity SBM and therefore contributing more MP to the animal. The objective of this trial was to estimate MP concentrations of three treated SBM products relative to commodity SBM using different lots of products than in 1999.

Procedure

Three treated SBM products and commodity SBM were obtained for estimation of MP: nonenzymatically browned SBM (Soy Pass®), expeller SBM (SoyPlus®), and a heated SBM:soyhull mixture (AminoPlus®). Two bags (100 lb) were chosen randomly from each lot and lots were at least one ton in size. Two separate lots of commodity SBM were obtained from different vendors to provide an estimate of between-vendor variation. Two separate lots of AminoPlus were purchased from different vendors because the pre-trial UIP estimate of the first lot was substantially lower than last year's AminoPlus.

A three-period digestion study was conducted with 29 crossbred wether lambs (75 lb mean weight). All lambs were fed a common basal diet at the same percentage of body weight (DM basis; Table 1). The basal diet was balanced to contain a minimum of 11.5% CP, .42% Ca, and .18% P. Urea was included to ensure rumen ammonia concentration did not limit digestion and to provide 40% of the basal dietary nitrogen (N).

Table 1. Composition of basal diet.

Item	Percent of diet DM
Cottonseed hulls	72.63
Dehydrated alfalfa pellets	15.00
Molasses	5.00
Dry rolled corn	5.00
Urea	1.48
Dicalcium phosphate	.34
Sodium chloride	.30
Ammonium sulfate	.17
Sheep trace mineral premix	.04
Vitamin premix	.03
Se premix	.02

Five lambs in each period were fed only the basal diet and served as a urea control. The remaining lambs consumed the basal diet at the same percentage of body weight (DM basis) as control lambs, with an additional 3.75% of the basal dietary DM added as units of CP from one of the treated SBM products. Treatment diets were isonitrogenous and each experimental treatment contributed 27% of the total N intake for treatment lambs.

Each period consisted of a 10-day diet adaptation phase, a four-day metabolism crate adaptation phase, and a seven-day of total fecal collection phase, for a total of 21 days. Lambs were housed in individual pens during the 10-day diet adaptation phase. Lambs were weighed at the end of each period. The amount of basal diet offered to each lamb was adjusted based on its most recent weight.

Feed, feces and orts were dried for 48 hours in a forced air oven at 140°F, and subsequently analyzed for DM and N. Apparent N digestibility was calculated for the urea control diet: {(N consumed - N excreted) / N consumed}. The following formula was used to calculate true nitrogen digestibility of each SBM source: $\{(A - (B * C)) / D\} * 100$, where: A = digestibility of N in total diet, B = apparent N digestibility of urea control, C = proportion of total N in diet supplied by basal diet, and D = proportion of total N in diet supplied by SBM.

The UIP concentrations of the treatments were estimated by the in-vitro ammonia release procedure. Briefly, rumen fluid was collected from a ruminally fistulated steer fed bromegrass hay (7.5% CP, DM basis) and strained through four layers of cheese cloth. A bicarbonate buffer solution was added to the rumen fluid and 30 ml of the fluid mixture were added to test tubes containing enough sample to provide 20 mg of N. Six tubes were incubated for each sample (three for 18 hours and three for 24 hours). Tubes were stoppered and incubated for the two different periods at 102°F. The ammonia concentration of fluid in each tube was used to calculate UIP relative to standards whose *in vivo* UIP concentrations have been measured. Three separate UIP values were calculated using one tube from each time point for each value.

The MP supplied by each treatment source was calculated from the UIP concentration and TND estimate, where: MP = UIP - (100 - TND). This value equals the percentage of N that escapes ruminal degradation and is digested in the small intestine.

Results

Estimates of CP, UIP, TND and MP for each sample in each year are shown in Table 2. All samples from both years were analyzed in the same ammonia release run in order to make relative comparisons of UIP. Both Soy Pass treatments ranked the highest in UIP, followed by AminoPlus, SoyPlus, and commodity SBM. Each sample was statistically different from the rest, except 1999 AminoPlus was not different from 2000 Soy Pass ($P > .05$).

Table 2. Comparison of the metabolizable protein concentrations of commodity soybean meal and three treated soybean meal products analyzed in two different years.

Treatment[a]	Year[b]	CP (% of DM)[c]	UIP (% of CP)	TND (%)	MP (% of CP)
SBM	1999	48.5	31.2^{d}	91.4^{n}	22.6
Soy Pass		52.1	80.2^{e}	89.0^{n}	69.2
SoyPlus		48.7	57.9^{f}	81.4^{o}	39.3
AminoPlus		54.6	71.4^{g}	81.0^{o}	52.4
SBM #1	2000	48.0	34.5^{h}	87.0^{p}	21.5
SBM #2		48.4	29.6^{i}	91.6^{p}	21.2
Soy Pass		52.1	71.6^{g}	82.4^{p}	54.0
SoyPlus		43.7	47.0^{k}	69.5^{q}	16.5
AminoPlus #1		51.4	55.8^{l}	84.6^{p}	40.4
AminoPlus #2		53.9	67.1^{m}	$79.6^{p,q}$	46.7

[a]SBM- commodity soybean meal.
[b]1999 data previously reported in 1999 Nebraska Beef Report, pp. 65-66.
CP and UIP from 1999 re-analyzed together with 2000 samples; some values vary from last year.
[c]CP = crude protein.
UIP = undegraded intake protein.
TND = true nitrogen digestibility.
MP = metabolizable protein, calculated as MP = UIP - (100 - TND).
[d-m]Means within column with different superscripts differ ($P < .05$).
[n,o]Means within column (1999) with different superscripts differ ($P < .05$).
[p,q]Means within column (2000) with different superscripts differ ($P < .05$).

Means for TND were separated statistically within year ($P = .05$). Both SoyPlus and AminoPlus had lower TND than commodity SBM and Soy Pass in 1999, but only SoyPlus was lower in TND in 2000 and all other treatments in 2000 were not different. The TND of Soy Pass was not lower than commodity SBM in either year. These data show SoyPlus is processed in a way that is detrimental to TND and therefore calculated MP. The data also show more variation in AminoPlus TND than commodity SBM.

No statistics are available for a year (same as trial) effect on TND of different treatments because each year had separate control animals. Statistics are also not available for MP because those values were calculated. However, several useful observations can be made about year effects on the variables tested. UIP and TND values for commodity SBM were very similar, both between years and between lots within year 2000. These data indicate commodity SBM is homogeneous both in CP concentration and protein quality (based on MP). A second concept indicated by this research is commodity SBM serves as an effective control in an MP estimation trial. A third observation is variation in the MP of treated SBM products exists (both within separate lots of product and among products) and is greater than commodity SBM.

All treated SBM's in these trials were processed using the same basic concept, known as nonenzymatic browning (heating to cause a chemical reaction between protein and carbohydrate). Soy Pass is produced by adding the carbohydrate xylose and heating it to induce browning. This treatment increases UIP while not affecting TND (in either year tested). SoyPlus was treated with heat alone; this method resulted in variable UIP and lower TND relative to commodity SBM (both 1999 and 2000). AminoPlus is produced by heating a SBM:soyhull

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mixture. Although it is not clear how this method is effective, it is obvious from the UIP concentration that the browning reaction is induced by this treatment. However, variable UIP results were achieved and the TND of the protein sometimes was affected. In 1999, AminoPlus was lower in TND than commodity SBM ($P < .05$). In 2000 one of the AminoPlus samples was numerically lower in TND than commodity SBM while the other AminoPlus sample was not lower than commodity SBM. These data demonstrate not all methods of treating SBM (to increase UIP) lower TND.

The MP concentrations of several treated SBM products were estimated. These products are marketed based on their higher UIP concentrations. However, UIP alone does not completely describe the protein value a product has in ruminant diets. Incorporation of UIP and TND in the calculation of MP is the true indicator of protein quality. We conclude that the MP concentrations of treated SBM products vary more from lot to lot than does commodity SBM. We also conclude that the UIP concentrations of all three treated SBM products tested are variable and should be monitored.

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