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# Protein Evaluation of Treated Soybean Meal Products

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# Protein Evaluation of Treated Soybean Meal Products

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Treated soybean meal products vary in undegraded intake protein concentration and true nitrogen digestibility. Therefore, the value of these products in ruminant diets also varies.

**Summary**

*Three treated soybean meal (SBM) products: 1) nonenzymatically browned SBM (Soy Pass®); 2) expeller SBM (SoyPlus®); and 3) a product of an unpublished manufacturing process (AminoPlus®), were compared using the following measurements: undegraded intake protein concentration (UIP), true nitrogen digestibility (TND) and metabolizable protein (MP) concentration. Soy Pass had the highest UIP, TND and MP values of the three treated SBM, followed by AminoPlus and then SoyPlus. The degree of heating may explain the differences in the three treated SBM products.*

**Introduction**

Although soybean meal is the most commonly used protein supplement in the United States, the amount of metabolizable protein (MP) it supplies is not optimal because it is highly degradable in the rumen. The value of soybean meal for ruminants can be greatly enhanced by nonenzymatic browning (also known as the Maillard reaction). This chemical reaction complexes the protein with carbohydrate, increases its undegraded intake protein (UIP) concentration and increases MP supplied to the animal if intestinal digestibility is not reduced. However, excessive browning polymerizes the protein and decreases true nitrogen digestibility (TND).

Several commercial sources of soybean meal treated (TSBM) to increase UIP are available and each source is processed under different conditions. The objective of this research was to compare the UIP concentration, TND and MP supplied by each of three TSBM products.

**Procedure**

In this digestion study, 15 crossbred wether lambs (70 lb) were utilized. All lambs were fed a common basal diet at 2.5 percent of body weight (DM basis; Table 1). The basal diet was formulated to contain a minimum of 10 percent CP, .42 percent Ca and .18 percent P. Urea was included to ensure rumen ammonia did not limit digestion and to provide 40 percent of the basal dietary nitrogen (N).

Three TSBM products were obtained for protein evaluation: 1) nonenzymatically browned TSBM (Soy Pass®); 2) TSBM (SoyPlus®); and 3) a TSBM product of an unpublished manufacturing process (AminoPlus®). Commodity soybean meal was also evaluated. Three lambs in each period were fed only the basal diet and served as a urea control. The remaining 12 lambs consumed the basal diet at the same percentage of body weight (DM basis) as control lambs, with an additional 3.75 percent of the basal diet DM added as units of N from one of the TSBM. Treatment diets were

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**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 |
| Selenium premix | .02 |

Table 2. **Crude protein concentration (CP), undegraded intake protein concentration (UIP), true nitrogen digestibility (TND) and calculated metabolizable protein concentration (MP) of commodity soybean meal and three treated soybean meal products.**

| Treatments | CP (% of DM) | UIP (% of CP)[a] | TND (%) | MP (% of CP)[b] |
|---|---|---|---|---|
| Commodity soybean meal | 48.2 | 31.2 | 91.4[f] | 22.6 |
| Soy Pass[c] | 52.9 | 80.2 | 89.0[f] | 69.2 |
| SoyPlus[d] | 51.1 | 50.9 | 81.4[g] | 32.3 |
| AminoPlus[e] | 54.9 | 71.4 | 81.0[g] | 52.4 |

[a]Measured by the ammonia release procedure.
[b]MP = UIP - (100 - TND).
[c]Nonenzymatically browned soybean meal.
[d]Expeller soybean meal.
[e]Treated soybean meal whose treatment conditions are unpublished.
[f,g]Values within column with different superscripts differ (*P* < .05).

isonitrogenous and each experimental treatment contributed 27 percent of the total N intake for treatment lambs.

The trial consisted of three 21-day periods. Each period included 10 days of diet adaptation, four days of crate adaptation and seven days of total fecal collection. Lambs were housed in individual pens during the 10-day diet adaptation phase. Lambs were reassigned randomly to another treatment at the end of each period. The amount of basal diet offered to each lamb was adjusted based on a weight taken at the beginning of each period.

Feed, feces and orts were dried for 48 hours in a forced air oven at 140° F, and analyzed for DM and nitrogen (N). Apparent N digestibility was calculated for the urea control diet: (N consumed - N excreted) / N consumed. The following formula was used to calculated TND of each TSBM source: (A - (B * C)) / D * 100, where: A = apparent 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 treatment.

The UIP concentration of the treatment sources was estimated by the in-vitro ammonia release procedure. Rumen fluid was collected from a ruminally fistulated steer 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. Tubes were stoppered and incubated for two amounts of time (three for 18 hours and three for 24 hours) at 39° C. The ammonia concentration of each tube's fluid was used to calculate UIP relative to standards whose *in vivo* UIP concentrations have been measured.

The MP supplied by the each treatment source was calculated from the UIP concentration and TND estimates, 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 are shown in Table 1. All TSBM sources were higher in UIP and MP than commodity soybean meal. Soy Pass was not different from commodity soybean meal in terms of TND and had a higher (P < .05) TND estimate than both AminoPlus and SoyPlus. Soy Pass had the highest UIP, TND and MP values of the three treated SBM, followed by AminoPlus and then SoyPlus.

Each TSBM source is processed with some degree of heating, which induces the nonenzymatic browning reaction. This reaction can occur to two distinct degrees: 1) complexing of proteins and reducing sugars by chemical condensation and 2) the polymerization of these condensation products. A protein-sugar complex from condensation resists degradation by rumen microbes because the protein is less soluble and is inaccessible to protein degrading enzymes. However, this complex is highly digestible in the small intestine because acid in the abomasum breaks it up. On the other hand, products of polymerization are largely indigestible in the entire gastrointestinal tract because acid does not affect them. Care should be taken to avoid polymerization when nonenzymatic browning is induced.

Soy Pass is produced when sulfite liquor is added to soybean meal and heated. Sulfite liquor is a by-product of the wood pulping industry and contains the reducing sugar xylose. Addition of reducing sugar results in more condensation products and increases the UIP concentration of soybean meal. The level of heat is controlled precisely to optimize browning while minimizing polymerization. The TND estimates of this trial indicate the condensation products in Soy Pass are as digestible as commodity soybean meal. The result: more of the protein in Soy Pass is available to the animal in the form of MP.

SoyPlus is produced by the expeller process of manufacturing soybean meal. This is an older method in which high levels of pressure (which produces heat) are used to extract oil from soybeans. Although SoyPlus is higher in UIP and MP than commodity soybean meal, it does not approach the levels of either Soy Pass or AminoPlus. The UIP concentration of SoyPlus is lower than Soy Pass because no reducing sugars are added to increase condensation products. The fact that SoyPlus had a lower (*P* < .05) TND estimate than commodity soybean meal suggests some degree of polymerization has occurred and reduced the animal availability of protein that escapes ruminal degradation.

Although the exact processing conditions of AminoPlus are unpublished, it has similar physical characteristics (color and smell) to the other TSBM products. It has a higher UIP concentration than either commodity SBM or SoyPlus. However, its TND estimate was lower (P < .05) than commodity soybean meal. This indicates it may be overheated and lower in MP.

This trial demonstrates the animal availability of three different TSBM products. Because of the identified processing differences, not all TSBM products are equal in terms of the MP they supply.

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