Ruminal Degradability and Intestinal Digestibility of Protein and Amino Acids in Treated Soybean Meal Products

A recent study at McGill University, Quebec, Canada (Castro, et al, JDS 90:810) evaluated the impact of various soybean meal (SBM) processing methods on ruminal protein degradability and intestinal digestibility of ruminally bypassed protein and amino acids. Soybean products compared were SBM, expeller SBM (EP), lignosulfonate-treated SBM (LS) and AminoPlus (AP).
Nutrient composition of the soybean products as determined in their laboratory is listed in Table 1.

Table 1. Nutrient composition of Soybean Products

	SBM	EP	LS	AP
CP, % of DM	51.8	47.8	49.2	51.1
NPN, % of CP	20.2	16.5	17.1	17.8
Sol CP, % of CP	29.0	18.6	13.9	15.6
NDF, % of DM	11.5	29.5	33.0	31.0
ADF, % of DM	6.3	13.8	12.3	10.1
NDIP, % of CP	4.0	29.5	38.6	29.3
ADIP, % of CP	1.8	8.2	7.6	3.6
Lysine, % of DM	2.99	2.58	2.67	2.89
Methionine, % of DM	0.69	0.58	0.66	0.66

Reported nutrient values for SBM are reasonably consistent with the CNCPS data base. The NPN, Sol CP, and fiber fractions reported in this study are generally higher than previously observed values for the treated soybean products, particularly for EP and AP. The amino acid values for the treated soybean products are lower than other published data or values obtained through internal analysis however the degree of deviation appears similar across all products.

Two measures of degradability were conducted to estimate protein degradation within the rumen using lactating dairy cows equipped with rumen and duodenal cannulas. The first estimate utilized multiple incubation times and corrected samples for particle loss and lag phase. Based on this estimate, rumen degradability of SBM protein was greater (58.3%) than EP, LS, and AP, which were all similar in degradability at 32.2, 38.4, and 35.4%, respectively. A second estimate of ruminal protein degradation utilized the same lactating cows and was based on a single 16 hr *in situ* incubation time with 4 replicates of each soybean product placed in the rumens of the 4 test cows (Table 2). The protein degradability SBM was again greater than the treated products. Comparing the treated soybean products EP was more degradability than LS and AP, with AP being less degradable than LS. The 30% degradability or 70% bypass corresponds with ongoing AminoPlus Quality Control results of 72% also estimated based on 16 hr *in situ* rumen incubation. Lysine degradation was greater than total protein degradation for SBM indicating a reduction of lysine as a percent of protein in the RUP fraction however lysine degradation was similar or slightly less than total protein degradation for the treated SBM products so lysine concentration in the RUP fraction would be similar to that analyzed in the original sample. Methionine degradation was less than total protein degradation for all SBM products indicating this amino acid may be slightly concentrated in the RUP fraction compared to the original product.

Table 2. Protein Degradation, 16 hr *In Situ*

	SBM	EP	LS	AP
CP, %[bcd]	70.2	37.8	34.9	30.0
Lysine, %[b]	77.3	36.2	30.9	30.3
Methionine, %[b]	68.7	32.2	28.7	28.1

[b] SBM vs. EP, LS,AP; P<0.001
[c] EP vs. LS, AP; P<0.001; [d]LS vs. AP; P<0.001

The importance of bypass protein is widely recognized however to be of value to the animal this protein fraction must be digestible in the intestine. Measurement of intestinal digestibility in the animal is a time consuming, laborious task requiring surgically modified animals using a procedure known as the Mobile Dacron Bag Technique (MBT). This procedure requires the introduction of small Dacron

bags containing the test material into the intestine through a cannula which is located at the entrance to the small intestine and then collected from a second cannula located at the end of the small intestine or more frequently collected from the feces.

Digestibility is estimated by difference between the nutrient content of the bags placed into the small intestine and the bags collected from the lower tract. It has been suggested that results obtained from bags collected from the feces could be influenced by contamination with bacteria and fermentations of the large intestine however this concern has been determined to be insignificant when evaluating high protein ingredients such a soybean products. Due to the labor and specific animal requirements for the MBT, a procedure which could be conducted in a laboratory would have obvious advantages. One such procedure is the Minnesota 3-Step which uses pH modification and enzyme addition to simulate the conductions of the post-ruminal digestive tract. Castro, et al. compared these two procedures to determine digestibility of the soybean products on the residual material (RUP fraction) following a 16 hr *in situ* incubation (Table 3). Statistical analysis indicated no agreement between the two procedures for prediction of intestinal digestibility. A comparison of the procedures indicated greater magnitude of difference for the treated soybean products (25%) than for SBM (less than 10%). Based on a comparison of this data with previously published data the authors suggested the 3- Step procedure was not a reasonable replacement for the MBT. Intestinal digestibility for all soybean products, based of the MBT measurements, was high with the observed numeric differences of little practical significance.

Table 3. Intestinal Disappearance of Soybean Products[A]

	SBM	EP	LS	AP
MBT[B]				
CP, %	98.5	98.4	99.1	98.9
Lysine, %	98.5	98.7	99.3	99.0
Methionine, %	100.0	100.0	100.0	100.0
3-Step[C]				
CP, %	87.5	76.7	74.3	79.4
Lysine, %	97.8	84.4	82.2	87.8
Methionine, %	85.7	76.6	71.2	76.5

[A] 16 hr in situ residues [B] mobile dacron bag
[C] Minnesota 3-Step

When balancing rations for lactating dairy cows, RUP and digestibility values are important but the bottom line is the quantity of nutrient supplied. From the nutrient profile, the 16 hr *in situ* degradability and MBT data a comparison of the quantity of intestinally available protein and amino acid per quantity of product fed can be calculated. The amount of intestinally available protein was greater for all treated soybean products (Table 4) compared to SBM. AminoPlus had the greatest quantity of intestinally available protein at 353.8 grams per kilogram fed which is 21 and 11% greater than EP and LS, respectively. A comparison for lysine and methionine (Table 5) shows a similar pattern with all treated soybean products providing increased quantities of intestinally available amino acids. Based on these calculations AminoPlus provides 23% and 9% more lysine and 23% and 2% more methionine than EP and LS, respectively.

Table 4. Intestinally Available Crude Protein

Nutrient, g/kg fed	SBM	EP	LS	AP
Crude Protein	518.0	478.0	492.0	511.0
RUP Protein	154.4	297.3	320.3	357.8
Int. Dig Protein	152.1	292.3	317.4	353.8

Table 5. Available Lysine and Methionine

Nutrient, g/kg fed	SBM	EP	LS	AP
Lysine	29.9	25.8	26.7	28.9
RUP Lysine	6.8	16.5	18.4	20.1
Int. Dig. Lys	6.7	16.2	18.3	19.9
Methionine	6.9	5.8	6.6	6.6
RUP Met	2.2	3.9	4.7	4.8
Int. Dig. Met	2.2	3.9	4.7	4.8

The predicted RUP and intestinal digestibility values for AminoPlus reported by Castro et al. are similar to the previous Quality Control data obtained for AminoPlus and support the high value of AminoPlus for lactating dairy cattle. Based of this data AminoPlus supplies more bypass and intestinally available protein, lysine and methionine than the competitive products evaluated.