

# Conference on Gastrointestinal Function

Chicago, Illinois, April 11-13, 2005

## Effects of Various Methods Used to Process Soybean Meal on Protein Digestion in the Rumen and Small Intestine

M. D. Stern\*<sup>1</sup>, M. Ruiz Moreno<sup>1</sup> and C. A. Macgregor<sup>2</sup>

<sup>1</sup>University of Minnesota, St. Paul and <sup>2</sup>Grain States Soya, West Point, NE

**Abstract  
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### INTRODUCTION

Ruminal degradation of protein (RDP) from dietary feed ingredients is one of the most important factors influencing intestinal amino acid supply to ruminants. Proteolysis determines the availability of ammonia nitrogen, amino acids, peptides, and branched-chain volatile fatty acids, which influence microbial growth rates in the rumen. Rate and extent of ruminal proteolysis not only affect microbial protein synthesis in the rumen but also the quantity and quality of ruminally undegraded dietary protein (RUP) that reaches the duodenum. As animal production increases, additional protein must be provided from RUP to meet the animal's protein requirement. The use of high RUP in diets fed to ruminants with high protein requirements can improve the amino acid supply to the animal provided that enough degradable protein is included in the diet to maximize microbial protein.

Solvent-extracted soybean meal (SBM), a protein supplement commonly fed to ruminants, has a high quality amino acid profile. However, SBM is extensively degraded in the rumen, providing an excellent source of RDP for the ruminal microbes, but not enough RUP to meet the demands of high producing ruminants. Because SBM is a high quality protein that is highly digestible in the small intestine, various processing methods have been used to increase its RUP value. Processes for protecting SBM protein have incorporated heat used in physical processing such as use of expellers, extruders and expanders, or heat in conjunction with lignosulfonate/xylose resulting in nonenzymatically browned SBM. Animal responses to heat-processed SBM have been inconsistent and may be due to underprotection or in some cases to overprotection, which may render protein less digestible in the small intestine.

### OBJECTIVE

The main objective of this study was to estimate ruminally undegraded protein, intestinal crude protein digestion and intestinally absorbable dietary protein of soybean meal processed using various methods.



## MATERIALS AND METHODS

- Seven SBM products including solvent-extracted SBM (SE), mechanical-extracted (ME) SBM #1 with fresh soy gums (ME1G), ME SBM #2 (ME2), ME SBM #3 (ME3), ME SBM extruded (MEE), SE heat treated (SEH), SE nonenzymatically browned (SENB) were evaluated.
- Each of the seven processed SBM products were evaluated for RUP using the in situ Dacron Polyester bag technique at ruminal incubation times of 0, 2, 8, 16, 24 and 48 h. Ruminally undegraded protein was estimated using the equation of Mathers and Miller (1981).
- A three-step procedure (Calsamiglia and Stern, 1995) was used to evaluate the effects of soybean meal processing on intestinal CP digestion. Residue from 16 h in situ ruminal incubation simulated RUP, and was incubated for 1 h in a 0.1 N HCl solution with 1 g/L of pepsin, simulating abomasal CP digestion. After incubation, pH was neutralized and a pH 7.8 phosphate buffer with 3 g/L of pancreatin added, then incubated for 24 h at 38.6°C, simulating intestinal digestion.

## RESULTS

**Table 1.** Ruminally undegraded protein (RUP), intestinal CP digestion (ID) and intestinally absorbable dietary protein (IADP) of various processed soybean meal (SBM) products.

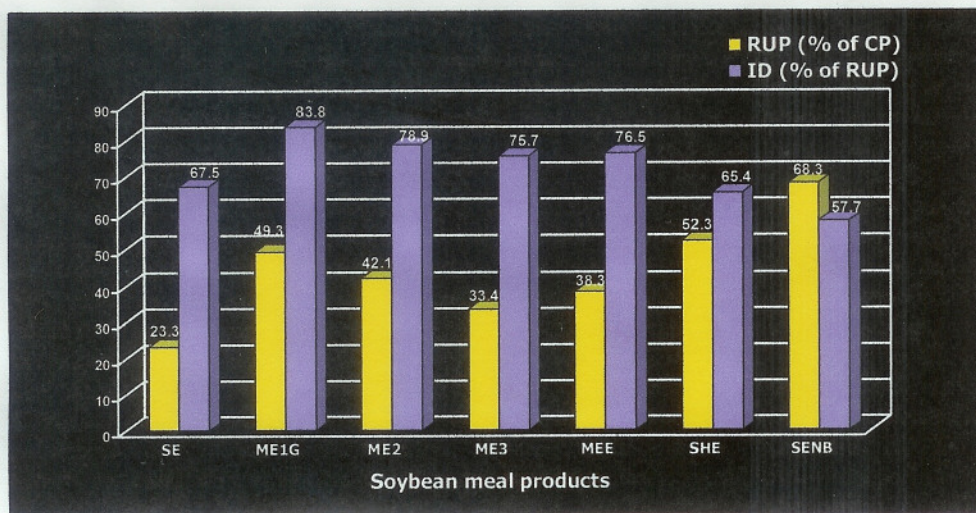
Soybean meal products	Protein measurement		
	RUP <sup>a</sup>	ID <sup>b</sup>	IADP <sup>c</sup>
Solvent-extracted SBM (SE)	23.3	67.5	15.7
Mechanical-extracted (ME)			
SBM #1 with fresh soygums (ME1G)	49.3	83.8	41.3
Mechanical-extracted SBM #2 (ME2)	42.1	78.9	33.2
Mechanical-extracted SBM #3 (ME3)	33.4	75.7	25.2
Mechanical-extracted SBM extruded (MEE)	38.3	76.5	29.3
Solvent-extracted heat treated (SEH)	52.3	65.4	34.2
Solvent-extracted nonenzymatically browned (SENB)	68.3	57.7	39.4

<sup>a</sup> % of CP.

<sup>b</sup> % of RUP.

<sup>c</sup> RUP x ID.





**Figure 1.** Ruminally undegraded protein (RUP) and intestinal protein digestion (ID) of various soybean meal products.



**Figure 2.** Intestinally absorbable dietary protein (RUP x ID) of various soybean meal products.



## SUMMARY

- Ruminally undegraded protein ranged from 23.2 to 68.3 % with solvent-extracted SBM being most degradable and solvent-extracted nonenzymatically browned SBM being most resistant to microbial degradation in the rumen.
- Intestinal protein digestion (% of RUP) ranged from 57.7% for solvent-extracted nonenzymatically browned SBM to 83.8% for the mechanical-extracted SBM #1 with fresh soy gums.
- Intestinally absorbable dietary protein, calculated as  $RUP \times ID$ , ranged from 15.5% for solvent-extracted SBM meal to 41.3% for the mechanical-extracted SBM #1 with fresh soygums. It is interesting to note that solvent-extracted nonenzymatically browned SBM was next highest at 39.4% because of a high RUP value that compensated for lower intestinal protein digestion.

## CONCLUSION

Results from this study demonstrated that it is important to account for both RUP and intestinal protein digestion when selecting a soybean meal source to include in the ruminant diet.

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Note: Soy Best with gums is treatment ME1G in this trial.

RUP values in this trial were calculated from the natural log of nitrogen disappearance over 24 hours. These values are not comparable to the more usual procedure involving a 16-hour incubation in the rumen.