NUTRITION—DAIRY

The Feeding Value of Heated Soybean Meal for Lactating Dairy Cows

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Story in Brief

Twenty-four lactating dairy cows were utilized in a feeding trial to evaluate the effects which the amount of heat-treatment of soybean meal (SBM) during processing had on animal performance. Three rations were formulated containing either regular SBM, extra-heat SMB or extra-heat SBM plus urea. Response criteria were feed intake, yield and composition of milk, weight change and concentration of rumen ammonia.

SBM protein accounted for approximately 41 percent of total protein intake by cows fed the regular SBM and 45 percent of the protein in the ration containing extra-heat SBM. Milk yield and composition were similar for cows fed the different rations.

Introduction

The feeding value of soybean meal subjected to different amounts of heating has been investigated in recent years. Previous work at OSU and other universities has demonstrated an increase in milk production during the first 15 weeks of lactation when extensively heated SBM replaced regular SBM. This response was presumed to result from an increase in amino acids at the site of absorption due to greater ruminal by-pass of feed protein. More extensive heating of SBM during processing lowered the solubility of protein and reduced microbial degradation of it in an *in vitro* system. An increase in proportion of the protein digested by enzymes in a second phase of the test nearly offset the decrease in microbial digestion. Assuming the same effect in the digestive system of a cow, the effect of more extensive heating of SBM would be to shift the site of digestion of a portion of the protein to avoid the loss of nitrogen which commonly occurs when a high proportion of feed protein is degraded in the rumen.

The objective of this study was to compare the feeding value of regular SBM with meal heated more extensively during processing with or without the addition of urea.

Materials and Methods

Feeding Trial

Regular SBM, designated PDI-40, and more extensively heated SBM, designated PDI-10, were compared in a feeding trial using lactating dairy cows. The PDI value is a measure of protein solubility used in the feed trade. Three rations containing either regular SBM (PDI-40), extra-heat SBM (PDI-10), or extra-heat SBM with .5 percent urea were compared. The rations were formulated so that energy content, expressed as the net energy for lactation (NE$_l$), was kept constant. The complete rations were calculated to provide 85 percent of the protein specified by the National Research Council (NRC) feeding standard, with the grain mix containing 18 percent protein on a

dry matter basis (Table 1). All three rations consisted of 60 percent grain mix, 28 percent sorghum silage and 12 percent sudangrass hay on a dry basis.

Prior to initiating the study, 24 cows (20 Holsteins, 4 Ayrshires) were adjusted to rations with 60:40 concentrate-to-forage ratio. The cows ranged from 8 to 9 weeks postpartum when started on trial. A switchback design with 4-week periods allowed each cow to be fed the rations in a planned sequence. Only the data collected during the last 3 weeks of each period were used in comparing treatments to minimize carryover effects between periods. Initial feed allowances were based on size of cow, age, and production during the preliminary period; these were reduced by 5 percent at the end of each period. Cows were fed in individual stalls twice daily, and feed weighbacks were recorded daily. Cows were weighed on 3 consecutive days at the end of the preliminary period and at the end of each experimental period.

Representative samples of all feeds used in the trial were analyzed for dry matter and protein. Individual cow milk yields were recorded twice daily, and samples were collected at four consecutive milkings each week for analysis of total solids, milk fat, and protein. Samples of rumen fluid were obtained by stomach tube 2 hours after feeding during the last week of each period to determine the concentration of ammonia.

Results and Discussion

Intake of dry matter by cows was similar in all SBM treatment groups as expected since feed allowances were controlled (Table 2). SBM protein represented approximately 41 percent of the total protein intake of cows fed the regular SBM (PDI-40) and 45 percent of the total protein intake of cows fed the more extensively heated SBM

Table 1. Composition of concentrate mixtures

Item	SBM treatment		
	PDI-40	PDI-10	PDI-10 + urea
	(%, as fed)		
Ingredients			
Corn, ground	79.0	79.0	78.5
Soybean meal	18.5	18.5	18.5
Urea	—	—	.5
Dicalcium phosphate	1.0	1.0	1.0
Limestone	1.0	1.0	1.0
Salt	.5	.5	.5
Calculated protein content	16.4	16.4	17.8

Table 2. Feed intake and milk yield of cows

Item	SBM treatment		
	PDI-40	PDI-10	PDI-10 + urea
Feed intake			
Total DM, lb/day	37.6	37.8	37.5
Total protein, lb/day	5.42	5.35	5.67
SBM protein, % of total	41	45	42
Milk yield			
Milk, lb/day	52.0	51.7	51.6
Fat, %	3.84	3.80	3.85
Protein, %	3.12	3.11	3.09
Milk/feed DM	1.38	1.37	1.37
Rumen ammonia, mg/dl	8.8	8.9	11.8
Weight change, lb/day	-.03	.63	-.01

(PDI-10). SBM protein in the PDI-10-plus-urea ration accounted for approximately 42 percent of the total protein equivalent. In all groups, SBM protein comprised a high enough percentage of the total protein to have an effect on production responses.

It was planned that protein intake by the cows would meet approximately 85 percent of NRC requirements; however, milk yields were lower than anticipated, resulting in higher protein intake than planned, relative to requirements. Protein intake averaged 92 percent of the requirement during the first period of the experiment but was higher, i.e., 98 and 110 percent, during the second and third experimental periods. Decreasing the feed allowances by 5 percent at the start of the second and third 4-week periods was not sufficient to keep protein intake at the desired level because persistency of milk production was less than predicted. Over the entire experiment, protein intake was 99, 98 and 104 percent of NRC requirements for the regular SBM, extra-heat SBM, and extra-heat-plus-urea groups. Since urea was added to the ration for the latter group without replacement of soybean meal (Table 1), its protein equivalent value was included in the calculation of total protein intake by this group.

Yield and composition of milk were similar for cows fed the regular SBM and those fed SBM heated more extensively (Table 2). This result was in contrast to results of a previous experiment in which milk yield of cows fed extensively heated SBM was higher than that of cows fed regular SBM (Bush *et al.*, 1980). One possible explanation for the difference observed in the two experiments is that protein intake of cows in the previous experiment was approximately 94 percent of NRC requirement compared to 98 percent in this trial. During the first period of this trial, where protein intake averaged 92 percent of requirements, milk yield, adjusted by covariance analysis for differences in pre-trial yields, was 58.8, 61.2 and 57.8 lb/day for the regular SBM, extra-heat SBM and extra-heat SBM-plus-urea groups. However, there was sufficient variability within groups that differences among these means cannot be regarded as true effects of the ration treatments.

The extent to which the PDI-10 SBM was heated may have been a factor affecting results of this feeding trial. The solubility of nitrogen in a NaCl solution was 7 percent of total nitrogen in the more extensively heat-treated SBM available for the trial compared to 12 percent for the regular SBM. In a previous trial solubility of nitrogen in heat-treated SBM was substantially lower than that of the regular SBM which may account for different results in the two trials. Solubility of feed proteins in a NaCl solution may not adequately characterize the protein of SBM subjected to different amounts of heating during processing; however, it does appear that SBM may need to be heated more extensively than that which was available for this trial to be of benefit in rations for lactating dairy cows.

Whereas the cows in the PDI-10 group gained some weight, weight changes of cows in the PDI-40 and PDI-10-plus-urea groups were negligible. Although the changes in body weight of the different groups were somewhat different, they were too variable within groups to be of real importance.

A difference in concentration of rumen ammonia was observed (Table 2). Concentrations of rumen ammonia were higher in cows on all the rations than that generally considered ideal for efficient microbial synthesis of protein. Values for cows fed the PDI-10 and PDI-40 rations were very similar. The higher concentration of rumen ammonia observed in cows fed the PDI-10-plus-urea ration could be expected since adequate nitrogen evidently was available for synthesis of microbial protein without the addition of non-protein nitrogen as urea. However, under conditions where protein intake is lower relative to that needed for milk production, addition of urea might be beneficial.

Literature Cited

Bush, L. J. *et al.* 1980. Okla. Agr. Exp. Sta. Res. Rep. MP-107:96.