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Abstract

The loss of meat and bone meal as a source of high quality protein for lactating cows creates an increased need for nonanimal sources. Fifty six Holstein cows were used to evaluate expeller soybean meal as a source of rumen undegradable intake (by-pass) protein for high producing cows. Expeller soybean meal tended to improve 3.5% contain fat-corrected milk yield and increased milk fat percentage relative to diets containing either solvent soybean meal or a meat and bone meal: blood meal mixture. In contrast, the protein percentage in milk was depressed significantly when cows were fed expeller soybean meal compared to animal protein. A limiting amino acid (possibly methionine) is implicated.; Dairy Day, 1997, Kansas State University, Manhattan, KS, 1997;

Keywords

Dairy Day, 1997; Kansas Agricultural Experiment Station contribution; no. 98-100-S; Report of progress (Kansas Agricultural Experiment Station and Cooperative Extension Service); 792; Dairy; Lactating cows; UIP; Expeller soybean meal

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**EXPELLER SOYBEAN MEAL AS A SOURCE OF
RUMEN UNDEGRADABLE PROTEIN
FOR LACTATING DAIRY COWS**

*J. E. Shirley, D. Piehl,
E. Titgemeyer, and M. Scheffel*

Summary

The loss of meat and bone meal as a source of high quality protein for lactating cows creates an increased need for nonanimal sources. Fifty-six Holstein cows were used to evaluate expeller soybean meal as a source of rumen undegradable intake (by-pass) protein for high producing cows. Expeller soybean meal tended to improve 3.5% fat-corrected milk yield and increased milk fat percentage relative to diets containing either solvent soybean meal or a meat and bone meal: blood meal mixture. In contrast, the protein percentage in milk was depressed significantly when cows were fed expeller soybean meal compared to animal protein. A limiting amino acid (possibly methionine) is implicated.

(Key Words: Lactating Cows, UIP, Expeller Soybean Meal.)

Introduction

A previous study at Kansas State University determined that expeller soybean meal (SBM) contained 50% undegradable intake protein (UIP) and improved the efficiency of milk production when substituted for solvent SBM in diets fed to dairy cows during mid-lactation. Further, plasma amino acids were elevated in cows fed the expeller SBM relative to those fed solvent SBM. These data suggest that expeller SBM improved the protein status of dairy cows. Although this improvement did not translate into improved milk production, less feed was required to produce a pound of milk. This observation indicates that the diets containing expeller SBM supplied protein in excess of the mammary gland's need to support milk production during mid-lactation.

Dietary UIP is required by genetically superior dairy cows because rumen microbial protein is insufficient to supply the quantity of amino acids required to maximize milk production. Fishmeal, blood meal, and meat and bone meal are recognized as high quality sources of UIP. They are used commonly to increase the UIP percentage in diets for high producing cows during early lactation. In addition, diets containing elevated UIP of high quality generally will support milk production at a lower total dietary crude protein than diets low in UIP.

The purpose of this study was to determine if expeller SBM, containing 50% of the crude protein as UIP, could replace a blend of blood meal and meat and bone meal or solvent SBM as a source of UIP.

Procedures

Fifty-six Holstein cows were utilized to evaluate mechanically processed expeller SBM as a source of UIP. A blend of blood meal and meat and bone meal was used as a standard for comparison. All cows were fed the high-group herd mix normally used at Kansas State University for the first 28 days postpartum and then assigned to one of the following diets: 1) 18% crude protein, 35% UIP from solvent SBM; 2) 16% crude protein, 35% UIP from solvent SBM; 3) 16% crude protein, 40% UIP from expeller SBM; and 4) 16% crude protein, 40% UIP from a blood meal-meat and bone meal blend. The fat content of the diets was equalized with tallow. Alfalfa hay and corn silage were used for the forage portion of the diets and shelled corn was the primary grain. Diets were evaluated for 84 days.

The diet with 18% CP/35% UIP served as a positive control with which we expected milk production to be optimized. The 16% CP/35% UIP diet was expected to yield less quality milk because it supplied insufficient quantities of amino acids to the cow and served as a negative control. The final two diets with 16% CP and 40% UIP were expected to yield improvements in performance relative to the negative control that were related directly to the ability of the protein sources (expeller SBM and the blood/meat blend) to supply amino acids to the cows.

Cows in dietary treatments were balanced for parity, milk production, and body condition based on pretreatment performance. Treatment comparisons included milk production, dry matter intake, body condition change, body weight gain, and efficiency (lb of milk per lb of feed dry matter consumed). Body weight was measured on 2 consecutive days at the beginning and end of the study and weekly during the study. Body condition was scored weekly. Daily feed intake and milk production were recorded, and milk composition (protein, fat, lactose, and solids-not-fat) was determined weekly. Blood samples were obtained during the pretreatment period and every 3 wk during the study to evaluate energy and protein status.

Results and Discussion

Compositions of the experimental diets are presented in Table 1. Tallow was used to equalize fat content (energy density) across diets because solvent SBM contained 1.5% fat, expeller SBM contained 5% fat, and meat and bone meal contained 10.4% fat.

Cows fed expeller SBM consumed slightly more dry matter (Table 2) than cows fed the other diets. Milk production was numerically greater from cows fed diets containing 40% UIP than from those fed diets containing 35% UIP. Milk production was similar for cows receiving the 18% and 16% crude protein diets containing 35% UIP. These results are consistent with recommendations of the National Research Council for diets containing approximately 16%

crude protein. Other published reports also indicated that high producing dairy cows respond positively to an increase in UIP at lower total dietary protein.

Milk composition among treatments was interesting in that the percent fat and protein tended to move in opposite directions. Expeller SBM increased ($P<.05$) milk fat percentage compared to animal protein and tended ($P=.16$) to increase milk fat percent compared to the 18% protein/35% UIP diet. In contrast, protein percentage was depressed in milk from cows fed expeller SBM compared to cows fed animal protein ($P<.01$), 18% protein/35% UIP ($P<.05$), and 16% protein/35% UIP. The improvement in milk fat percentage resulted in a numerical increase in 3.5% fat-corrected milk from cows receiving the expeller SBM diet compared to the other three diets. Total milk fat (lb/day) was also highest for the expeller SBM diet. Although milk protein percentage was depressed by the expeller SBM diet, total milk protein (lb/day) was similar among the three SBM diets. The animal protein blend led to higher total milk protein (lb/day) than the expeller SBM.

Both expeller SBM and the animal protein blend increased ($P<.05$) total plasma amino acids relative to the negative control (16% solvent SBM) diet (Table 2). Plasma urea nitrogen was highest for the 18% protein diet and, among the 16% protein diets, was lowest for the animal protein blend. The expeller SBM was effective in delivering amino acids to the bloodstream, but the depressed milk protein percentage indicates that amino acids were not translated into milk protein. The expeller SBM diet may have been deficient in at least one essential amino acid. This conclusion is strengthened by the fact that fat percentage was greater in milk from cows fed the expeller SBM diet relative to the other diets. Elevated milk fat percentage has been observed in diets deficient in one or more amino acids.

In conclusion, expeller SBM tended to improve milk and milk fat production but depressed milk protein relative to diets containing a mixture of meat and bone meal and blood meal. Methionine is suggested as being limiting in

heat-treated soy diets. Additional work is under-way to verify this hypothesis. If methionine is limiting, the inclusion of corn gluten meal (an excellent source of methionine) in diets containing expeller SBM might improve milk protein percentage.

Table 1. Experimental Diets: Ingredients as a Percentage of Dairy Matter

Ingredients	Diet ¹			
	35% UIP		40% UIP	
	18% Protein (SSBM)	16% Protein (SSBM)	16% Protein (ESBM)	16% Protein (BM/MBM)
Alfalfa	20	20	20	20
Corn silage	25	25	25	25
Whole cottonseed	8	8	8	8
Shelled corn	26.24	30.99	29.34	33.55
Solvent SBM	14.10	9.50	--	4.80
Expeller SBM	--	--	11.50	--
Blood meal	--	--	--	1.20
Meat & bone meal	--	--	--	2.40
Molasses (wet)	1.50	1.50	1.50	1.50
Tallow	1.15	1.00	.65	.75
Dicalcium phosphate	.833	.833	.833	.208
Limestone	1.610	1.610	1.610	1.023
Na bicarbonate	.870	.870	.870	.871
MgO	.227	.227	.227	.227
TM salt	.340	.340	.340	.341
Vit ADE	.109	.109	.109	.109
Vit E	.0109	.0109	.0109	.0109
Selenium premix	.0109	.0109	.0109	.0109

¹SSBM = solvent SBM;
 ESBM = expeller SBM; and
 BM/MBM = blend of blood meal and meat and bone meal.

Table 2. Response of Dairy Cows to Variable Dietary Protein and Rumen Undegradable Protein

Item	Diet ^a			
	35% UIP		40% UIP	
	18% Protein (SSBM)	16% Protein (SSBM)	16% Protein (ESBM)	16% Protein (BM/MBM)
DMI (lb/day)	57.7	57.9	59.4	58.0
Milk (lb/day)	91.9	90.6	94.6	94.2
Milk fat (%)	3.47	3.45	3.65	3.30
Milk protein (%)	3.10	3.09	2.98	3.16
Milk fat (lb/day)	3.15	3.08	3.43	3.10
Milk protein (lb/day)	2.84	2.78	2.82	2.96
Lactose (%)	4.94	5.02	5.05	5.03
SNF (%)	8.76	8.85	8.77	8.94
3.5% FCM ^b (lb/day)	91.0	89.2	97.1	91.5
ECM ^c (lb/day)	91.5	89.6	96.1	92.7

^aSSBM = solvent SBM; ESBM = expeller SBM; and BM/MBM = blend of blood meal and meat and bone meal.

^bFat-corrected milk.

^cEnergy-corrected milk.

Table 3. Effect of Variable Dietary and Rumen Undegradable Protein on Plasma Amino Acids and Urea Nitrogen

Item	Diet ¹			
	35% UIP		40% UIP	
	18% Protein (SSBM)	16% Protein (SSBM)	16% Protein (ESBM)	16% Protein (BM/MBM)
Amino acid (mg/dl)	4.11 ^{xy}	3.99 ^y	4.35 ^y	4.30 ^y
Urea nitrogen (mg/dl)	18.09 ^x	15.26 ^y	15.53 ^y	13.89 ^z

¹SSBM = solvent SBM; ESBM = expeller SBM; and BM/MBM = blend of blood meal and meat and bone meal.

^{x,y,z}Means within a row without a common superscript letter differ ($P < .05$).