PENNSYLVANIA SOYBEAN BOARD PROJECT – FINAL REPORT

INVESTIGATING THE POTENTIAL OF IMPROVING SOYBEAN MEAL PROTEIN VALUE FOR LACTATING DAIRY COWS

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Background: Extruded soybean meal (**ESBM**) has higher fat content and lower ruminal protein degradability than solvent-extracted soybean meal (**SSBM**), but information on its nutritive value for dairy cows is scarce. With funds from the Pennsylvania Soybean Board, we conducted a pilot study at the Fabin Bros. Farms soybean processing plant to determine ruminal degradability and intestinal digestibility of extruded soybean meal processed at various dryer and extruder temperatures. The conclusion from the pilot study was that increasing extruder temperature from 300 to 340°F increased ESBM protein undegradability (i.e., **RUP**) in situ by 28% with no apparent effect on in vitro intestinal protein digestibility. The next step in this project was to evaluate the effect of increased ruminal undegradability of ESBM on milk production and milk protein yield responses in cows fed slightly deficient metabolizable protein (**MP**) diets.

Materials and Methods: We conducted a replicated 3 × 3 Latin square design trial with 9 Holstein cows (parity, 3.1 lactations; DIM and BW at the beginning of the trial, 161 ± 21 d and 637 ± 20.3 kg, respectively) and 28-d experimental periods. The objective of the trial was to evaluate the effect of ESBM processed at 2 extruder temperatures, 300°F (**LTM**) and 340°C (**HTM**), on milk production and composition, nutrient digestibility and urinary N losses, and blood plasma amino acid (**AA**) and milk fatty acid (**FA**) profiles in dairy cows. The control diet contained 13% SSBM [53.8% crude protein (**CP**) with 71.4% ruminal degradability and 1.8% ether extract (**EE**)], which was replaced with equivalent amount (DM basis) of LTM (46.8% CP, 59.8% degradability, 10.0% EE) or HTM (46.9% CP, 41.1% degradability, 10.9% EE) ESBM in the 2 experimental diets (LTM and HTM, respectively) (Table 1). The diets had 16% CP and met or exceeded the energy ($\mathbf{NE_L}$) and MP requirements of the cows (based on NRC, 2001). All diets were deficient in Met but met the requirements of Lys and His.

Results and Discussion: The AA profile of the SBM used in the trial was similar (Table 2) but with slightly reduced Lys content for the HTM. Lysine is the AA that is most sensitive to heating and the higher extrusion temperature for HTM was most likely the reason for the decreased Lys content of that meal. Some other AA, such as Arg, were also decreased in the extruded meals compared with the control SSBM.

Both LTM and HTM tended to increase ($P = 0.06$) DMI compared with the control diet (Table 3). This resulted in increased ($P < 0.001$) milk yield by both ESBM diets. Milk fat and milk true protein (contents and milk fat yield were not affected by treatment. Milk protein yield tended to be increased (on average by 60 g/d; $P = 0.09$) by the ESBM diets. Plasma and milk urea N were increased ($P < 0.03$) 18

and 13%, respectively, by the ESBM diets compared with the control, which was a result of the higher N intake with the former diets.

Intake of all nutrients was increased or tended to be increased ($P \leq 0.06$) by the ESBM compared with the control, following the trend in DMI (Table 4). Total tract apparent digestibility of most nutrients, excluding CP, was also increased or tended to be increased ($P \leq 0.07$) for the ESBM diets. Surprisingly, digestibility of fiber (NDF and ADF) was also increased for the extruded SBM diets. These diets had higher fat content and usually unsaturated fat (as in soybeans) has a negative effect on fiber digestibility, specifically rumen degradability. The opposite effect was observed in this trial.

Milk true protein N and urinary N secretion/excretion was increased or tended to be increased ($P \leq 0.10$) by the ESBM diets (Table 5), which was a result of increased milk production and milk protein content and increased N intake compared with the control diet. Excretion of purine derivatives in urine, an indication of microbial protein synthesis in the rumen, and the estimated microbial protein production in the rumen of the cows were not different among diets.

Blood plasma concentration of His, an important essential AA limiting milk production in dairy cows, was increased ($P < 0.01$) by the HTM diet compared with LTM or the control (Table 6). Other essential AA, i.e. Leu and Val, were also increased ($P \leq 0.03$) by HTM compared with the control and LTM. Concentration of plasma Met, however, was decreased ($P = 0.05$) by the ESBM diets compared with the control. Concentration of Lys was not affected by diet.

Many changes in milk FA profile were triggered by inclusion of ESBM in the diet (Table 7). Generally, the ESBM diets resulted in greater concentrations of mono- and poly-unsaturated FA and lower concentration of saturated FA ($P < 0.001$) compared with the control diet.

Income-over-feed-cost (**IOFC**) estimates for the time the trial was conducted are shown in Table 8. Based on the price of the ESBM provided to us by Fabin Bros. and marker prices for the other feed ingredients in the diet, IOFC was higher for the ESBM diets, by $0.46 (LTM) to $0.80/cow/day (HTM), compared with the control, SSBM diet.

Conclusions: The main conclusion of this study was that replacing SSBM with ESBM in the diet of lactating dairy cows increased feed intake, which resulted in increased milk yield, and increased milk protein yield. Digestibility of dietary nutrients was generally increased with the ESBM diets but urinary N losses were also increased due to the increased N intake compared with the SSBM diet. Blood His concentration was increased but Met was decreased by the ESBM diets. Both amino acids are limiting milk production and milk protein synthesis in dairy cows but it is possible that the specific effect of His on feed intake counteracted the decreased Met bioavailability with the ESBM diets. The ESBM diets triggered extensive changes in milk fatty acid profile, increasing the concentrations of mono- and poly-unsaturated fatty acids and decreasing the concentration of saturated fatty acids. Income-over-feed-costs was also increased for the ESBM diets compared with the SSBM diet.

Table 1. Ingredient, chemical composition, and protein and amino acid (AA) balance of the diets fed during the lactating cow trial

	Diet[1]		
Item	**Control**	**HTM**	**LTM**
Ingredient, % of DM			
Corn silage[2]	40.0	40.0	40.0
Alfalfa haylage[3]	20.0	20.0	20.0
Grass hay[4]	5.0	5.0	5.0
Cottonseed, hulls	5.0	5.0	5.0
Corn grain, ground	9.0	8.65	8.65
Soybean meal, solvent-extracted[5]	13.0	-	-
Soybean meal, extruded[6]	-	13.0a	13.0b
Urea	-	0.35	0.35
Molasses[7]	5.0	5.0	5.0
Mineral/vitamin premix[8]	2.8	2.8	2.8
Salt	0.2	0.2	0.2
Composition, % of DM			
CP[9]	16.0	16.0	16.0
RDP[10]	10.1	10.5	10.5
RUP[10]	5.8	5.4	5.4
NDF[9]	33.4	33.6	33.5
ADF[9]	22.5	22.5	22.5
Fat[9]	3.09	4.35	4.23
Starch[11]	20.5	20.4	20.5
NEL[10] Mcal/kg	1.49	1.51	1.51
NEL balance,[10] Mcal/d	3.9	5.1	5.5
NFC[12]	44.0	42.5	42.7
Ca[9]	0.81	0.81	0.81
P[9]	0.32	0.33	0.33
Protein and AA supply,[13,14,15] g/d			
RDP and RUP			
RDP supply	2,706	2,965	2,978
RDP balance	162	260	265
RUP supply	1,555	1,534	1,536
RUP balance	266	188	193
MP			
Requirements	2,588	2,720	2,723
Supply	2,810	2,877	2,882

Balance	222	157	159
dMet			
Requirements[15]	57	60	60
Supply from the diet	49	51	50
Balance	-8	-9	-10
dHis			
Requirements[15]	57	60	60
Supply from the diet	58	58	58
Balance	1	-2	-2
dLys			
Requirements[15]	171	180	180
Supply from the diet	181	186	187
Balance	10	6	7

[1] Control = solvent-extracted soybean meal (SBM); HTM = SBM extruded at 340°F; LTM = SBM extruded at 300°F.

[2]Corn silage was 40.9% DM and (DM basis) 36.7% NDF and 8.1% CP.

[3]Alfalfa haylage was 45.2% DM and (DM basis) 42.4% NDF and 18.6% CP.

[4]Grass hay contained (DM basis) 74.0% NDF and 7.1% CP.

[5]SBM solvent-extracted contained (DM basis) 53.8% CP

[6a] SBM extruded at 340°F contained (DM basis); 46.9% CP; [6b] SBM extruded at 300°F contained (DM basis) 46.8% CP

[7]Molasses (Westway Feed Products, Tomball, TX) contained (DM basis) 3.9% CP and 66% total sugar.

[8]The premix (Cargill Animal Nutrition, Cargill Inc., Roaring Spring, PA) contained (%, as-is basis) trace mineral mix, 0.86; MgO (56% Mg), 8.0; NaCl, 6.4; vitamin ADE premix (Cargill Animal Nutrition, Cargill Inc.), 0.48; limestone, 37.2; selenium premix (Cargill Animal Nutrition, Cargill Inc.), 0.07; and dry corn distillers grains with solubles, 46.7. Ca, 14.1%; P, 0.39%; Mg, 4.59%; K, 0.44%; S, 0.39%; Se, 6.91 mg/kg; Cu, 362 mg/kg; Zn, 1,085 mg/kg; Fe, 186 mg/kg, vitamin A, 276,717 IU/kg; vitamin D, 75,000 IU/kg; and vitamin E, 1,983 IU/kg.

[9]Values calculated using the chemical analysis (Cumberland Valley Analytical Services Inc., Maugansville, MD) of individual feed ingredients of the diet.

[10]Estimated based on NRC (2001) using actual DMI, milk yield, milk composition, and BW of the cows throughout the trial.

[11]Values determined using an enzymatic colorimetric method (Bach Knudsen, K.E., 1997) on TMR composites.

[12]Estimated by NRC (2001).

[13]Due to rounding, balance may not exactly match requirements and supply

[14]All values were estimated using NRC (2001) based on actual DMI, milk yield, milk composition, and BW of the cows throughout the trial; dLys, dMet, dHis = digestible Lys, Met, and His, respectively.

[15]Requirements of dLys and dMet were calculated as 6.6 and 2.2% (respectively) of MP requirements. Requirements of dHis were assumed as 2.2% of MP requirements.

Table 2. Amino acid profile of the soybean meal (SBM) fed in the lactating cow trial

	Soybean meal[1]		
Item	**Control**	**HTM**	**LTM**
Crude protein,[2] % DM	53.8	46.9	46.9
Amino acid, % of crude protein			
Taurine	0.08	0.07	0.07
Aspartic Acid	11.2	11.0	10.8
Hydroxyproline	0.19	0.22	0.23
Threonine	3.85	3.85	3.80
Serine	4.43	4.46	4.44
Glutamic Acid	17.8	17.2	17.0
Proline	4.95	4.97	4.99
Glycine	3.87	4.09	4.12
Alanine	4.18	4.37	4.28
Valine	4.58	4.40	4.44
Methionine	1.44	1.45	1.42
Cysteine	1.32	1.38	1.35
Isoleucine	4.45	4.29	4.35
Leucine	7.96	7.76	7.66
Tyrosine	3.52	3.50	3.48
Phenylalanine	5.19	5.08	5.01
Tryptophan	1.46	1.41	1.33
Hydroxylysine	0.25	0.26	0.25
Ornithine	0.10	0.11	0.05
Lysine	**6.47**	**6.22**	**6.43**
Histidine	2.49	2.40	2.38
Arginine	7.17	6.90	6.91

[1] Control = solvent-extracted SBM; HTM = SBM extruded at 340°F; LTM = SBM extruded at 300°F.
[2] N × 6.25.

Table 3. Effect of extruded soybean meal (SBM) processed at different temperatures on milk production, milk composition, and plasma urea nitrogen in dairy cows

	Diet[1]				
Item	**Control**	**HTM**	**LTM**	**SEM[2]**	***P*-value**
Dry matter intake (DMI), kg/d	26.8	28.2	28.3	1.48	0.06[3]
Milk yield, kg/d	37.5[b]	40.8[a]	40.2[a]	2.12	<0.001
Milk yield/DMI, kg/kg	1.43	1.49	1.44	0.062	0.28
Body weight, kg	630	637	645	20.3	0.11
Milk fat, %	3.60	3.42	3.38	0.16	0.23
Milk protein, %	2.95	2.86	2.90	0.053	0.23
Milk urea N, mg/dL	13.1[b]	14.8[a]	14.7[a]	0.47	<0.01
Milk lactose, %	4.71	4.71	4.72	0.062	0.93
Milk fat, kg/d	1.34	1.40	1.37	0.065	0.68
Milk protein, kg/d	1.11	1.17	1.17	0.053	0.09[4]
Lactose, kg/d	1.77[b]	1.93[a]	1.92[a]	0.10	0.04
4% FCM,[5] kg/d	35.1	37.3	36.9	1.69	0.24
4% FCM/DMI, kg/kg	1.32	1.34	1.31	0.046	0.62
ECM,[6] kg/d	34.5	36.5	36.2	1.64	0.25
ECM/DMI, kg/kg	1.29	1.31	1.29	0.046	0.74
Milk NEL,[7] Mcal/d	25.7	27.2	27.0	1.22	0.26
PUN,[8] mg/dL	10.3[b]	11.7[ab]	12.6[a]	0.76	0.03

[a,b] Means with different letter superscripts differ at $P < 0.05$.

[1] Control = solvent-extracted SBM; HTM = SBM extruded at 340°F; LTM = SBM extruded at 300°F.

[2] Largest SEM published in table. DMI, n= 217 ; milk yield, n = 250; milk yield/DMI, n = 208; BW, n = 253; milk composition data, n = 26 (n represents number of observations used in the statistical analysis).

[3] Control vs. HTM and Control vs. LTM, $P < 0.05$.

[4] Control vs. LTM, $P < 0.05$.

[5] 4% Fat-Corrected Milk (kg/d) = kg of milk × (0.4 + (15 × % fat /100)) (NRC, 2001).

[6] Energy-corrected milk (kg/d) = kg of milk × ((38.3 × % fat x 10+24.2 × % true protein x 10+16.54 × % lactose x 10+20.7)/3,140) (Sjaunja et al., 1990).

[7] Milk Net Energy for lactation (Mcal/d) = kg of milk × (0.0929 × % fat + 0.0563 × % true protein + 0.0395 × % lactose) (NRC, 2001).

[8] Plasma urea N.

Table 4. Effect of extruded soybean meal (SBM) processed at different temperatures on nutrient intake and total-tract apparent digestibility of nutrients in dairy cows

Item	Diet[1]			SEM[2]	*P*-value
	Control	HTM	LTM		
Nutrient intake, kg/d					
DM	26.9	28.0	28.2	1.15	0.05
OM	25.1	26.1	26.3	1.08	0.06
NDF	8.98[b]	9.42[a]	9.45[a]	0.38	0.03
ADF	6.05	6.31	6.35	0.26	0.05
CP	4.30	4.49	4.51	0.18	0.05
Starch	5.50	5.72	5.77	0.23	0.06
Apparent digestibility, %					
DM	63.5[b]	67.1[a]	66.1[a]	0.76	<0.01
OM	64.8[b]	68.1[a]	67.3[a]	0.75	<0.01
NDF	38.2[b]	43.5[a]	42.6[a]	1.45	0.03
ADF	36.5[b]	43.6[a]	41.4[a]	1.33	<0.001
CP	64.2	66.5	65.6	1.22	0.29
Starch	97.4	97.0	97.0	0.24	0.07

[a,b] Means with different letter superscripts differ at $P < 0.05$.

[1] Control = solvent-extracted SBM; HTM = SBM extruded at 171°C; LTM = SBM extruded at 149°C.

[2] Largest SEM published in table; n = 26 (n represents number of observations used in the statistical analysis).

Table 5. Effect of extruded soybean meal (SBM) processed at different temperatures on milk nitrogen secretion, urinary and fecal N excretion, and urine purine derivative (PD) excretion in dairy cows

	Diet[1]				
Item	**Control**	**HTM**	**LTM**	**SEM[2]**	***P*-value**
N intake, g/d	688	718	722	29.4	0.05
N secretion and excretion, g/d					
Milk TPN[3]	174	183	184	7.2	0.10
Urinary N	153	175	176	14.4	0.26
Urinary urea-N (UUN), g/d	93[b]	116[a]	117[a]	7.9	0.01
UUN ÷ total urinary N, %	61.8	67.3	69.5	4.68	0.51
Fecal N	245	235	246	11.7	0.66
Total excreta N	398	413	423	21.1	0.48
Total N in excreta and milk	572	598	609	24.6	0.24
As proportion of N intake %					
Milk TPN	25.5	25.6	25.5	0.84	0.97
Urine N	21.9	22.9	23.1	1.72	0.88
UUN	13.5	15.6	15.8	0.78	0.08
Fecal N	35.8	33.5	34.4	1.22	0.29
Total N in excreta and milk	83.5	83.9	84.2	2.11	0.96
Urinary PD excretion					
Urine output, kg/d	19.7	21.5	21.6	1.72	0.48
Allantoin, mmol/d	548	529	514	37.8	0.71
Uric acid, mmol/d	63.8	62.4	60.2	6.17	0.78
Total PD, mmol/d	611	591	574	42.1	0.71
Microbial N flow, g/d	523	504	488	38.7	0.70
Microbial CP flow g/d	3,269	3,149	3,051	241.8	0.70

[a,b] Means with different letter superscripts differ at $P < 0.05$.

[1] Control = solvent-extracted SBM; HTM = SBM extruded at 171°C; LTM = SBM extruded at 149°C.

[2] Largest SEM published in table; n = 26 (n represents number of observations used in the statistical analysis).

[3] Milk true protein N (milk true protein ÷ 6.38).

Table 6. Effect of extruded soybean meal (SBM) processed at different temperatures on blood plasma amino acid (AA) profile (μmol/L) in dairy cows

	Diet[1]				
Item	**Control**	**HTM**	**LTM**	**SEM[2]**	***P*-value**
pSer	3.65	5.50	4.25	0.55	0.11
Tau	30.4	35.4	31.8	2.26	0.06
Asp	6.30	7.19	6.15	0.75	0.32
Hyp	9.46	9.85	9.66	1.65	0.94
Thr	90.3	79.4	85.0	5.08	0.07
Ser	78.6	83.1	78.6	2.63	0.13
Asn	33.8	34.3	33.7	0.97	0.90
Glu	44.3	44.8	45.1	2.18	0.81
Gln	208	198	203	5.34	0.40
Sar	5.45	3.73	4.19	1.14	0.45
α-aminoadipic acid	3.25	3.72	2.28	0.88	0.28
Pro	69.0[b]	79.8[a]	73.4[ab]	3.05	0.02
Gly	241	254	243	15.3	0.35
Ala	197	208	202	9.33	0.55
Cit	65.9	71.0	73.7	6.45	0.17
Abu	13.2	14.7	13.8	2.02	0.27
Val	**190[b]**	**215[a]**	**196[b]**	**12.2**	**0.03**
Met	**18.4**	**16.4**	**16.7**	**1.14**	**0.05**
Cys	0.22	0.27	0.30	0.08	0.84
Ile	**100**	**112**	**105**	**5.36**	**0.07**
Leu	**115[b]**	**133[a]**	**121[b]**	**7.34**	**0.02**
Tyr	40.8	40.6	40.6	2.26	0.99
Cystathionine/allocystathionine	0.91	0.86	0.81	0.09	0.33
Phe	39.3	40.5	39.5	1.45	0.66
BALA	1.34	1.38	1.78	0.70	0.77
GABA	1.06	1.07	1.53	0.35	0.45
HCY	1.49	3.91	4.21	1.44	0.31
Trp	67.5	67.4	66.6	2.67	0.97
HYL	0.16	0.19	0.14	0.03	0.33
Orn	36.7	38.4	37.7	1.67	0.59
Lys	66.6	64.4	66.9	2.19	0.58
1-methylhistidine	4.99[b]	7.88[a]	4.87[b]	0.58	<0.001
His	**39.9[b]**	**50.0[a]**	**43.3[b]**	**2.62**	**<0.01**

3- methylhistidine	3.39	3.08	3.50	0.38	0.10
Ans	0.03	0.00	0.09	0.05	0.15
Car	10.3[b]	12.7[a]	12.0[a]	0.68	0.02
Arg	66.3	69.5	69.6	2.98	0.37
EAA	794	850	811	37.8	0.12
Non-EAA	914	948	922	29.2	0.34
Total AA	1708	1798	1733	60.9	0.14

[a,b] Means with different letter superscripts differ at $P < 0.05$.

[1] Control = solvent-extracted SBM; HTM = SBM extruded at 340°F; LTM = SBM extruded at 300°F.

[2] Largest SEM published in table; n = 26 (n represents number of observations used in the statistical analysis).

[3] Essential amino acids.

Table 7. Effect of extruded soybean meal (SBM) processed at different temperatures on milk fatty acid composition (g/100 g of total fatty acids) in dairy cows

	Diet[1]				
Fatty acid	**Control**	**HTM**	**LTM**	**SEM[2]**	***P*-value**
C4:0	3.99	4.04	4.14	0.143	0.39
C6:0	2.35	2.25	2.30	0.079	0.38
C8:0	1.41[a]	1.28[b]	1.31[b]	0.052	0.02
C10:0	3.40[a]	2.86[b]	2.92[b]	0.148	<0.001
C12:0	3.84[a]	3.09[b]	3.16[b]	0.151	<0.001
C14:0	10.9[a]	9.89[b]	9.97[b]	0.197	<0.001
C14:1	1.16[a]	1.00[b]	0.95[b]	0.091	<0.01
C15:0	0.90[a]	0.78[b]	0.75[b]	0.025	<0.01
C16:0	28.4[a]	23.8[c]	24.7[b]	0.62	<0.001
C16:1	1.74[a]	1.38[b]	1.33[b]	0.129	<0.001
C17:0	0.48[a]	0.43[b]	0.44[b]	0.011	<0.01
C18:0	8.05[b]	9.82[a]	9.86[a]	0.381	<0.001
C18:1, *trans*-4	0.02[c]	0.03[a]	0.03[b]	0.001	<0.001
C18:1, *trans*-5	0.02[b]	0.03[a]	0.03[a]	0.001	<0.001
C18:1, *trans*-6-8	0.30[b]	0.47[a]	0.44[a]	0.016	<0.001
C18:1, *trans*-9	0.24[c]	0.37[a]	0.35[b]	0.010	<0.001
C18:1, *trans*-10	0.50[b]	0.88[a]	0.74[a]	0.093	<0.01
C18:1, *trans*-11	0.93[c]	1.75[a]	1.57[b]	0.071	<0.001
C18:1, *trans*-12	0.45[b]	0.69[a]	0.66[a]	0.021	<0.001
C18:1, *cis*-9	20.9[b]	22.5[a]	22.6[a]	0.796	0.04
C18:1, *cis*-11	1.09[b]	1.30[a]	1.27[a]	0.058	<0.001
C18:2, *cis*-9,*cis*-12	2.71[c]	4.22[a]	3.54[b]	0.090	<0.001
C20:0	0.10	0.11	0.11	0.006	0.11
C18:3	0.38[c]	0.51[a]	0.46[b]	0.013	<0.001
CLA-*cis*-9,*trans*-11	0.42[b]	0.73[a]	0.64[a]	0.052	<0.001
CLA-*trans*-10,*cis*-12	ND	ND	ND	0.001	0.28
Others	5.33[b]	5.82[a]	5.66[a]	0.118	<0.01
Trans-10/*trans*-11	0.55	0.50	0.48	0.058	0.24
Trans 10 + *trans* 11	1.42[c]	2.63[a]	2.31[b]	0.127	<0.001
Total *trans* fatty acids	2.46[c]	4.22[a]	3.82[b]	0.162	<0.001
Σ saturated fatty acids	63.9[a]	58.2[c]	59.6[b]	1.16	<0.001
Σ MUFA[3]	26.6[b]	29.9[a]	29.4[a]	0.98	<0.001
Σ PUFA[3]	3.09[c]	4.73[a]	4.00[b]	0.100	<0.001

[a,b] Means with different letter superscripts differ at $P < 0.05$.
[1] Control = solvent-extracted SBM; HTM = SBM extruded at 171°C; LTM = SBM extruded at 149°C.
[2] Largest SEM published in table; n = 26 (n represents number of observations used in the statistical analysis); ND = not detected.
[3]MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids.

Table 8. Income-Over-Feed-Cost ($/cow/d) for lactating cow diets containing solvent-extracted soybean meal (SBM) or extruded SBM processed at different temperatures.

Diet[1]	July'13	August'13	September'13	Average
Control	$9.04	$9.59	$9.82	$9.48
LTM	$9.71	$9.78	$10.33	$9.94
HTM	$10.03	$10.13	$10.67	$10.28

[1] Control = solvent-extracted SBM; HTM = SBM extruded at 340°F; LTM = SBM extruded at 300°F.