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Using Extruded-Expelled Soybean Meal in Swine Diets

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Extrusion processing is an effective means of improving the nutritional value of whole soybeans fed to swine. Recently, Insta-Pro International has combined extrusion technology with expelling, an oil extraction process, to produce an extruded-expelled soybean meal (Insta-Pro Express™ extruder/press system). The resulting soybean meal contains slightly higher levels of fat (approximately 5 vs 1%, respectively) than conventional, solvent-extracted soybean meal, and the higher energy could lead to improved feed efficiency. The nutritional value of dry, extruded-expelled soybean meal has not been determined for swine, therefore a series of trials were designed to determine the nutritional adequacy of the new protein source.

Experiment 1. Our first study was designed to determine the apparent ileal digestibility of amino acids for dry, extruded-expelled soybean meal with or without hulls and compare the values to solvent extracted 46.5% CP soybean meal.

Experiment 2. The second trial was designed to determine the digestible (DE) and metabolizable (ME) energy values of the same soybean meal sources used in Exp. 1.

Experiment 3. A total of 216 pigs (initially 23.3 lb and 35 d of age; 14 d post-wean) was used in a 21-d growth trial to determine the influence of different soybean meal processing techniques on weanling pig growth performance. Six experimental diets fed in meal form were designed to form three pre-planned comparisons. Using the apparent ileal digestible amino acid coefficients and ME values determined in Exp. 1 and 2, two diets were formulated using dry, extruded-expelled soybean meal with or without hulls. Pigs fed one of these diets were compared with those fed corresponding corn-44% CP (with hulls) or 46.5% CP (without hulls) solvent-extracted soybean meal diets with added soy oil. Soy oil was added to equalize ME across comparative treatments. A fifth diet containing an alternative expelled soybean meal source (Soyplus) was formulated to a similar total lysine content. Pigs fed this diet were compared with pigs fed a 44% CP soybean meal diet formulated to the same total lysine and crude fat concentrations. The last two diets were formulated on a calculated total nutrient basis because digestibility values for the alternative expelled soybean meal product were not available.

Experiment 4. The last experiment was designed to compare dry, extruded-expelled soybean meal with hulls from three different commercial manufacturers. The control diet contained conventionally processed 46.5% CP soybean meal formulated to 1.10% total lysine and 1.48 Mcal ME/lb. Three diets (1.14% lysine and 1.55 Mcal ME/lb) containing dry, extruded-expelled soybean meal from one of three different manufacturers were formulated to the same lysine:ME ratio as the control diet. Lastly a positive control diet was used containing conventionally processed 46.5% CP soybean meal and 3.29% soy oil formulated to the same total lysine and ME concentration as the diets containing the dry, extruded-expelled soybean meal.

Results. In Exp. 1 and 2, dry, extruded-expelled soybean meal with or without hulls had greater apparent ileal digestibility of some amino acids (Table 1) and greater DE and ME (Table 2) compared to conventional, solvent-extracted soybean meal. There were no differences between the two dry, extruded-expelled soybean meal sources in amino acid digestibility or energy content. In Exp. 3, pigs fed diets containing dry extruded-expelled soybean meal with or without hulls had similar growth performance (Table 3) compared to pigs fed their corresponding solvent extracted soybean meal and soy oil diets. This suggests that the extrusion-expelling process achieved proper destruction of the anti-nutritional factors found in raw soybeans. Pigs fed diets containing the alternative expelled soy product had decreased growth performance

compared to conventional soybean meal. The alternative expelled soy product is commonly used in ruminant diets as a source of by-pass protein. Our data suggests that it does not support maximum growth performance of pigs and should not be included in swine diets.

Because the extruded-expelled soybean meal products used in Exp. 1, 2, and 3, were produced at the Insta-Pro International's headquarters, Exp. 4's objective was to ensure that commercial manufacturers were producing products with similar quality. In Exp. 4, there were no differences in growth performance of pigs fed diets containing dry, extruded-expelled soybean meal from any of the manufacturers or the diet containing conventional soybean meal and soy oil (Table 4). This indicated that the commercial manufacturers are producing a high-quality soybean meal similar to that used in the first three studies. Pigs fed the negative control diet containing 46.5% CP soybean meal without soy oil had similar ADG but poorer F/G than pigs fed any of the other diets reflecting the lower energy concentration of that diet.

Our data suggests that dry, extruded-expelled soybean meal can replace conventionally processed soybean meal and added soy oil in swine diets. An example price matrix (Table 5) was calculated to determine the price that can be paid for the dry, extruded-expelled products based on conventionally processed soybean meal and fat prices. The price that can be paid per ton of dry, extruded-expelled soybean meal is greater than that of solvent-extracted soybean meal because of the greater energy density of the dry, extruded-expelled meal. Understanding the dry matter content of the products used is essential in this price relationship. The dry, extruded-expelled soybean meals contained 95 to 96% dry matter in our experiment compared to 88% dry matter for the conventionally processed soybean meal. Price comparisons should be made on a dry matter basis.

Conclusion. Dry, extruded-expelled soybean meal can be used as an alternative protein source in swine diets. This meal has the advantage of improved digestibility of some amino acids and greater energy concentrations compared to conventional soybean meal. Growth performance of pigs fed the dry, extruded-expelled soybean meal was not compromised when compared to that of pigs fed conventional soybean meal in our experiments. Economics and product availability should dictate which soybean meal source to use in swine diets.

Table 1. Apparent Ileal Digestibility of Some Amino Acids, Exp. 1[a]

	Soybean meal processing technique		
		Dry, extruded-expelled	
Apparent ileal digestibility, %	Solvent-extracted	With hulls	Without hulls
Lysine	88.58[b]	90.90[c]	91.08[c]
Arginine	91.39[b]	93.70[c]	93.75[c]
Isoleucine	86.95[b]	89.72[c]	89.85[c]
Leucine	85.52[b]	88.48[c]	88.58[c]
Valine	85.23[b]	87.37[c]	87.42[c]

[a] Values are the means of six pigs (initially 85 lb) used in a replicated 3 × 3 Latin square design.

[b, c] Means within a row with different superscripts differ (P < .05).

Table 2. Energy Values of Soybean Meal Sources, Mcal/lb[a]

	Soybean meal processing technique		
		Dry, extruded-expelled	
Item	Solvent-extracted	With hulls	Without hulls
Digestible energy	1.66[b]	1.87[c]	1.91[c]
Metabolizable energy	1.55[b]	1.76[c]	1.80[c]

[a] Values are the means of six pigs (initially 91 lb) used in a replicated 3 × 3 Latin square design.

[b,c] Means within a row with different superscripts differ (P < .05).

Table 3. Influence of Different Soybean Meal Processing Techniques on Growth Performance of the Weanling Pig[a,b]

	Soybean meal source								
	Extruded-expelled SBM with no hulls	46.5% CP SBM	Extruded-expelled SBM with hulls	44% CP SBM	Soyplus	44% CP SBM	Contrasts		
Item	T1	T2	T3	T4	T5	T6	T1 vs T2	T3 vs T4	T5 vs T6
Day 0 to 21									
ADG, lb	1.21	1.22	1.22	1.20	1.13	1.25	.71	.36	.0001
ADFI, lb	2.11	2.09	2.08	2.12	2.16	2.13	.69	.55	.65
F/G	1.74	1.71	1.71	1.78	1.92	1.71	.53	.19	.0004

[a] A total of 216 pigs 14 d after weaning (initially 23.25 lb and 35 d of age), six pigs per pen and six pens per treatment.
[b] Pigs were fed a common diet for the first 14 d after weaning with overall ADG=.70 lb, ADFI=.88 lb, and F/G=1.25.

Table 4. Influence of Dry, Extruded-expelled Soybean Meal from Different Processors on Growth Performance[a]

	46.5% CP	Dry, extruded-expelled SBM			46.5% CP	Contrasts, P <[b]		
Item	SBM	Source 1	Source 2	Source 3	SBM + oil	1	2	3
Day 0 to 15								
ADG, lb	1.18	1.18	1.17	1.19	1.23	.76	.24	.34
ADFI, lb	1.93	1.74	1.78	1.67	1.81	.005	.22	.10
F/G	1.65	1.47	1.52	1.40	1.47	.007	.99	.03

[a] Values are the means of 150 pigs (initially 22 lb) with five pigs per pen and six pens per treatment.
[b] Contrasts were 1) 46.5% CP SBM vs others, 2) Source 1, 2, 3 vs 46.5% CP SBM + oil, and 3) 46.5% CP SBM vs 46.5% CP SBM + oil.

Table 5. Price Matrix for Dry, Extruded-expelled Soybean Meal with Hulls Compared to Soybean Meal on an Equal Dry Matter Basis (88%), $/ton[a]

		Soybean meal (46.5% CP) price, ($/ton)										
		150	160	170	180	190	200	210	220	230	240	250
Fat price, ($/lb)	.15	179	189	200	211	221	232	242	253	263	274	284
	.20	192	203	214	224	235	245	256	266	277	287	298
	.25	206	217	227	238	248	259	269	280	290	301	311
	.30	220	230	241	251	262	272	283	293	304	314	325
	.35	233	244	254	265	275	286	296	307	318	328	339

[a] Assumes corn price is $2.15/bu. Values represent the highest price that can be paid for extruded-expelled soybean meal without hulls to be economically feasible, compared to given soybean meal and fat prices.

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