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Replacing Conventionally Processed Soybean Meal with Extruded/Expelled Soybean Meal in Swine Diets

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Summary and Implications

The effects of extruded/expelled soybean meal (ESBM) on growth performance and carcass composition of pigs from weaning to slaughter were investigated. Two experiments were conducted. In the first experiment, weaned pigs were fed a diet containing either conventional solvent-extracted soybean meal or ESBM. Average daily gain and feed efficiency were greater in pigs fed the control diet. The second experiment was designed to determine whether nursery diet influenced performance during the growing-finishing period. In the second experiment, half of the pigs from Experiment 1 were assigned to either a control or ESBM diet and were fed until slaughter. Average daily gain and feed efficiency of pigs fed the control diet were slightly greater than those of pigs fed the ESBM diets. Differences in performance of pigs fed the two diets were greater during the nursery phase than during the growing-finishing phase. These results support our previous research in that ESBM offers no advantage in swine growth performance over conventional solvent-extracted soybean meal.

Introduction

Extruded/expelled soybean meal (ESBM) is produced by mechanical friction creating a high temperature for a short time period. The temperature and the time spent at a given temperature directly affects the quality and nutritional value of the product. Extruded/expelled soybean meal has the potential to be a high-quality protein and oil source if processed correctly. After extrusion, soybeans (~18% fat) are expelled (pressed) to remove

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the oil. Extruded/expelled soybean meal (the final product) has about 7% fat compared to <1% fat in conventional soybean meal. Therefore, ESBM has a greater energy content than conventional soybean meal and has the potential to be an excellent feed ingredient. Extruded/expelled soybean meal is a convenient way to include fat in swine diets for purposes such as dust reduction, in addition to its nutritional value.

In the 1998 Nebraska Swine Report, results of a study comparing conventional solvent-extracted soybean meal to ESBM fed to early-weaned pigs were presented. In that study, pigs fed ESBM grew more slowly and were less efficient than pigs fed conventional soybean meal. In contrast, recent work completed at Kansas State University (KSU) suggests that pigs fed ESBM perform similarly to pigs fed conventional solvent-extracted soybean meal. The ESBM used at KSU was from a different source than that used in the Nebraska study. An article in the 2000 Nebraska Swine Report concluded that there is considerable variation in the quality of ESBM fed to pigs and that affects its economic value.

The primary objective of this research was to investigate the effects of soybean meal type on pig performance in pigs fed either a diet containing conventional soybean meal or ESBM.

Procedures

Two experiments were conducted. Experiment 1 was a 28-day nursery trial and Experiment 2 was a 119-day growing-finishing trial.

Experiment 1

Four-hundred-eighty crossbred pigs weaned at 11 to 14 days of age (initial body weight 9.05 lb) were used. Pigs were housed in an environmentally controlled nursery with heat lamps for supplemental heat and had continuous fluorescent lighting throughout the trial. Pigs were allotted to pens with 20 pigs/pen (10 barrows and 10 gilts), and the pen was the experimental unit. Pens were allocated to either a control diet

Table 1. Composition of experiment 1 diets, % (as fed basis).

	Phase 1[a]		Phase 2[a]	
Ingredient, %	Control	ESBM[b]	Control	ESBM
Corn	39.15	40.40	50.00	50.65
Soybean meal (47.5% CP[c])	15.75	—	25.75	—
ESBM (43% CP)	—	16.50	—	27.10
Dried whey	27.00	27.00	14.00	14.00
Plasma protein	5.00	5.00	—	—
Menhaden fishmeal	7.00	7.00	4.00	4.00
Corn oil	2.00	—	2.00	—
Dicalcium phosphate	1.15	1.15	1.25	1.25
Limestone	.15	.15	.20	.20
Mineral premix	.10	.10	.10	.10
Vitamin premix	1.00	1.00	1.00	1.00
Salt	.30	.30	.30	.30
Mecadox-50	1.00	1.00	1.00	1.00
Zinc oxide	.40	.40	.40	.40
Calculated composition				
CP, %	22.26	21.98	20.57	20.04
Lysine[d], %	1.34	1.34	1.09	1.09
ME, kcal/lb[c]	1,514	1,495	1,513	1,512

[a]Phase 1 diets fed from d 0 to 14, Phase 2 diets fed from d 14 to 28.
[b]ESBM = Extruded/expelled soybean meal.
[c]CP = Crude protein; ME = metabolizable energy.
[d]Apparent digestible basis.

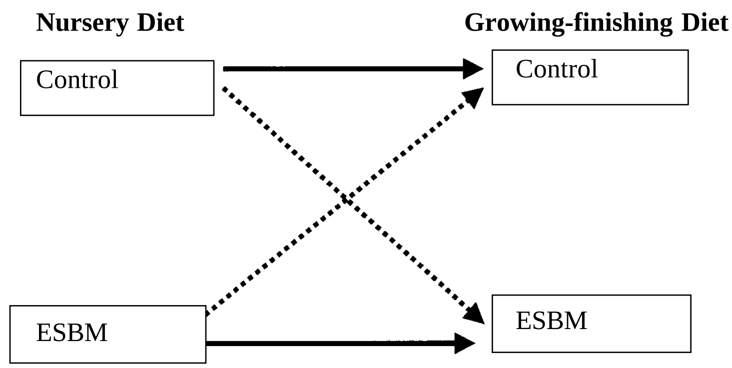
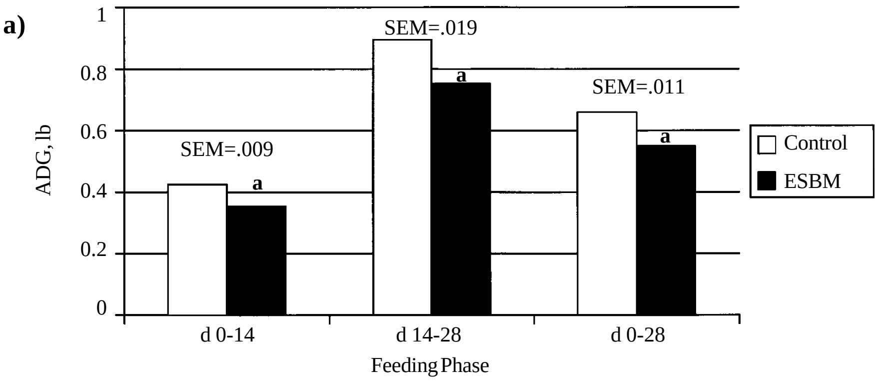


Figure 1. Experiment 2 pig allotment.

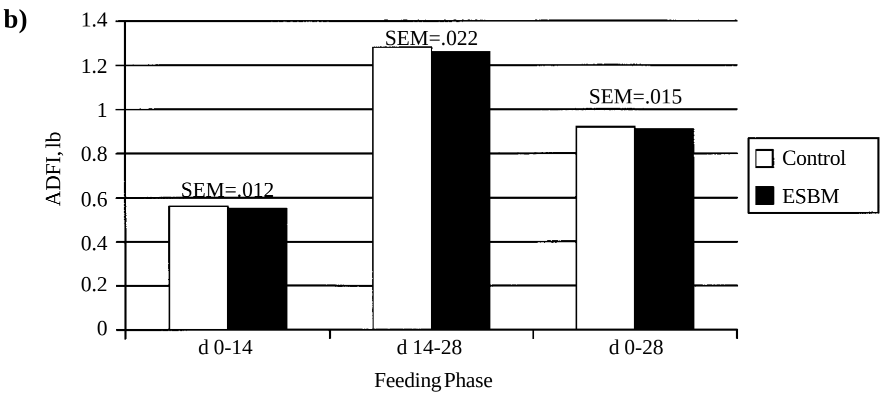
Table 2. Composition of experiment 2 diets, % (as fed basis).

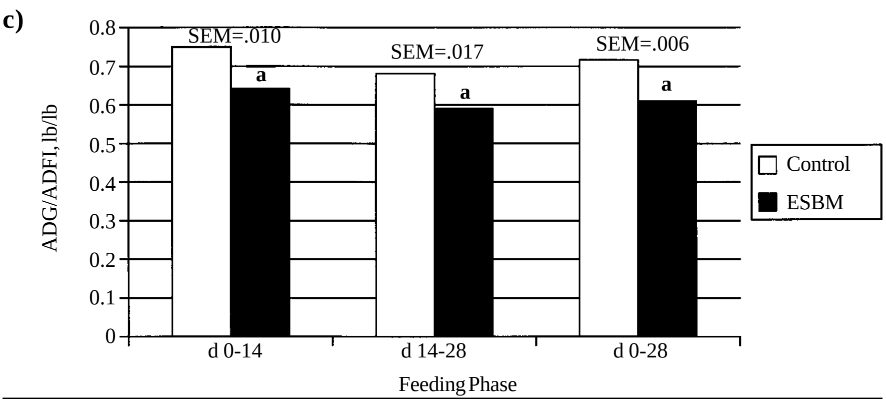
	Phase 1[a]		Phase 2[a]		Phase 3[a]	
Ingredient, %	Control	ESBM[b]	Control	ESBM	Control	ESBM
Corn	68.15	68.65	76.15	76.90	80.30	81.59
Soybean meal (47.5% CP[c])	27.25	—	19.25	—	15.25	—
ESBM (43% CP)	—	28.75	—	20.50	—	15.96
Tallow	2.00	—	2.00	—	2.00	—
Dicalcium phosphate	1.10	1.10	1.10	1.10	.95	.95
Limestone	.40	.40	.40	.40	.40	.40
Mineral premix	.10	.10	.10	.10	.10	.10
Vitamin premix	.70	.70	.70	.70	.70	.70
Salt	.30	.30	.30	.30	.30	.30
Calculated Composition						
CP,%	18.60	18.06	15.46	15.20	13.91	13.63
Lysine[d], %	1.00	1.00	.78	.78	.67	.67
ME, kcal/lb[c]	1,547	1,556	1,549	1,544	1,552	1,539

[a]Phase 1 diets fed from 27 to 110 lb (d 0 to 56), Phase 2 diets fed from 110-180 lb (d 56 to 91), Phase 3 fed diets from 180-240 lb (d 91 to 119).
[b]ESBM = Extruded/expelled soybean meal.
[c]CP = Crude protein; ME = metabolizable energy.
[d]Apparent digestible basis.



[a]Nursery Diet effect (P<.05).





[a]Nursery Diet effect (P<.05).

Figure 2. The response of a) average daily gain (ADG), b) average daily feed intake (ADFI), and c) ADG/ADFI to extruded/expelled soybean meal (ESBM) in Experiment 1.

(n = 12) or an experimental diet (n = 12). Pigs were given ad libitum access to feed and water throughout the 28-day feeding trial.

Diets were formulated to contain similar percentages of digestible lysine and were corn-soybean meal based containing either conventional soybean meal (Control) or ESBM (Table 1). Pigs were fed their respective treatment diet for 28 days. There were two feeding phases during Experiment 1 to meet the changing nutritional requirements of the pigs. Phase 1 diets were fed from day 0 to 14 (1.34% digestible lysine) and phase 2 diets were fed from day 14 to 28 (1.09% digestible lysine).

Pig and feeder weights were recorded weekly and blood samples were collected on days 0, 14, and 28 of the trial for analysis of plasma urea nitrogen.

Experiment 2

Two-hundred-forty pigs from Experiment 1 were selected immediately after the nursery trial to continue on in the grower-finisher phase of the study. We selected an equal number of pigs from each Experiment 1 diet (120 pigs fed Control and 120 pigs fed ESBM) to achieve a common initial pig body weight (27 lb) for all pens in Experiment 2. Pigs were housed in a modified-open-front building 10 pigs/pen (5 barrows and 5 gilts), and pen was the experimental unit. Pens were assigned either a Control diet (n = 12) or an ESBM diet (n = 12). Pigs were assigned to a pen based on the dietary treatment fed during the nursery phase such that all pigs in a pen were fed the same diet during Experiment 1. This created four possible Experiment 1-Experiment 2 diet combinations: Control-Control, Control-ESBM, ESBM-Control, and ESBM-ESBM, respectively (Figure 1).

Diets were formulated on an equal digestible lysine basis (Table 2). Experiment 2 was divided into three feeding phases. Phase 1 diets were fed from days 0 to 56 (27 to 110 lb). Phase 2 diets were fed from days 56 to 91 (110 to 180 lb), and Phase 3 diets were fed from days 91 to 119 (180 to 240 lb). The diets contained 1.00%, 0.78% and 0.67% lysine, respectively.

Pigs and feeders were weighed approximately every two weeks to make phase changes close to target weights. Blood samples were collected on days 56, 91 and 119. On day 119, backfat (BF) and longissimus muscle area (LMA) were measured using real-time ultrasound by a trained technician. Pigs were transported to a slaughter facility and TOBEC (total body electrical conductivity) measurements were recorded for each carcass.

Results

Experiment 1

Average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (ADG/ADFI) are shown in Figures 2 a, b, and c, respectively. Overall, and from days 0-14 and days 14-28, ADG was greater (P < .05) in the Control pigs than the ESBM pigs.

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There were no significant differences between the treatment groups in ADFI at any point during the nursery trial. From days 0-14, days 14-28 and days 0 to 28, ADG/ADFI was greater (P < .05) in the Control pigs than the pigs fed ESBM. On days 14 and 28, plasma urea concentrations (PUC) were greater (P < .05) for pigs fed ESBM compared to the Control group (data not shown).

Experiment 2

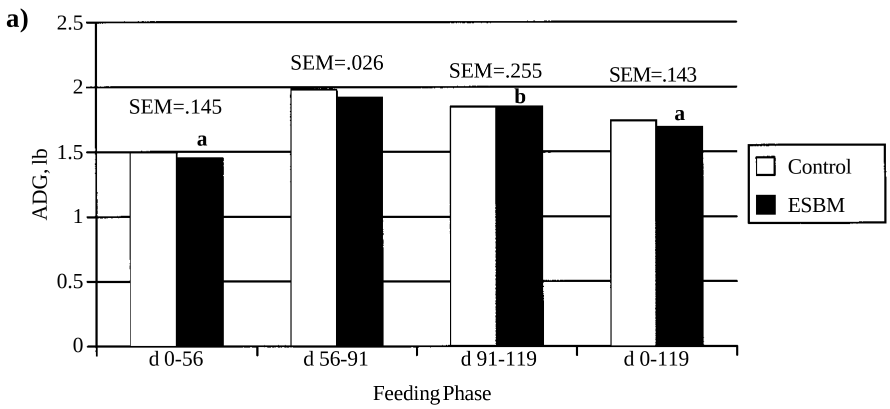
Average daily gain, average daily feed intake, and ADG/ADFI data are shown in Figure 3 a, b, and c, respectively. From days 0-56 and for the entire growing-finishing period (days 0 to 119), ADG was greater (P < .05) for the Control pigs than for ESBM-fed pigs. From days 91-119 there was a nursery x growing-finishing diet interaction (P < .05) for ADG. Average daily feed intake was greater (P < .05) for Control pigs from days 56-91. Control pigs had a greater (P < .05) ADG/ADFI from days 0-56. There were no significant differences in plasma urea concentration (data not shown) between the treatment groups.

Carcass data are shown in Table 3. There were no differences in BF and LMA measurements between treatments. Hot carcass weight (HCW) and total pounds of primal cuts were greater (P < .05) for Control pigs than for pigs fed ESBM.

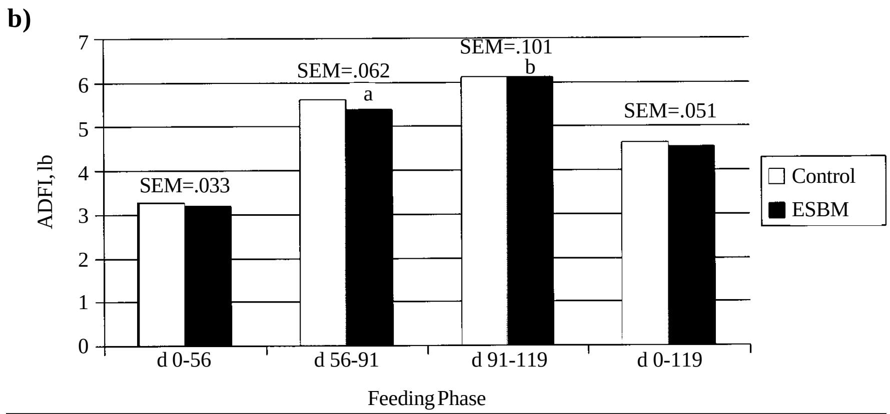
Considering only the 120 pigs that were maintained on either the Control diet or the ESBM diet from weaning till slaughter, there was a trend (P < .10) for greater ADG and ADG/ADFI for the Control pigs vs. ESBM-fed pigs (ADG: 1.52 vs. 1.47 lb, respectively; ADG/ADFI: 1.00 vs. 0.98 , respectively).

Conclusions

During the nursery trial, pigs fed ESBM had reduced ADG and ADG/ADFI versus pigs fed the Control diet. The greater PUC for the ESBM-fed



[a]Growing-finishing diet effect (P<.05).
[b]Growing-finishing diet x nursery diet interaction (P<.05).



[a]Growing-finishing diet effect (P<.05).
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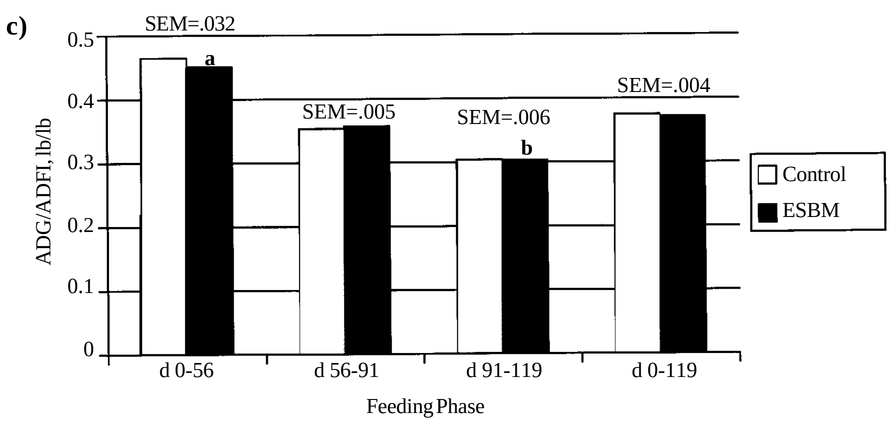

[a]Growing-finishing diet effect (P<.05).
[b]Nursery diet (P<.05).

Figure 3. The response of a) average daily gain (ADG), b) average daily feed intake (ADFI), and c) ADG/ADFI to extruded/expelled soybean meal (ESBM) in Experiment 2.

Table 3. Effects of soybean meal type on carcass composition.

	GF[a] Diet		P-value
	Control	ESBM	GF Diet
HCW[b]	178.88	173.81	<.05
Ham, lb	21.52	20.97	NS
Loin, lb	24.65	24.23	NS
Shoulder, lb	25.89	25.32	NS
Total pounds lean[c]	90.23	87.40	<.05
Primal cut[d], %	40.28	40.57	NS
Total lean[e], %	50.44	50.28	NS
Backfat, in	.70	.70	NS
LMA[f], in^2	16.00	15.58	NS

[a]GF = growing-finishing diet; Control = conventional soybean meal; ESBM = extruded/expelled soybean meal.
[b]HCW = hot carcass weight.
[c]Total pounds lean = pounds of boneless ham, loin, shoulder, belly, and trimmings.
[d]Primal cut, % = pounds of boneless ham, loin, and shoulder/HCW.
[e]Total lean, % = total pounds of boneless lean/HCW.
[f]LMA = longissimus muscle area.
[g]NS = Not significant (P > .05).

pigs suggests that protein quality and(or) amino acid availability may be compromised in ESBM. During the growing-finishing trial, growth performance differences between the Control group and the ESBM-fed pigs were reduced. This observation could be related to age of the pig. If the quality of the ESBM was poor (damaged protein and(or) presence of antinutritional factors), the deleterious affects would be reduced as the pig matured. Considering the whole period from weaning to finishing, there was a trend for pigs fed the Control to have a slight advantage over pigs fed ESBM.

Extruded/expelled soybean meal may be a satisfactory ingredient in swine diets when fed either during the growing-finishing period or from weaning to finishing. The variation in ESBM from different processing plants and questions about quality control and nutrient availability in ESBM need to be explored.

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