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Protein Sources for Segregated Early Weaned (SEW) Pigs

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Summary and Implications

Three experiments were conducted to examine different protein sources for segregated, early weaned (SEW) pigs. Protein sources evaluated included extruded soybeans, extruded-expelled soybeans, solvent-extracted soybean meal and spray-dried egg product as a substitute for spray-dried plasma protein. Performance differences among the four treatments could not be detected after seven weeks (two-week experimental period and five-week common corn-soybean meal diet). The cost of gain was reduced during the two-week treatment period by feeding diets with reduced plasma protein levels with or without the partial or complete substitution of spray-dried egg product. In addition, SEW pigs consuming the diet containing 20 percent soybean meal and 6 percent spray-dried plasma performed similarly to pigs receiving a more conventional SEW nursery diet (10 percent soybean meal, 6 percent spray-dried plasma protein). These experiments suggest egg protein and soybean proteins may be used for SEW pigs without significantly decreasing nursery performance over a seven-week period. The role of plant protein sources in diets for SEW pigs needs to be reevaluated.

Introduction

Early weaning at 14 to 18 days of age, is becoming increasingly common in the pork industry. Research has been directed toward easing the transition from sows' milk to dry feed in order to minimize lags in postweaning pig performance. It has been suggested two proteins present in soybeans, glycinin and beta-conglycinin, may cause a hypersensitivity response in pigs and decrease in performance. Conventionally processed, commercial soybean meal may retain some antigens that cause this transient hypersensitivity in pig. When soybeans are extruded, however, the concentrations of these antigens can be reduced to low levels which may lead to improvements in growth performance. In addition, the price and availability of some high-quality protein sources, such as egg processing by-products, are becoming favorable for inclusion into nursery diets. The objective of this study was to determine whether blood plasma products in diets for SEW pigs could be replaced by alternative, less expensive protein sources.

Procedures

General

In each of three experiments, all pigs were segregated and early weaned between 11 and 14 days of age. Pigs were housed in an 18-pen nursery with four pigs/pen. Each pen contained one nipple waterer and pigs had ad libitum access to feed and water throughout the experimental period. Heat lamps and comfort boards were provided to pigs on arrival and were removed after the treatment diets began. Continuous fluorescent lighting was provided throughout the trial. Access to the nursery was limited to individuals who had no contact with other pigs during the previous 48 hours. The nursery had its own ventilation system. Upon arrival, pigs were fed a common pelleted diet on the comfort board and in feeders from day -4 to day 0. On day 0 all pigs were weighed and randomly placed in a treatment according to weight. Pen served as the experimental unit.

Compositions of the treatment diets fed from day 0 to day 14 are shown in Table 1. All diets were formulated to contain the same amino acid ratios on an apparent digestible basis and the same lysine:metabolizable energy ratio. Diets were fed in meal form. Treatment diets were followed by two phases of common corn-soybean meal-based diets. The phase-I diet was fed from day 14 to 28 and the phase-II diet was fed from day 28 to 49 (the termination of the experiment). Pigs were weighed and feed disappearance was measured weekly to calculate average daily gain, average daily feed intake, feed conversion efficiency and feed cost per pound of gain. Feed ingredient prices used to calculate cost of gain are shown in Table 2.

Table 1. Composition of diets used in Experiments 1, 2, and 3 (as-fed basis)

	Experiment 1		Experiment 2			Experiment 3		
Ingredient, %	Complex[a]	Simple	Simple + 6% SDPP	Simple + 3% SDPP, 6%SDEP[b]	Simple + 12% SDEP	Extruded Soybean	Extruded-expelled Soybean	Soybean Meal
Corn	30.00	27.40	28.20	27.75	24.66	29.00	27.20	32.35
Spray-dried plasma protein	6.00	—	6.00	3.00	—	6.00	6.00	6.00
Spray-dried egg product	—	—	—	6.00	12.00	—	—	—
Extruded soybeans, 35% CP	—	36.00	27.00	27.00	27.00	26.25	—	—
Extruded-expelled soybeans, 42% CP	—	—	—	—	—	—	25.50	—
Soybean meal, 46.5% CP	10.00	—	—	—	—	—	—	20.50
Dried whey	27.50	27.50	27.50	27.50	27.50	27.50	27.50	27.50
Oat groats	12.50	—	—	—	—	—	—	—
Menhaden fishmeal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Soybean oil	5.00	—	2.50	—	—	2.50	5.00	5.00
Premix[c]	4.00	4.00	3.80	3.75	3.84	3.75	3.80	3.65
Formulated composition[d]								
CP,%	20.80	22.70	23.90	24.60	25.20	24.00	24.10	23.90
Ca,%	1.03	1.06	1.04	1.05	1.06	1.04	1.04	1.04
P,%	.79	.81	.85	.84	.83	.85	.84	.84
ME, Mcal/lb	1.54	1.48	1.53	1.55	1.61	1.53	1.55	1.55
Amino acids, %								
Lysine	1.57(1.32)[e]	1.62(1.32)	1.63(1.33)	1.62(1.33)	1.68(1.39)	1.66(1.34)	1.61(1.34)	1.61(1.34)
Tryptophan	.31(.26)	.32(.26)	.34(.26)	.34(.26)	.34(.26)	.34(.27)	.33(.27)	.33(.27)
Threonine	1.09(.88)	1.09(.86)	1.13(.86)	1.13(.86)	1.15(.89)	1.18(.88)	1.17(.88)	1.13(.88)
Methionine	.42(.36)	.43(.35)	.49(.42)	.49(.42)	.51(.43)	.44(.37)	.45(.36)	.43(.36)

[a]The composition of the complex diet was the same for Exp. 1, 2, and 3.
[b]SDPP=spray-dried plasma protein and SDEP=spray-dried egg product.
[c]The premix contained crystalline amino acid additions, limestone, dicalcium phosphate, copper sulfate, vitamin and mineral premixes, and antibiotic.
[d]CP = crude protein; Ca= calcium; P = phosphorus; ME = metabolizable energy.
[e]The values in parentheses represent apparent digestible amino acid percentage in the diet.

Experiment 1

Seventy-two SEW barrows (Danbred®, USA, Inc.) were blocked by weight (initial weight = 11.7 lb) and assigned to two dietary treatments in a randomized complete block design. The two treatment diets included a "complex" diet and a "simple" diet, containing no spray dried plasma protein (SDPP, Table 1).

Experiment 2

Thirty-two SEW barrows and 32 SEW gilts [(University of Nebraska White Line x Duroc x Hampshire x Yorkshire x Danbred) x Danbred] assigned to one of four dietary treatments in a randomized complete block design. The first diet was the complex diet used in Experiment 1. The second diet (Simple + 6 percent SDPP) was the simple diet with the addition of 6 percent SDPP. The third diet was the simple diet with 3 percent SDPP and 6 percent spray-dried egg product (SDEP). The fourth diet was the simple diet with 12 percent SDEP (Table 1).

Table 2. Feed ingredient prices

Ingredient	Cost/ton, $
Corn	96
Spray-dried plasma protein	4360
Spray-dried egg protein	1300
Extruded soybeans	360
Extruded-expelled soybeans	360
Soybean meal	250
Dried whey	600
Oat groats	340
Menhaden fishmeal	760
Soybean oil	950

Experiment 3

Sixty-four SEW barrows (Danbred®, USA, Inc.) were blocked by weight (initial weight = 9.1 lb) and assigned to one of four dietary treatments in a randomized complete block design. The first diet was similar to the complex diet. The other three diets were formulated to contain the same lysine contribution from either extruded soybeans, extruded-expelled soybeans, or soybean meal (Table 1).

Results and Discussion

Experiment 1

Results from Experiment 1 are shown in Table 3. During both weeks of the treatment period, pigs fed the complex diet gained faster and consumed more feed than pigs fed the simple diet (P < .01). Average daily gain and average daily feed intake were not different for pigs during the day 0 to 49 period. While pigs consuming the complex diet were more efficient (P < .002) during the first week on treatment (P < .01), feed efficiency was not different (P > .3) during the second week of treatment. Pigs fed the complex diet gained more efficiently during the two-week treatment period (P < .02), but were not more efficient than pigs consuming the simple treatment during the day 0 to 49 period (P > .1). Feed cost per pound of gain for pigs fed the complex diet was greater (P < .0001) than that of pigs fed the simple diet during treatment week 1,

(Continued on next page)

Table 3. Effect of diet on growth performance of pigs in Experiment 1

Item	Complex	Simple	P-value	SEM[a]
No. of pens	9	9		
Initial wt, lb	11.7	11.6	.8853	.30
Final wt, lb	75.8	73.9	.2997	1.25
Day 0-7[b]				
ADG, lb	.59	.44	.0002	.02
ADFI, lb	.77	.64	.0014	.02
ADG/ADFI	.77	.69	.0019	.03
$/lb gain	.44	.29	.0001	.03
Day 7-14				
ADG, lb	1.19	1.06	.0097	.03
ADFI, lb	1.56	1.43	.0038	.02
ADG/ADFI	.76	.74	.3223	.03
$/lb gain	.44	.27	.0001	.03
Day 0-14				
ADG, lb	.88	.75	.0006	.02
ADFI, lb	1.17	1.03	.0012	.02
ADG/ADFI	.76	.71	.0150	.02
$/lb gain	.44	.28	.0001	.02
Day 0-49				
ADG, lb	1.32	1.28	.2390	.02
ADFI, lb	2.00	1.96	.1501	.03
ADG/ADFI	.62	.61	.1231	.01
$/lb gain	.29	.24	.0001	.01

[a]Pooled standard error of the mean.
[b]ADG = average daily gain; ADFI = average daily feed intake; ADG/ADFI = feed conversion efficiency; $/lb gain = feed ingredient cost/lb of gain.

Table 4. Effect of diet on growth performance of pigs in Experiment 2

Item	Complex	Simple + 6% SDPP[a]	3% SDPP+ 6% SDEP[a]	12% SDEP[a]	SEM[b]
No. of pens	4	4	4	4	
Initial wt, lb	10.3	10.6	10.7	10.5	.08
Final wt, lb	68.8	69.9	69.8	69.0	1.56
Day 0-7[c]					
ADG, lb	.53[d]	.46[d]	.46[d]	.35[e]	.01
ADFI, lb	.73[d]	.68[de]	.66[de]	.59[e]	.01
ADG/ADFI	.73[d]	.68[de]	.68[de]	.58[e]	.03
$/lb gain	.45	.47	.42	.44	.04
Day 7-14					
ADG, lb	.79	.77	.73	.79	.01
ADFI, lb	1.10	1.10	1.08	1.17	.01
ADG/ADFI	.72	.69	.68	.67	.01
$/lb gain	.46[d]	.47[d]	.41[e]	.38[e]	.02
Day 0-14					
ADG, lb	.66[d]	.62[de]	.59[e]	.57[e]	.01
ADFI, lb	.90	.90	.88	.88	.01
ADG/ADFI	.72[d]	.69[de]	.68[de]	.63[e]	.01
$/lb gain	.46[de]	.47[d]	.42[de]	.41[e]	.03
Day 0-49					
ADG, lb	1.19	1.21	1.21	1.19	.02
ADFI, lb	2.05	2.05	2.07	2.05	.02
ADG/ADFI	.57	.59	.59	.59	.01
$/lb gain	.28	.28	.26	.26	.01

[a]SDPP= Spray-dried plasma protein, SDEP = spray-dried egg protein.
[b]Pooled standard error of the mean.
[c]ADG = average daily gain; ADFI = average daily feed intake; ADG/ADFI = feed conversion efficiency; $/lb gain = feed ingredient cost/lb of gain.
[de]Means in the same row without a common superscript are different (P < .05).

treatment week 2, the entire treatment period and for the duration of the trial. After 49 d, no differences in pig performance could be detected between treatments, but a cost advantage still remained for the pigs fed the simple diet.

Experiment 2

Results from Experiment 2 are presented in Table 4. During the first week of treatment, pigs fed the 12 percent SDEP diet gained more slowly (P < .05) than pigs on the other three treatments. Average daily feed intake and feed efficiency of pigs on the complex diet were greater (P < .05) than that of pigs receiving the 12 percent SDEP diet during the first week of treatment. There were no differences in feed cost/per pound of gain during the first week of treatment. During the second week of treatment, there were no significant diet effects observed but the cost of gain for pigs fed diets with SDEP decreased (P < .05) compared to the complex and simple + 6 percent SDPP diet. Pigs fed the complex diet gained faster and more efficiently (P< .05) during the two week period than those fed the 12 percent SDEP diet. By the end of 49-day period, no differences among any of the treatments were detected for any performance criteria.

Experiment 3

Results of Experiment 3 are shown in Table 5. There were no differences in feed conversion during week 1 (P > .05). The cost of gain was lower (P < .05) for pigs fed the soybean meal vs complex diet. Pigs consuming the extruded-expelled soybean diet exhibited reduced (P < .05) average daily gain compared to pigs consuming either the complex or soybean meal diets. During the second week of treatment, pigs had a lower average daily gain on the extruded-expelled soybean treatment (P < .05) compared to the other three treatments. Pigs fed the soybean meal diet had reduced (P < .05) cost of gain compared to pigs fed either the complex or extruded-expelled

Table 5. Effect of diet on growth performance of pigs in Experiment 3

Item	Complex	Extruded Soybean	Extruded-Expelled Soybean	SBM[a]	SEM[b]
No. of pens	4	4	4	4	
Initial wt, lb	9.1	9.2	9.1	9.1	.06
Final wt, lb	67.3	65.7	63.7	67.5	.92
Day 0-7[c]					
ADG, lb	.66[d]	.59[de]	.48[e]	.66[d]	.01
ADFI, lb	.81[d]	.73[de]	.59[e]	.75[de]	.02
ADG/ADFI	.80	.80	.85	.89	.02
$/lb gain	.42[d]	.36[de]	.36[de]	.32[e]	.04
Day 7-14					
ADG, lb	.84[d]	.79[d]	.64[e]	.81[d]	.01
ADFI, lb	1.25[de]	1.30[d]	1.17[de]	1.16[e]	.01
ADG/ADFI	.66[de]	.60[de]	.56[e]	.70[d]	.02
$/lb gain	.50[d]	.48[de]	.53[d]	.42[e]	.04
Day 0-14					
ADG, lb	.75[d]	.68[d]	.57[e]	.73[d]	.01
ADFI, lb	1.03[d]	1.01[de]	.88[e]	.95[de]	.01
ADG/ADFI	.71[de]	.67[de]	.65[e]	.77[d]	.02
$/lb gain	.46[d]	.42[de]	.45[d]	.37[e]	.03
Day 0-49					
ADG, lb	1.19	1.14	1.12	1.17	.01
ADFI, lb	1.87	1.85	1.74	1.83	.03
ADG/ADFI	.64	.62	.65	.64	.01
$/lb gain	.27[d]	.27[de]	.26[de]	.25[e]	.01

[a]Soybean meal, 46.5% crude protein.
[b]Pooled standard error of the mean.
[c]ADG = average daily gain; ADFI = average daily feed intake; ADG/ADFI = feed conversion efficiency; $/lb gain = feed ingredient cost/lb of gain.
[de]Means in the same row with different superscripts differ (P < .05).

diet. Average daily gain was less for pigs fed the extruded-expelled diet than for pigs fed the other three treatments from day 0 to 14 (P < .05). Pigs fed the extruded-expelled soybean diet had decreased average daily gain and increased cost of gain when compared to pigs fed the soybean meal diet. No differences could be detected among treatments for any of the growth performance criteria for the entire 49-d period. Pigs fed the soybean meal diet had a lower (P < .05) cost of gain compared to pigs fed the complex diet for the 49-d trial period.

Conclusion

The performance of the SEW pigs used in this study was excellent, reflecting the source of pigs used are characterized to have a superior lean-gain/growth potential. Growth performance data suggest SEW pigs can efficiently utilize egg and soybean-based protein sources during the immediate postweaning period. Further refinement of the potential of these protein sources will help provide an economical alternative to conventional protein sources used in SEW diets.

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