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The effect of pre-weaning exposure to soybean meal on subsequent post-weaning growth performance in the early-weaned pig

Abstract

Two hundred and forty pigs averaging 11.3 lb and 21 d of age were utilized to determine the effect of pre-weaning exposure to soybean meal on nursery performance. Pigs were derived from sows that were fed either a soybean meal based- or a corn gluten meal based-diet throughout gestation and lactation. Across sow treatments, pigs were stomach-infused with 6 g/d of soybean meal or placebo from d 5 to 9 of age. Treatment structuring prior to weaning allowed for comparisons between pigs immunologically sensitized to soy proteins and pigs nonsensitized to soy proteins. Nursery treatments allowed for a comparison between a diet containing known soy antigens (glycinin and beta-eonglycinin) and a diet that did not contain dietary antigens (milk protein). Thus, eight nursery treatments resulted based upon sow treatment (soybean meal vs corn gluten meal diets), stomach infusion (soybean meal vs placebo), and Phase I dietary treatment (soybean meal vs milk diets). Pigs were allotted by weight and sex within sow treatment by stomach infusion group. Pig weights and feed consumption were recorded weekly for the determination of average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G). Sow treatment and infusion treatments did not cause differences in growth performance, allowing data to be analyzed for the main effect of nursery diet treatment. Phase I diets (1.4% lysine) were fed from d 0 to 14 post-weaning. During this time, ADG was increased by 18% in pigs fed a diet containing all milk protein. Average daily feed intake was decreased by 6% and F/G by 24% in pigs fed the soybean meal diet, compared to pigs fed the milk diet. Pigs fed a soybean meal diet during Phase I appeared to respond to the diet with a delayed transient hypersensitivity (DTH) to soy proteins. On d 14, all pigs were placed on a common (1.25% lysine) Phase II diet. This diet contained 22.7% soybean meal and 10% dried whey. Phase II performance was inverse to Phase I performance, with pigs fed a milk diet during Phase I having a 20% decrease in ADG, an 8% decrease in ADFI, and 14% poorer F/G than pigs fed a soybean meal diet during Phase I. These results suggest that the DTH response occurred during Phase II in pigs fed an all milk diet during Phase I. The magnitude of the DTH response was similar for pigs in both phases. The overall performance (d 0 to 35) indicated a 7% decrease in ADG, a 5% decrease in ADFI, with a 2% poorer F/G in pigs fed a milk diet during the Phase I period. These data indicate that pigs develop a tolerance to soy proteins within 2 wk post-weaning. Early-weaned pigs fed a diet devoid of soybean meal for 14 d will exhibit the same DTH response when placed on a corn-soybean meal diet as pigs fed a diet containing soybean meal immediately following weaning. This experiment also points out that prior infusion to soy protein is not necessary for a possible DTH response.; Swine Day, Manhattan, KS, November 21. 1991

Keywords

Swine day, 1991; Kansas Agricultural Experiment Station contribution; no. 92-193-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 641; Swine; Pig; Starter; Subsequent performance; Transient hypersensitivity; Soybean

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THE EFFECT OF PRE-WEANING EXPOSURE TO SOYBEAN MEAL ON SUBSEQUENT POST-WEANING GROWTH PERFORMANCE IN THE EARLY-WEANED PIG[1]

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Summary

Two hundred and forty pigs averaging 11.3 lb and 21 d of age were utilized to determine the effect of pre-weaning exposure to soybean meal on nursery performance. Pigs were derived from sows that were fed either a soybean meal based- or a corn gluten meal based-diet throughout gestation and lactation. Across sow treatments, pigs were stomach-infused with 6 g/d of soybean meal or placebo from d 5 to 9 of age. Treatment structuring prior to weaning allowed for comparisons between pigs immunologically sensitized to soy proteins and pigs nonsensitized to soy proteins. Nursery treatments allowed for a comparison between a diet containing known soy antigens (glycinin and beta-conglycinin) and a diet that did not contain dietary antigens (milk protein). Thus, eight nursery treatments resulted based upon sow treatment (soybean meal vs corn gluten meal diets), stomach infusion (soybean meal vs placebo), and Phase I dietary treatment (soybean meal vs milk diets). Pigs were allotted by weight and sex within sow treatment by stomach infusion group. Pig weights and feed consumption were recorded weekly for the determination of average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G). Sow treatment and infusion treatments did not cause differences in growth performance, allowing data to be analyzed for the main effect of nursery diet treatment. Phase I diets (1.4% lysine) were fed from d 0 to 14 post-weaning. During this time, ADG was increased by 18% in pigs fed a diet containing all milk protein. Average daily feed intake was decreased by 6% and F/G by 24% in pigs fed the soybean meal diet, compared to pigs fed the milk diet. Pigs fed a soybean meal diet during Phase I appeared to respond to the diet with a delayed transient hypersensitivity (DTH) to soy proteins. On d 14, all pigs were placed on a common (1.25% lysine) Phase II diet. This diet contained 22.7% soybean meal and 10% dried whey. Phase II performance was inverse to Phase I performance, with pigs fed a milk diet during Phase I having a 20% decrease in ADG, an 8% decrease in ADFI, and 14% poorer F/G than pigs fed a soybean meal diet during Phase I. These results suggest that the DTH response occurred during Phase II in pigs fed an all milk diet during Phase I. The magnitude of the DTH response was similar for pigs in both phases. The overall performance (d 0 to 35) indicated a 7% decrease in ADG, a 5% decrease in ADFI, with a 2% poorer F/G in pigs fed a milk diet during the Phase I period. These data indicate that pigs develop a tolerance to soy proteins within 2 wk post-weaning. Early-weaned pigs fed a diet devoid of soybean meal for 14 d will exhibit the same DTH response when placed on a corn-soybean meal diet as pigs fed a diet containing soybean meal immediately following weaning. This experiment also points out that

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prior infusion to soy protein is not necessary for a possible DTH response.

(Key Words: Pig, Starter, Subsequent Performance, Transient Hypersensitivity, Soybean.)

Introduction

Research has identified a delayed transient hypersensitivity (allergic) response (DTH) to soybean protein in the early-weaned pig. Research at Kansas State University has characterized the extent of this allergic response by sensitizing the young pig (4 to 9 d of age) to soybean meal. Once the pig has been sensitized to soybean proteins, antibodies specific to soybean meal are produced by the pig to protect against future infiltrations of soy protein in the small intestine. Pigs that are weaned at 21 d of age are typically placed on a starter diet that contains varied amounts of soybean meal. At this point, the antibodies specific to soy antigens mount an immune response at the intestinal level of the pig. The immune response to this antigenic infiltration results in damage to the microvilli lining of the small intestine, reducing the absorptive capacity of the intestinal tissues. Poor growth performance and possible secondary bacterial infections (*E. coli*) can result because of the intestinal damage. European research indicates that young pigs fed creep feed containing soybean meal must consume .9 to 1.1 lb of feed prior to weaning before a tolerance to soybean meal is obtained. Creep feed intakes below this amount may actually sensitize the young pig to soy proteins. When soy proteins are fed in the nursery diet, the delayed type hypersensitivity results. Thus, the purpose of this trial was to characterized the immune response from a practical approach. Data were collected to determine if young pigs require prior exposure to soybean meal, either by passive immunity from the sow or by stomach infusion, or if soybean meal in starter diets alone could trigger the immune response. The potential for a maternal transfer of antibodies to the young pig was also considered.

Procedures

Eighty crossbred sows were randomly allotted to one of two treatments at breeding: 1) milo-soybean meal diet or 2) milo-corn gluten meal diet (Table 1). Sows remained on these treatments throughout gestation and lactation. Thus, sows fed corn gluten meal were not exposed to soy proteins for 135 d. By eliminating soy exposure, a possible maternal transfer of antibodies to the young pig through the colostrum could be assessed compared to the soybean meal fed sows. On d 5 through 9 post-farrowing, six to eight pigs per litter were stomach-infused with 6 g/d of soybean meal or a placebo. These two treatments were conducted within each of the two sow treatments. Stomach infusion of soybean meal served to sensitize the young pig to soy proteins. Two hundred and forty pigs averaging 11.3 lb were weaned at 21 d of age and placed on one of two dietary treatments: 1) corn-soybean meal-lactose or 2) corn-dried skim milk-dried whey (Table 1). The final treatment structure consisted of eight treatments based upon sow treatment, infusion treatment, and nursery diet treatment. Pigs were blocked in the nursery based on nursery treatment within infusion treatment within sow treatment (Table 2).

Gestation diets were formulated to contain .5% lysine with milo and soybean meal or corn gluten meal (Table 1). The corn gluten meal diet was supplemented with 4% fish meal as an added protein source. Lactation diets were formulated to contain .65% lysine, also based on soybean meal or corn gluten meal. Phase I nursery diets were formulated to 1.4% lysine and 24.4% lactose (Table 1). A corn-soybean meal diet supplemented with 24.4% lactose was compared to a diet formulated with corn, dried skim milk, dried whey, and casein. The milk diet contained only milk products as the protein source. Pigs were switched to a common corn-soybean meal diet (1.25% lysine) with 10% dried whey on d 14 of the trial (Phase II).

Pigs were housed in an environmentally controlled nursery on wire mesh flooring. Each pen contained a self feeder and a nipple waterer to provide ad libitum access to feed and water. Four pigs were placed in each pen, with 8 replicate pens (4 ft × 5 ft) for each of the eight treatments. Pig weights and feed consumption were recorded weekly to calculate ADG, ADFI, and F/G.

Results and Discussion

Sow treatment differences ($P > .10$) were not detected in subsequent starter pig performance. Numerical increases in ADG (d 0-14 post-weaning) were detected for pigs reared on sows fed a corn gluten meal-based diet throughout gestation and lactation compared to a soybean meal-based diet. These results suggest a possible maternal transfer of anti-soy antibodies to the young pig. Pigs stomach-infused with soybean meal had similar ADG, ADFI, and F/G post-weaning as pigs stomach-infused with a placebo (Table 2). These results suggest that prior infusion of soy proteins is not neccessary to develop a DTH response.

Phase I nursery performance was drastically affected by dietary treatment. Average daily gain decreased ($P < .01$) by 18% when a soybean meal diet was fed instead of a milk diet (Table 3). Feed efficiency was 24% poorer ($P < .01$) for pigs fed a soybean meal diet, with a 6% decrease in feed intake ($P < .05$). The poor performance of pigs fed a soybean meal diet can possibly be attributed to the DTH response at the intestinal level. The 6% decrease in ADFI does not fully account for the 24% poorer F/G, indicating that soy proteins were poorly utilized by the pig.

Growth performance during Phase II (d 14-35) was inverse to that observed during Phase I (d 0-14). During this period all pigs were fed a common 1.25% lysine corn-soybean meal diet supplemented with 10% dried whey. This diet contained 22.7% soybean meal. Average daily gain for pigs fed a milk diet during the Phase I period decreased ($P < .01$) by 20% compared to pigs fed a soybean meal diet in Phase I. An 8% decrease in ADFI ($P < .01$) was detected in milk-fed pigs, whereas F/G was 14% poorer ($P < .01$). Exposing milk-fed pigs to soybean meal during Phase II may have caused a DTH response. The response was delayed 2 wk post-weaning in pigs fed a milk-diet during Phase I, but similar depressions in growth performance were detected during Phase II and Phase I. Pigs fed a soybean meal-based diet for the entire trial did not exhibit the DTH response a second time. It is possible that a tolerance to soy protein, allowing improved utilization, may have developed in pigs fed a soybean meal diet during Phase I.

Overall growth performance indicated increased ADG ($P < .05$) for pigs fed soybean meal throughout Phase I and II. Daily gains were increased by 7% for the 35 d trial. Average daily intake also increased ($P < .05$) for pigs fed soybean meal throughout the trial. Feed efficiency was not different for the entire trial. Excellent feed conversion for pigs fed a milk diet during Phase I negated the poor efficiency detected during Phase II. The adverse effects caused by the allergic reaction during Phase II remained evident for the overall performance in milk-fed pigs. Even though pigs had higher ADG and were more efficient on milk based diets during Phase I, pigs receiving soybean meal throughout the trial possibly developed a tolerance to soybean meal earlier than pigs fed a milk diet during Phase I. Diets containing strictly milk products as protein sources did not improve overall nursery performance, even though improved growth performance was detected during Phase I.

From this trial, the severity of a possible DTH response was observed in both the Phase I and II periods. It is evident that pigs cannot be fed diets devoid of soybean meal during Phase I without decreased growth performance from d 14-35 post-weaning. At some point, the pig has to be introduced to soy products for the development of tolerance to soy protein.

Pigs introduced to soybean meal in both Phase I and II exhibited a similar allergic response, which reduced growth performance. These data suggest that a tolerance to soy protein needs to be obtained soon in the early-weaned pig. European research indicated that .9 to 1.1 lb of creep feed is required to develop a tolerance to soy protein prior to weaning. Further research is necessary to determine the amount of soybean meal needed to develop soy tolerance in the early weaned pig that has not received creep feed prior to weaning.

Table 1. Composition of Diets

	Gestation		Lactation		Phase I		Phase II
Ingredient, %	SBM[a]	CGM[a]	SBM	CGM	SBM	MILK	
Milo	86.02	80.13	80.30	61.40			
Corn					24.94	43.66	55.83
Soybean meal, (48%)	9.68		14.90		40.35		22.71
Corn gluten meal		12.24		31.00			
Fish meal		4.00		4.00			4.00
Dried skim milk						20.00	
Dried whey						20.00	10.00
Casein						7.41	
L-Lysine					.10	.15	.15
DL-Methionine					.05		
Lactose					24.40		
Soybean oil					6.00	6.00	4.00
Monocalcium P[a]	2.37	1.94	2.80	1.80	2.23	1.24	1.46
Limestone	1.03	.79	1.00	.90	.73	.49	.55
Salt	.50	.50	.50	.50	.15		.25
Vitamin premix	.25	.25	.25	.25	.25	.25	.25
Trace min. premix	.15	.15	.15	.15	.15	.15	.15
Biotin premix			.10	.10			
Selenium premix					.05	.05	.05
Copper sulfate					.10	.10	.10
Antibiotic[c]					.50	.50	.50
Total:	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis, %							
Lysine	.50	.50	.65	.65	1.40	1.40	1.25
Ca	.90	.90	.90	.90	.90	.90	.90
P	.80	.80	.80	.80	.80	.80	.80

[a]SBM = soybean meal; CGM = corn gluten meal.
[b]21% phosphorus.
[c]CSP 250.

Table 2. **Nursery Growth Performance of Pigs Exposed to Soybean Meal Prior to Weaning[a]**

	SBM[b]				CGM				
	SBM[c]		Placebo		SBM		Placebo		
Item	SBM[d]	MILK	SBM	MILK	SBM	MILK	SBM	MILK	CV
d 0 to 14									
ADG, lb[e]	0.47	0.63	0.48	0.67	0.50	0.66	0.45	0.69	13.0
ADFI, lb[e]	0.61	0.63	0.63	0.66	0.62	0.66	0.60	0.67	10.3
F/G[e]	1.32	1.00	1.33	0.99	1.24	1.00	1.33	0.98	9.4
d 14 to 35									
ADG, lb[e]	1.08	0.86	1.08	0.88	1.14	0.90	1.15	0.91	14.5
ADFI, lb[e]	1.72	1.52	1.79	1.62	1.80	1.69	1.78	1.69	12.0
F/G [e]	1.60	1.78	1.66	1.88	1.58	1.91	1.57	1.87	9.2
d 0 to 35									
ADG, lb[e]	0.83	0.77	0.84	0.79	0.89	0.81	0.87	0.82	12.2
ADFI, lb[e]	1.28	1.60	1.33	1.24	1.32	1.28	1.31	1.28	10.4
F/G	1.53	1.53	1.58	1.57	1.50	1.60	1.52	1.56	6.7

[a]Means calculated from 4 pigs/pen, 8 pens/treatment.
[b]Sow gestation and lactation dietary treatment; soybean meal vs corn gluten meal.
[c]Pre-weaning infusion treatment; soybean meal vs placebo.
[d]Phase I nursery diet; soybean meal vs milk.
[e]Phase I dietary treatment milk vs soybean meal ($P<.05$).

Table 3. Nursery Growth Performance Analyzed by Main Effect of Starter Diet[a]

	Phase I Dietary Treatment[b]			
Item	Milk	Soybean Meal	S.E.[c]	Percent Difference
d 0 to 14				
ADG, lb[d]	0.66	0.48	0.013	18
ADFI, lb[e]	0.65	0.61	0.012	6
F/G[d]	0.99	1.31	0.019	24
d 14 to 35				
ADG, lb[d]	0.89	1.11	0.026	20
ADFI, lb[d]	1.63	1.78	0.036	8
F/G[d]	1.86	1.60	0.028	14
d 0 to 35				
ADG, lb[e]	0.80	0.86	0.018	7
ADFI, lb[e]	1.24	1.31	0.023	5
F/G	1.56	1.53	0.018	2

[a]Means calculated from 4 pigs/pen, 32 pens/treatment.
[b]All pigs were fed a common 10% dried whey, 1.25% lysine during Phase II.
[c]Standard error of mean.
[d]Milk vs soybean meal ($P<.01$).
[e]Milk vs soybean meal ($P<.05$).