Potential for Fish Meal Analog as a Replacement for Fish Meal in Early-Weaned Pig Diets

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Story in Brief

A total of 288 pigs (20 d of age; 7.9 ± 0.08 kg BW) were fed one of four dietary treatments to determine the potential for an animal-based protein with similar composition to fish meal (fish analog) to replace fish meal in early-weaned pig diets. Pigs were sorted into nine weight blocks, and pigs within each weight block were randomly assigned to pens of eight pigs each. Four dietary treatments fed from d 0 to 14 (Phase 1) after weaning consisted of: 1) positive control with 8% fish meal, 2) negative control with soybean meal and lysine replacing fish meal, 3) positive control with fish analog replacing 50% of the fish meal, and 4) positive control with fish analog replacing 100% of the fish meal. Fish meal was replaced in each diet on an equal lysine basis. Dietary treatments fed from d 14 to 28 (Phase 2) after weaning were similar to those in Phase 1, although the positive control diet contained 6% fish meal during Phase 2. A common Phase 3 diet was fed from d 28 to 42 after weaning. From d 0 to 7, d 7 to 14, and d 0 to 14, pigs fed the positive control diet and those fed fish analog replacing 100% of fish meal had similar ADG. From d 0 to 28, pigs fed the negative control diet had the highest ADG, while there were no differences in ADG between pigs fed the positive control diet and those fed fish analog at either replacement level. Gain:feed ratio from d 0 to 7 was highest when pigs were fed the positive and negative control diets compared to pigs fed fish analog at either replacement level. Although average body weights of pigs fed fish analog at the 100% replacement level was lower than that observed in pigs fed the negative control diet at the end of Phase 1 and Phase 2, there were no differences between body weight of pigs fed fish analog at the 100% replacement level and the positive control. This study indicates that fish analog protein results in comparable gain to fish meal when added to Phase 1 and Phase 2 diets for early-weaned pigs.

Introduction

Pigs produced in conventional intensively managed swine production systems are routinely weaned as early as 19 to 21 days of age and as early as 10 to 14 days of age in off-site segregated early-weaning systems. At these ages, pigs are very sensitive to the source of dietary protein. Many dietary proteins produce allergic reactions in which diarrhea, reduced growth, and increased mortality can occur (Bimbo and Crowther, 1992). Various protein sources have been tested in early-weaned pig diets in an attempt to overcome these problems and to decrease diet cost. Select grade menhaden fish meal has been one of the most widely utilized protein sources due to a combination of consistent quality and competitive price. Increased demand and decreased supply of fish meal has resulted in increased price volatility and periodic high prices. Spray dried plasma protein is another protein source that has consistently been shown to improve performance of early-weaned pigs when included in Phase 1 (d 0 to 14 postweaning) diets at the expense of dried skim milk (Hansen et al., 1993; Kats et al., 1994; de Rodas et al., 1995), soybean meal (Fakler et al., 1993; Coffey and Cromwell, 1995; de Rodas et al., 1995), and whey (Hansen et al., 1993). However, the supply of these proteins is limited and, therefore, these protein sources are expensive.

Mid-South Milling Co., Inc., Memphis, TN, has produced a product based on animal proteins that has a composition very similar to fish meal and should be an excellent protein and amino acid source for young pigs. This may provide a high quality protein and amino acid source for use in early weaning pig diets at costs lower than those associated with fish meal. This study was conducted to determine the potential for fish analog as a replacement for fish meal in early weaning pig diets.

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Experimental Procedures

Allotment of pigs: A total of 288 weanling pigs (20 days of age; 7.9 ± 0.08 kg body weight; Dekalb 348 mated to Dekalb EB sires) were transported to the University of Arkansas wean-to-finish facilities, sorted by weight, and divided into weight groups (blocks). Pigs within each weight group were allotted into equal subgroups (eight pigs per pen) with stratification based on litter and sex. Then treatments were randomly assigned to pens (subgroups) within each of the weight groups.

Dietary Treatments: This study was conducted to determine the efficacy of fish analog as a replacement for fish meal in Phase 1 and Phase 2 nursery diets in pigs weaned at 20 ± 2 days of age and reared in a wean-to-finish nursery.Diets during the first 14 days postweaning (Phase 1) consisted of the following:

1) A positive control Phase 1 diet containing 8.00% fish meal (Table 1).
2) A negative control diet devoid of fish meal with 48% soy bean meal and lysine added at the expense of fish meal on an equal lysine basis (requires 12.00% soybean meal and 0.05% lysine).
3) The positive control diet with fish meal analog replacing 50% of the fish meal on an equal lysine basis (replaces 4.00% fish meal).
4) The positive control diet with fish meal analog replacing 100% of the fish meal on an equal lysine basis (replaces 8.00% fish meal).

Substitutions in all diets were made at the expense of corn. Dietary metabolizable energy was maintained constant by adding fat. Diets were formulated to contain 1.50% lysine, 0.86% methionine plus cystine, 0.90% Ca, 0.80% P, and 14.85% lactose.

Diets during the second 14 days postweaning (Phase 2) consisted of the following:

1) A positive control Phase 1 diet containing 6.00% fish meal (Table 2).
2) A negative control diet devoid of fish meal with 48% soybean meal and lysine added at the expense of fish meal on an equal lysine basis (requires 8.60% soybean meal and 0.05% lysine).
3) The positive control diet with fish meal analog replacing 50% of the fish meal on an equal lysine basis (replaces 3.0% fish meal).
4) The positive control diet with fish meal analog replacing 100% of the fish meal on an equal lysine basis (replaces 6.0% fish meal).

Upon completion of Phase 2, a common phase-3 corn-soybean meal-based diet (1.20% lysine) was fed from day 28 to 42 postweaning.

Housing, Equipment & Environment: Pigs were housed in a wean-to-finish facility in totally slatted pens (1.52 m x 3.05 m) equipped with radiant heaters, a two-hole nursery feeder and wean to finish cup waterers. Ambient room temperature was maintained at approximately 78°F. In addition, a radiant heater provided supplemental heat to a 6' diameter area covering two pens/heater.

Experimental Management: On the day of weaning, the pigs were moved from the farrowing rooms and distributed to their assigned pen. The test diets were then randomly allocated to pens within block. The pigs were offered ad libitum access to the Phase 1 treatment diets for the 0- to 14-d period, the Phase 2 treatment diets for the 14- to 28-d period, and the Phase 3 diet for the 28- to 42-d period. Water was available freely throughout the study.

Animal care: Except for weighing the pigs and the feed added and leftover at the end of each test period, the pigs in this study were cared for following typical commercial management procedures. This experiment was carried out in accordance with the Animal Care Protocol # 01015 for swine experiments issued by the University of Arkansas Animal Care Committee.

Data Collection: Pig body weight and feed intake was determined weekly to evaluate ADG, ADFI, and gain:feed.

Statistical Analysis: Data were analyzed as a randomized complete block design with pen as the experimental unit and blocks based on initial body weight. Analysis of variance was performed using the GLM procedures of SAS (SAS Inst., Inc., Cary, NC). The effects of source of protein, level of fish meal replacement, and the source x level of replacement interaction were evaluated.

Results and Discussion

Overall performance was very good in this study. From d 0 to 7 (Week 1), d 7 to 14 (Week 2), and d 0 to 14 (Phase 1), pigs fed the positive control diet and those fed fish analog replacing 100% of fish meal had similar (Table 4, $P > 0.10$) ADG. During Phase 2 (Weeks 3 and 4), ADG was not significantly affected by dietary treatment. From d 0 to 28 (Phase 1-2), pigs fed the negative control diet had the highest ($P < 0.05$) ADG, while there were no differences ($P > 0.10$) in ADG between pigs fed the positive control fish meal diet and those fed fish analog at either replacement level. During phase 3 when all pigs were fed a common diet, gain in all pigs regardless of previous treatment was similar. Similarly, ADG for the overall experiment (Phase 1-3) was not affected by dietary treatment ($P > 0.10$).

Average daily feed intake was similar among the dietary treatments during Phase 1, Phase 2, and Phase 3 ($P > 0.10$); however, during Phase 2 and Phase 3, pigs fed the negative control diet tended to have increased ADFI ($P < 0.10$) when compared to those fed the positive control diet; daily feed intake in pigs fed fish analog at any replacement level was intermediary. For the overall nursery study (Phase I-III) pigs fed the negative control diet had increased ADFI ($P < 0.05$) when compared to those fed the positive control diet while there were no differences ($P > 0.10$) in ADFI between pigs fed the positive control fish meal diet and those fed fish analog at either replacement level.

Gain:feed ratio from d 0 to 7 was highest ($P < 0.05$) when pigs were fed the positive and negative control diets compared to pigs fed fish analog at either replacement level. However, during week 2 of Phase 1, for the overall Phase 1 period and during Phase 3, gain:feed was similar among the dietary treatments ($P > 0.10$). During Phase 2, gain:feed tended to be reduced in pigs fed the negative control diet compared to those fed the positive control diet ($P < 0.10$), and gain:feed in pigs fed fish analog at either replacement level was intermediary. For the overall experiment (Phase 1-3), gain:feed was improved in pigs fed the positive control diet when compared to all other treatments.

Although body weight of pigs fed fish analog at the 100% replacement level was lower ($P < 0.05$) than weight of pigs fed the negative control diet at the end of Phase 1 and Phase 2, there were no differences between body weight of pigs fed fish analog at the 100% replacement level and the positive control ($P > 0.10$). For the overall experiment (Phase 1-3), final body weight was similar among the dietary treatments ($P > 0.10$). This study indicates that fish analog protein resulted in gain comparable to fish meal when added to Phase 1 and Phase 2 diets for early-weaned pigs.

Implications

Results of this study indicate that fish meal analog, a product based on animal proteins that has a composition very similar to fish meal, is an effective replacement for select menhaden fish meal in Phase 1 and Phase 2 nursery diets at either the 50% or 100% replacement level.

Literature Cited

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Table 1. Composition of experimental phase 1 diets.

	Phase 1 diets			
	1	2	3	4
Item,%	Positive fish meal control	Negative control	50% Fish meal rep. 50% fish analog	100% Fish meal rep. fish analog
Yellow corn	38.90	32.25	38.54	38.12
Steam rolled oats	5.00	5.00	5.00	5.00
Lactose	15.00	15.00	15.00	15.00
AP –920 (plasma protein)	2.50	2.50	2.50	2.50
Soybean meal, 48% CP	**15.00**	**27.00**	**15.00**	**15.00**
Select menhaden fish meal	**8.00**	**0.00**	**4.00**	**0.00**
Fish meal analog	**0.00**	**0.00**	**4.00**	**8.00**
Pro. soy prot. (Optipro)	7.45	7.45	7.45	7.45
Fat	4.00	5.20	4.35	4.70
Ethoxyquin	0.03	0.03	0.03	0.03
Neo-terramycin 10/5	1.00	1.00	1.00	1.00
Zinc oxide	0.25	0.25	0.25	0.25
CuSO4	0.07	0.07	0.07	0.07
Mineral premix (NB-8534)	0.15	0.15	0.15	0.15
Vitamin premix (NB-6157C)	0.25	0.25	0.25	0.25
Dicalcium phosphate	1.20	2.15	1.20	1.23
Calcium carbonate	0.34	0.76	0.35	0.37
Lysine	0.15	0.20	0.15	0.15
Methionine	0.11	0.14	0.11	0.11
Threonine	0.10	0.10	0.10	0.12
Salt	0.50	0.50	0.50	0.50
Calculated composition				
Lysine	1.50	1.50	1.50	1.50
Threonine	0.98	0.98	0.98	0.98
Tryptophan	0.27	0.29	0.26	0.26
Met + cys	0.86	0.86	0.86	0.86
Isoleucine	0.89	0.93	0.87	0.85
Ca	0.90	0.90	0.90	0.90
P	0.80	0.80	0.80	0.80
Metabolizable energy	1574.89	1574.82	1574.93	1574.87
Lactose	14.85	14.85	14.85	14.85

Table 2. Composition of experimental phase 2 diets.

	Phase 2 diets			
	1	2	3	4
Item,%	Positive fish meal control	Negative control	50% fish meal rep. 50% fish analog	100% fish meal rep. fish analog
Yellow corn	53.15	48.51	52.87	52.59
Lactose	10.00	10.00	10.00	10.00
AP-301	2.00	2.00	2.00	2.00
Soybean meal, 48% CP	**21.00**	**29.60**	**21.00**	**21.00**
Select menhaden fish meal	**6.00**	**0.00**	**3.00**	**0.00**
Fish meal analog	**0.00**	**0.00**	**3.00**	**6.00**
Fat	3.70	4.60	3.95	4.22
Ethoxyquin	0.03	0.03	0.03	0.03
Neo-terramycin 10/5	1.00	1.00	1.00	1.00
Zinc oxide	0.25	0.25	0.25	0.25
CuSO4	0.07	0.07	0.07	0.07
Mineral premix (NB-8534)	0.15	0.15	0.15	0.15
Vitamin premix (NB-6157C)	0.25	0.25	0.25	0.25
Dicalcium phosphate	1.16	1.87	1.18	1.15
Calcium carbonate	0.37	0.72	0.38	0.42
Lysine	0.15	0.20	0.15	0.15
Methionine	0.11	0.13	0.10	0.10
Threonine	0.11	0.12	0.12	0.12
Salt	0.50	0.50	0.50	0.50
Calculated composition				
Lysine	1.35	1.35	1.35	1.35
Threonine	0.88	0.88	0.88	0.88
Tryptophan	0.24	0.25	0.23	0.23
Met + cys	0.76	0.76	0.76	0.76
Isoleucine	0.77	0.79	0.75	0.74
Ca	0.80	0.80	0.80	0.80
P	0.70	0.70	0.70	0.70
Metabolizable energy	1569.59	1569.10	1569.10	1569.22
Lactose	9.90	9.90	9.90	9.90

Table. 3. Treatment means for fish meal analog nursery study.

	Treatment					
	1	2	3	4		
Item,%	Positive fish meal control	Negative control	50% fish meal rep. 50% fish analog	100% fish meal rep. fish analog	SEM	P-value
ADG, lb						
Phase 1, wk 1	0.489^{ab}	0.525^{a}	0.412^{c}	0.437^{bc}	.02	< 0.01
Phase 1, wk 2	0.844^{b}	0.955^{a}	0.785^{b}	0.822^{b}	.03	< 0.01
Phase 1, wk 1-2	0.642^{b}	0.708^{a}	0.571^{c}	0.602^{bc}	.02	< 0.01
Phase 2, wk 3-4	1.265	1.303	1.283	1.281	.03	0.81
Phase 1-2, wk 1-4	0.928^{b}	0.983^{a}	0.899^{b}	0.915^{b}	.02	<0.03
Phase 3, wk 5-6	1.590	1.629	1.642	1.578	.03	0.37
Phase 1-3, wk 1-6	1.171	1.219	1.171	1.157	.02	0.12
ADFI, lb						
Phase 1, wk 1	0.492	0.527	0.454	0.485	.02	0.11
Phase 1, wk 2	0.800	0.935	0.825	0.917	.06	0.26
Phase 1, wk 1-2	0.624	0.701	0.613	0.668	.03	0.18
Phase 2, wk 3-4	1.563^{d}	1.772^{e}	1.618^{d}	1.662^{d}	.06	0.09
Phase 1-2, wk 1-4	1.058^{d}	1.193^{e}	1.075^{d}	1.124^{de}	.04	0.10
Phase 3, wk 5-6	2.346^{d}	2.542^{e}	2.480^{d}	2.427^{d}	.05	0.06
Phase 1-3, wk 1-6	1.526^{b}	1.684^{a}	1.590^{ab}	1.601^{ab}	.04	0.04
Gain:feed						
Phase 1, wk 1	$.992^{a}$	$.982^{a}$	$.902^{b}$	$.895^{b}$	.022	< 0.01
Phase 1, wk 2	1.109	1.022	1.021	.920	.076	0.40
Phase 1, wk. 1-2	1.043	1.001	.962	.905	.039	0.11
Phase 2, wk 3-4	$.823^{d}$	$.738^{e}$	$.803^{d}$	$.778^{d}$	.024	0.09
Phase 1-2, wk 1-4	$.888^{d}$	$.820^{e}$	$.849^{de}$	$.818^{e}$	.020	0.08
Phase 3, wk 5-6	.683	.646	.665	.653	.014	0.29
Phase 1-3, wk 1-6	$.772^{a}$	$.724^{b}$	$.742^{b}$	$.726^{b}$	.010	< 0.01
Weight, lb						
Initial	13.75	13.78	13.73	13.76	.01	0.29
Phase 1, wk 1	17.66^{ab}	17.90^{a}	17.02^{c}	17.26^{bc}	.18	< 0.01
Phase 1, wk 2	22.73^{ab}	23.63^{a}	21.74^{c}	22.18^{bc}	.26	< 0.01
Phase 2, wk 2	37.90^{ab}	39.29^{a}	37.10^{b}	37.54^{b}	.48	0.03
Phase 3, wk 2	61.75	63.71	61.77	61.24	.77	0.14

^{a,b,c} Means in a row with no letter in common differ (P < 0.05).

^{d,e} Means in a row with no letter in common differ (P < 0.10).