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Effect of Fish Meal Source on Nursery Pig Performance

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Effect of Fish Meal Source on Nursery Pig Performance

Abstract

A total of 600 pigs (Exp. 1, n=250, PIC 327 × 1050; Exp. 2, n=350, DNA Line 200 × 400 with an initial BW of 15.6 ± 0.1 and 14.3 ± 0.2, respectively) were used in two 14-d experiments to determine the effects of fish meal source on nursery pig performance. Each experiment had 10 pens per treatment and five pigs per pen. In Exp. 1, pigs were allotted to pens at weaning (d 0) and were fed a common starter diet for 5 d. On d 5, pens of pigs were allotted by BW to experimental diets that were corn and soybean meal-based and contained 10% dried whey. Dietary treatments included a corn and soybean meal-based diet, a diet containing 8.3% HP 300 (Hamlet Protein, Findlay, OH), or diets containing 6% fish meal from one of three sources (IPC 790 Fish Meal, The Scoular Company, Minneapolis, MN; Special Select Menhaden Fish Meal, Omega Proteins, Houston, TX; and Daybrook LT Prime Menhaden Fish Meal, Daybrook Fisheries, Morristown, NJ). The Special Select Menhaden fish meal was from the 2014 catch year, while the LT Prime and IPC 790 were from the 2015 catch year. Samples of each fish meal source were analyzed for total volatile N (New Jersey Feed Laboratories, Inc., Trenton, NJ); a measure of fish meal quality or freshness. All samples of fish meal contained less than 0.15% total volatile N indicating high quality. Results from Exp. 1 indicated that there were no differences observed in ADG or ADFI between any of the treatments. However, pigs fed IPC 790 fish meal had poorer F/G from d 7 to 14 ($P < 0.049$) and overall ($P < 0.009$) compared to pigs fed all other treatments.

In Exp. 2, pigs were allotted to pens at weaning (d 0) and were fed a common starter diet for 7 d and then pens were allotted by BW to experimental diets. Fish meal sources were the same as in Exp. 1, except they were all from the 2014 catch year. Dietary treatments included the same corn and soybean meal-based diet and diets with 6% fish meal from Exp. 1. In addition, diets with 3% fish meal were included. From d 0 to 14, a fish meal source × level interaction was observed for ADG and F/G. Pigs fed increasing IPC 790 fish meal had a linear improvement in ADG and F/G; however, for pigs fed either Special Select Menhaden or LT Prime Menhaden fish meals, there was no improvement in performance beyond the 3% inclusion. Traditional measures of fish meal quality (total volatile N) did not appear to be correlated with pig performance in these studies.

Keywords

fish meal, growth, nursery pig, protein quality

Cover Page Footnote

Appreciation is expressed to Scott Herbert Daybrook Fisheries, Morristown, NJ and Jeff Schaeffer, The Scoular Company, Minneapolis, MN for their technical support. Appreciation is expressed to Daybrook Fisheries, Inc., Morristown, NJ; The Scoular Company, Minneapolis, MN; and Hamlet Protein Inc., Findlay, OH for their donation of IPC 790, Daybrook LT Prime Menhaden and HP 300 for the use of this study respectively.

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Effect of Fish Meal Source on Nursery Pig Performance[1,2]

A. M. Jones, J. C. Woodworth, R. D. Goodband, M. D. Tokach, S. S. Dritz[3], and J. M. DeRouchey

Summary

A total of 600 pigs (Exp. 1, n=250, PIC 327 × 1050; Exp. 2, n=350, DNA Line 200 × 400 with an initial BW of 15.6 ± 0.1 and 14.3 ± 0.2, respectively) were used in two 14-d experiments to determine the effects of fish meal source on nursery pig performance. Each experiment had 10 pens per treatment and five pigs per pen. In Exp. 1, pigs were allotted to pens at weaning (d 0) and were fed a common starter diet for 5 d. On d 5, pens of pigs were allotted by BW to experimental diets that were corn and soybean meal-based and contained 10% dried whey. Dietary treatments included a corn and soybean meal-based diet, a diet containing 8.3% HP 300 (Hamlet Protein, Findlay, OH), or diets containing 6% fish meal from one of three sources (IPC 790 Fish Meal, The Scoular Company, Minneapolis, MN; Special Select Menhaden Fish Meal, Omega Proteins, Houston, TX; and Daybrook LT Prime Menhaden Fish Meal, Daybrook Fisheries, Morristown, NJ). The Special Select Menhaden fish meal was from the 2014 catch year, while the LT Prime and IPC 790 were from the 2015 catch year. Samples of each fish meal source were analyzed for total volatile N (New Jersey Feed Laboratories, Inc., Trenton, NJ); a measure of fish meal quality or freshness. All samples of fish meal contained less than 0.15% total volatile N indicating high quality. Results from Exp. 1 indicated that there were no differences observed in ADG or ADFI between any of the treatments. However, pigs fed IPC 790 fish meal had poorer F/G from d 7 to 14 ($P < 0.049$) and overall ($P < 0.009$) compared to pigs fed all other treatments.

In Exp. 2, pigs were allotted to pens at weaning (d 0) and were fed a common starter diet for 7 d and then pens were allotted by BW to experimental diets. Fish meal sources were the same as in Exp. 1, except they were all from the 2014 catch year. Dietary treatments included the same corn and soybean meal-based diet and diets with 6% fish meal from Exp. 1. In addition, diets with 3% fish meal were included. From d 0 to 14, a fish meal source × level interaction was observed for ADG and F/G. Pigs fed increasing IPC

[1] Appreciation is expressed to Scott Herbert Daybrook Fisheries, Morristown, NJ and Jeff Schaeffer, The Scoular Company, Minneapolis, MN for their technical support.
[2] Appreciation is expressed to Daybrook Fisheries, Inc., Morristown, NJ; The Scoular Company, Minneapolis, MN; and Hamlet Protein Inc., Findlay, OH for their donation of IPC 790, Daybrook LT Prime Menhaden and HP 300 for the use of this study respectively.
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790 fish meal had a linear improvement in ADG and F/G; however, for pigs fed either Special Select Menhaden or LT Prime Menhaden fish meals, there was no improvement in performance beyond the 3% inclusion. Traditional measures of fish meal quality (total volatile N) did not appear to be correlated with pig performance in these studies.

Key words: fish meal, growth, nursery pig, protein quality

Introduction

At weaning, pigs undergo many physiological and environmental changes that significantly impact the function and structure of the gastrointestinal tract. Consequently, when these stressors become too great for the newly weaned pig to overcome, feed intake is significantly reduced leading to sub-optimal performance (Pluske et al., 1997[4]). Thus to encourage feed intake, highly palatable and nutrient dense protein sources are commonly added to nursery diets.

One protein source that has been widely used in commercial nursery diets is fish meal. Fish meal is a protein source that is commonly used to stimulate feed intake and is highly digestible. However, the quality of fish meal used in the swine industry may vary considerably based on the catch year, storage duration, and species of fish. Due to these underlying constraints, growth response of pigs can vary significantly. Therefore, the objective of this study was to determine the effects of different fish meal sources on nursery pig performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocols used in these experiments. The studies were conducted at the K-State Swine Teaching and Research Center and the K-State Segregated Early Weaning facilities.

Two 14 d experiments were conducted and each experiment had 10 pens per treatment and 5 pigs per pen. Pigs were fed corn and soybean meal-based diets with 10% spray-dried whey.

For Exp. 1, a total of 250 mixed sex pigs (PIC 327 × 1050; initial BW 15.6 ± 0.1 lb) were weaned at 21 d of age, randomly allotted to pens, and fed a common starter diet for five days. Each pen had metal tri-bar flooring and was equipped with a 3-hole stainless steel feeder and one nipple waterer for ad libitum access to feed and water. Pens were 4 × 5 ft to allow 4 ft^2 per pig. Pigs were fed a common starter diet for 5 d then allotted by BW to 1 of 5 dietary treatments. Dietary treatments included a corn-soybean meal-based diet, a diet containing 8.3% HP 300 (Hamlet Protein, Findlay, OH), and diets that included 6% fish meal from one of three sources (Special Select Menhaden Fish Meal, Omega Proteins, Houston, TX; Daybrook LT Prime Menhaden Fish Meal, Daybrook Fisheries, Morristown, NJ; and IPC 790 Fish Meal, The Scoular Company, Minneapolis, MN; Table 1). The Special Select Menhaden fish meal was from the 2014 catch year, while the LT Prime and IPC 790 were from the 2015 catch year. Diets were

[4] Pluske, J.R., D.J. Hampson, and I.H. Williams. 1997. Factors influencing the structure and function of the small intestine in the weaned pig: a review. Livest. Prod. Sci. 51:215-236.

formulated such that 6% fish meal provided the same amount of standardized ileal digestible (SID) lysine as 8.3% HP 300. Calculated amino acid values (NRC 2012[5]) and SID coefficients were used in diet formulation for the 3 fish meal sources, while nutrient values for the HP 300 were provided by the manufacturer.

In Exp. 2, a total of 350 barrows (DNA Line 200 × 400; initial BW 14.3 ± 0.2 lb) were randomly allotted to pens and fed a common starter diet for 7 d. Each pen had metal tri-bar flooring and was equipped with a 3-hole stainless steel feeder and one cup waterer for ad libitum access to feed and water. Pens were 3.9 × 4.0 ft to allow approximately 3 ft^2 per pig. On d 7 post-weaning, pigs were allotted by BW to experimental diets. All sources of fish meal used in this experiment were from the 2014 catch year, but different batches than used in Exp. 1. Dietary treatments included the same corn and soybean meal-based diet and diets with 6% fish meal from Exp. 1. In addition, diets with 3% fish meal were also included (Table 2).

Samples of the HP 300 and fish meal sources were collected at the feed mill as diets were manufactured. Complete diet samples were obtained from feeders, composited, and stored at -4°F for subsequent analysis. Composite samples of protein sources and diets were analyzed for DM, CP, Ca, P, and ether extract (Ward Laboratory, Kearney, NE). In addition, fish meal sources were analyzed for amino acids (University of Missouri-Columbia College of Agriculture Experiment Station Chemical Laboratories) along with a modified Torry digestibility and total volatile N analysis (New Jersey Feed Laboratories, Inc., Trenton, NJ). Both of these tests are designed as an indicator of protein quality or freshness of fish meal. The modified Torry digestibility is calculated as portion of the acid insoluble N that is soluble in acid pepsin solution[6]. The total volatile N measures free N, which is an indication of volatilization of crude protein.

Pigs and feeders were weighed on d 0, 7, and 14 after weaning to determine ADG, ADFI, and F/G. Data were analyzed using the PROC GLIMMIX procedure in SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit and dietary treatments as the fixed effect. The main effects of source and level, as well as their interactions were tested. A P-value ≤ 0.05 was considered significant and 0.05 < P ≤ 0.10 was considered a trend.

Results and Discussion

Chemical analysis of fish meal sources used in Exp. 1 and 2 indicated that they were high quality as indicated by the total volatile N concentration (Table 3 and 4)[7]. Total volatile N was similar among the fish meal sources and a value less than 0.15% indicates very fresh fish meal[6]. The Special Select Menhaden fish meal had the lowest modified Torry digestibility value relative to IPC 790 or LT Prime Menhaden fish meal. The Special Select fish meal used in Exp. 1 and 2 contained less CP and Lys than the other

[5] NRC. 2012. Nutrient Requirements of Swine, 10th Ed. Natl. Acad. Press, Washington, D.C.
[6] Kjeldsen, N. J., V. Daniel- A. Just, H. E. Nielsen and B. O. Eggum. 1983. Inclusion of fish meal manufactured from fish with different degrees of freshness in diets for early weaned pigs. Natl. Inst. Anim. Sci., Copenhagen Newsletter No. 390.
[7] Stoner, G.R., G.L. Allee, J.L. Nelssen, M.E. Johnston, and R.D. Goodband. 1990. Effect of select menhaden fish meal in starter diets for pigs. J. Anim. Sci. 68:2729-2735.

sources with the largest difference from the calculated values used in formulation being observed in Exp. 1 compared with Exp. 2 (Table 5 and 7).

In Exp. 1, there were no differences between any treatments regardless of HP 300 or fish meal sources for ADG or ADFI (Table 6). However, pigs fed IPC 790 fish meal had poorer F/G from d 7 to 14 ($P < 0.049$) and overall ($P < 0.009$) compared to pigs fed diets with other protein sources.

In Exp. 2, there was a tendency ($P < 0.093$) for a source × level interaction for ADG from d 0 to 7 (Table 8). This was the result of pigs fed IPC 790 having a linear improvement in ADG; however, pigs fed Special Select fish meal had an improvement in ADG up to the 3% inclusion after which ADG decreased. Pigs fed LT Prime had no change in ADG beyond the 3% addition.

From d 7 to 14, a tendency ($P < 0.084$) for a source × level interaction was detected for ADG and was the result of no change in ADG observed when pigs were fed increasing levels of IPC 790 or LT Prime; however, pigs fed the highest level of Special Select fish meal had poorer performance compared to lower inclusion levels. While there was no significant treatment effect observed on ADFI, pigs fed LT Prime had a tendency ($P < 0.080$) for improved F/G compared to pigs fed Special Select with those fed IPC 790 intermediate.

Overall (d 0 to 14) a source × level interaction was observed for ADG ($P < 0.009$) similar to that observed from d 0 to 7. This observation is noted as the result of pigs fed increasing IPC 790 having a linear improvement in ADG with pigs fed Special Select fish meal having increased ADG with the 3% inclusion but then decreased ADG with the 6% inclusion. Pigs fed LT Prime fish meal had no change in ADG beyond the 3% addition. While no difference in ADFI was observed between treatments, there was a tendency ($P < 0.066$) for a source × level interaction for F/G. This was a result of F/G linearly improving as IPC 790 increased, but for pigs fed either Special Select or LT Prime fish meal sources, there was no further improvement in F/G beyond the 3% addition.

In conclusion, based on the total volatile N analyses, all fish meal sources were relatively fresh with high protein quality. In Exp. 2, adding 3% of any fish meal source improved ADG; however only pigs fed IPC 790 had a further improvement in ADG and F/G when 6% was fed. Traditional measures of fish meal quality (total volatile N and Modified Torry digestibility) did not explain the differences in performance found with the fish meal sources in this study.

Table 1. Diet composition (Exp. 1 as-fed basis)[1]

Ingredient, %	Control	HP 300	Fish meal[2]
Corn	40.55	41.53	44.86
Soybean meal, 46.5%	32.75	23.36	23.37
Corn DDGS[3]	10.00	10.00	10.00
Spray-dried whey	10.00	10.00	10.00
Fish meal	---	---	6.00
HP 300[4]	---	8.30	---
Choice white grease	3.00	3.00	3.00
Limestone	1.05	1.10	0.78
Monocalcium P, 21% P	1.05	1.15	0.35
Sodium chloride	0.30	0.30	0.30
L-lysine HCl	0.35	0.35	0.35
DL-methionine	0.15	0.15	0.14
L-threonine	0.11	0.10	0.13
L-tryptophan	---	---	0.03
L-valine	0.03	---	0.05
Trace mineral premix	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25
Phytase[5]	0.02	0.02	0.02
Zinc oxide	0.25	0.25	0.25
Total	100	100	100

continued

Table 1. Diet composition (Exp. 1 as-fed basis)[1]

Ingredient, %	Control	HP 300	Fish meal[2]
Calculated analysis			
SID amino acid, %			
Lys	1.35	1.35	1.35
Ile:lys	64	62	61
Met:lys	35	35	37
Met & cys:lys	58	58	58
Thr:lys	63	63	63
Trp:lys	18.5	18.5	18.5
Val:lys	71	71	71
Total Lys, %	1.52	1.51	1.53
ME, kcal/lb	1,546	1,560	1,570
NE kcal/lb	1,138	1,150	1,166
SID Lys:ME, g/Mcal	3.96	3.92	3.90
CP, %	23.4	23.6	23.1
Ca, %	0.77	0.77	0.77
P, %	0.69	0.65	0.66
Available P, %	0.51	0.51	0.51

[1] Diets were fed from approximately 15 to 25 lb BW.
[2] Fish meal sources were: IPC 790 (2015 catch year, The Scoular Company, Minneapolis, MN); Omega Special Select fish meal (2014 catch year, Omega Protein, Houston, TX); Daybrook LT Prime Menhaden fish meal (2015 catch year, Daybrook Fisheries, Inc., Morristown, NJ).
[3] Dried distillers grain with solubles.
[4] Hamlet Protein, Findlay, OH.
[5] Ronozyme® HiPhos 2700 (DSM Nutritional Products, Parsippany, NJ) provided 216 phytase units (FTU/lb) of diet with a release of 0.10% available P.

Table 2. Diet composition (Exp. 2 as-fed basis)[1]

		Fish meal[2]	
Ingredient, %	Control	3%	6%
Corn	40.55	42.70	44.86
Soybean meal, 46.5%	32.75	28.06	23.37
Corn DDGS[3]	10.00	10.00	10.00
Spray-dried whey	10.00	10.00	10.00
Fish meal	---	3.00	6.00
Choice white grease	3.00	3.00	3.00
Limestone	1.05	0.91	0.78
Monocalcium P, 21% P	1.05	0.70	0.35
Sodium chloride	0.30	0.30	0.30
L-lysine HCl	0.35	0.35	0.35
DL-methionine	0.15	0.14	0.14
L-threonine	0.11	0.12	0.13
L-tryptophan	---	0.01	0.03
L-valine	0.03	0.04	0.05
Trace mineral premix	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25
Phytase[4]	0.02	0.02	0.02
Zinc oxide	0.25	0.25	0.25
Total	100	100	100

continued

Table 2. Diet composition (Exp. 2 as-fed basis)[1]

		Fish meal[2]	
Ingredient, %	Control	3%	6%
Calculated analysis			
SID amino acid, %			
Lys	1.35	1.35	1.35
Ile:lys	64	62	61
Met:lys	35	36	37
Met & cys:lys	58	58	58
Thr:lys	63	63	63
Trp:lys	18.5	18.5	18.5
Val:lys	71	71	71
Total Lys, %	1.52	1.53	1.53
ME, kcal/lb	1,546	1,558	1,570
NE NRC, kcal/lb	1,138	1,552	1,166
SID Lys:ME, g/Mcal	3.96	3.93	3.90
CP, %	23.4	23.2	23.1
Ca, %	0.77	0.77	0.77
P, %	0.69	0.68	0.66
Available P, %	0.51	0.51	0.51

[1] Diets were fed from approximately 15 to 25 lb BW.
[2] Fish meal sources were: IPC 790 (The Scoular Company, Minneapolis, MN); Omega Special Select fish meal (Omega Protein, Houston, TX); Daybrook LT Prime Menhaden fish meal (Daybrook Fisheries, Inc., Morristown, NJ). All fish meal sources were from the 2014 catch year.
[3] Dried distillers grain with solubles.
[4] Ronozyme® HiPhos 2700 (DSM Nutritional Products, Parsippany, NJ) provided 216 phytase units (FTU/lb) of diet with a release of 0.10% available P.

Table 3. Nutrient analysis of protein sources (Exp. 1 as-fed basis)[1]

		Fish meal source		
Item	HP 300[2]	IPC 790[3]	Special Select[4]	LT Prime[5]
Proximate analysis, %				
DM	92.08	90.68	91.72	91.66
CP	55.80	66.50	61.90	64.10
Ca	0.27	3.88	5.85	5.38
P	0.72	2.45	3.07	3.04
Ether extract	1.00	7.30	9.10	7.60
Ash	6.14	15.90	19.77	19.02
Total volatile N	-	0.11	0.15	0.08
Modified Torry digestibility	-	86.7	70.6	83.4
Total amino acids, %				
Arginine	3.85	3.63	3.67	3.79
Histidine	1.31	1.95	1.09	1.37
Isoleucine	1.89	2.20	1.75	2.07
Leucine	3.91	4.66	3.60	4.42
Lysine	3.25	5.02	3.86	4.82
Methionine	0.72	1.84	1.46	1.84
Threonine	2.07	2.74	2.30	2.67
Tryptophan	0.82	0.80	0.54	0.75
Valine	2.03	2.69	2.23	2.53

[1] Values represent the composite sample analyzed in duplicate by the University of Missouri-Columbia College of Agriculture, Food and Natural Resources – Agriculture Experiment Station Chemical Laboratories, Columbia, MO.
[2] Hamlet Protein, Findlay, OH.
[3] 2015 catch year, The Scoular Company, Minneapolis, MN.
[4] 2014 catch year, Omega Protein, Houston, TX.
[5] 2015 catch year, Daybrook Fisheries, Inc., Morristown, NJ.

Table 4. Nutrient analysis of protein sources (Exp. 2 as-fed basis)[1]

	Fish meal source		
Item	IPC 790[2]	Special Select[3]	LT Prime[4]
Proximate analysis, %			
DM	91.07	89.64	91.72
CP	66.53	57.83	62.46
Ca	4.13	3.97	5.93
P	2.48	2.51	2.78
Ether extract	8.78	7.64	8.64
Ash	17.43	16.45	18.46
Total volatile N	0.13	0.10	0.09
Modified Torry digestibility	91.70	85.20	89.10
Total amino acids, %			
Arginine	3.66	3.59	3.89
Histidine	2.26	1.35	1.39
Isoleucine	2.13	1.93	2.18
Leucine	4.75	4.14	4.46
Lysine	5.18	4.54	4.86
Methionine	1.86	1.66	1.80
Threonine	2.79	2.54	2.64
Tryptophan	0.87	0.65	0.63
Valine	2.62	2.37	2.67

[1] Values represent the composite sample analyzed in duplicate by the University of Missouri-Columbia College of Agriculture, Food and Natural Resources – Agriculture Experiment Station Chemical Laboratories, Columbia, MO. All fish meal sources were from the 2014 catch year.
[2] The Scoular Company, Minneapolis, MN.
[3] Omega Protein, Houston, TX.
[4] Daybrook Fisheries, Inc., Morristown, NJ.

Table 5. Proximate analysis of diets (Exp. 1 as-fed basis)[1,2]

			Fish meal source		
Item, %	Control	HP 300[3]	IPC 790[4]	Special Select[5]	LT Prime[6]
DM	90.27	88.73	88.58	90.46	90.18
CP	24.20	24.20	22.30	24.00	23.20
Ca	0.81	0.89	0.84	0.89	0.89
P	0.71	0.73	0.64	0.69	0.72
Ether extract	5.70	5.10	5.50	5.40	5.60
Ash	6.11	5.36	5.76	5.73	6.21

[1] Diets were sampled at the feeder 2 d after initiation and 2 d prior to termination of the experiment. Samples were pooled, mixed, and then split to create a composite sample for analysis.
[2] Samples of the diets were then submitted for analysis (Ward Laboratories, Inc., Kearny, NE).
[4] 2015 catch year, The Scoular Company, Minneapolis, MN.
[5] 2014 catch year, Omega Protein, Houston, TX.
[6] 2015 catch year, Daybrook Fisheries, Inc., Morristown, NJ.

Table 6. Effects of fish meal source on nursery pig performance (Exp. 1)[1]

				Fish meal source			
Item	Control	HP300[2]	IPC 790[3]	Special Select[4]	LT Prime[5]	SEM	Probability, $P <$
BW, lb							
d 0	15.6	15.6	15.6	15.6	15.6	0.12	0.999
d 7	17.5	17.5	17.6	17.7	17.6	0.28	0.964
d 14	23.0	22.7	22.7	23.1	23.3	0.40	0.791
d 0 to 7							
ADG, lb	0.27	0.27	0.29	0.31	0.29	0.030	0.878
ADFI, lb	0.56	0.48	0.54	0.53	0.49	0.037	0.467
F/G	2.11	1.98	2.10	1.80	1.80	0.260	0.739
d 7 to 14							
ADG, lb	0.93	0.86	0.85	0.89	0.95	0.034	0.217
ADFI, lb	1.08	1.01	1.17	1.11	1.10	0.050	0.270
F/G	1.18[b]	1.17[b]	1.38[a]	1.26[ab]	1.17[b]	0.056	0.049
d 0 to 14							
ADG, lb	0.57	0.54	0.55	0.58	0.59	0.026	0.644
ADFI, lb	0.80	0.72	0.86	0.80	0.77	0.037	0.170
F/G	1.40[b]	1.34[b]	1.57[a]	1.39[b]	1.31[b]	0.050	0.009

[ab] Means without common superscripts differ $P < 0.05$.
[1] A total of 250 pigs (PIC, 327 × 1050) were used with 5 pigs/pen and 10 replications/treatment.
[2] HP 300 specialty soy protein (Hamlet Protein, Findlay, OH).
[3] IPC 790 fish meal, 2015 catch year (The Scoular Company, Minneapolis, MN).
[4] Omega Special Select, 2014 catch year (Omega Protein, Houston, TX).
[5] Daybrook LT Prime Menhaden fish meal, 2015 catch year (Daybrook Fisheries, Inc., Morristown, NJ).

Table 7. Proximate analysis of diets (Exp. 2 as-fed basis)[1,2]

		IPC 790[3]		Special Select[4]		LT Prime[5]	
Item, %	Control	3%	6%	3%	6%	3%	6%
DM	92.08	90.14	90.40	90.48	89.25	90.75	90.94
CP	24.80	24.70	24.20	24.50	23.90	23.30	23.70
Ca	0.81	0.76	0.87	0.81	0.92	0.78	0.87
P	0.73	0.77	0.70	0.71	0.66	0.69	0.68
Ether Extract	5.60	4.90	6.10	5.10	6.20	5.40	5.60
Ash	5.72	5.86	5.43	5.91	6.23	5.83	5.76

[1] Diets were sampled at the feeder 2 d after initiation and 2 d prior to termination of the experiment. Samples were pooled, mixed, and then split to create a composite sample for analysis. All fish meal sources were from the 2014 catch year.
[2] Samples of the diets were then submitted for analysis (Ward Laboratories, Inc., Kearny, NE).
[3] The Scoular Company, Minneapolis, MN.
[4] Omega Protein, Houston, TX.
[5] Daybrook Fisheries, Inc. Morristown, NJ.

Table 8. Effects of fish meal source and level on nursery pig performance (Exp. 2)[1]

		IPC 790[2]		Special Select[3]		LT Prime[4]			Probability, P <		
Item	Control	3%	6%	3%	6%	3%	6%	SEM	Source × level	Source	Level
BW, lb											
d 0	14.3	14.3	14.3	14.3	14.3	14.3	14.3	0.20	0.998	0.997	0.908
d 7	16.5	17.1	17.3	17.3	16.7	17.0	16.9	0.26	0.282	0.538	0.540
d 14	22.0[bc]	22.6[abc]	23.2[a]	22.9[ab]	21.8[c]	22.6[abc]	22.5[abc]	0.38	0.060	0.369	0.456
d 0 to 7											
ADG, lb	0.34[b]	0.39[ab]	0.43[a]	0.42[a]	0.33[b]	0.38[ab]	0.36[ab]	0.029	0.093	0.332	0.430
ADFI, lb	0.44	0.48	0.50	0.49	0.46	0.47	0.47	0.043	0.261	0.651	0.683
F/G	1.43	1.24	1.16	1.22	1.36	1.27	1.35	0.140	0.261	0.338	0.283
d 7 to 14											
ADG, lb	0.78[ab]	0.78[ab]	0.84[a]	0.81[a]	0.72[b]	0.81[a]	0.80[ab]	0.031	0.084	0.294	0.596
ADFI, lb	1.02	1.03	1.07	1.06	1.01	1.01	1.00	0.036	0.467	0.417	0.790
F/G	1.30	1.33	1.28	1.31	1.37	1.26	1.26	0.034	0.362	0.080	0.812
d 0 to 14											
ADG, lb	0.55[bc]	0.59[abc]	0.64[a]	0.62[a]	0.53[c]	0.59[ab]	0.58[abc]	0.021	0.009	0.213	0.325
ADFI, lb	0.73	0.76	0.78	0.78	0.73	0.73	0.74	0.025	0.327	0.399	0.700
F/G	1.33[ab]	1.29[abc]	1.24[c]	1.27[bc]	1.35[a]	1.24[c]	1.27[abc]	0.029	0.066	0.179	0.450

[abc] Means without common superscripts differ $P < 0.05$.
[1] A total of 350 maternal barrows (DNA, Line 200 × 400) were used in a phase 2 nursery trial with 5 pigs/pen and 10 replications/treatment.
[2] IPC 790 fish meal, 2014 catch year (The Scoular Company, Minneapolis, MN).
[3] Omega Special Select, 2014 catch year (Omega Protein, Houston, TX).
[4] Daybrook LT Prime Menhaden fish meal, 2014 catch year (Daybrook Fisheries, Inc., Morristown, NJ).