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Effect of Diet Complexity and Specialty Protein Source on Nursery Pig Performance[1,2]

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Summary

A total of 720 nursery pigs (PIC C-29 × 359, initially 12.5 lb BW) were used in a 42-d growth trial to determine the effects of diet complexity and specialty soy protein source on nursery pig performance. Pigs were allotted by BW and sex, and randomly assigned to 1 of 6 dietary treatments in a 2 × 3 factorial arrangement with main effects of diet complexity (complex vs. simple) and specialty protein source (fish meal, HP 300, or HP 800). The HP 300 and HP 800 are two different enzymatically treated soy products manufactured and sold by Hamlet Protein (Findlay, OH). Experimental diets were fed in two phases (Phase 1 was budgeted at 5 lb per pig and Phase 2 was fed thereafter until d 21) with a common diet fed for 3 wk following the experimental diets. No interactions were observed between diet complexity and protein source for growth performance for any phase or overall. From d 0 to 7, pigs fed the complex diet had a tendency for improved ADG ($P = 0.078$) and d 7 BW ($P = 0.053$) compared to pigs fed the simple diet. There was no difference in performance observed from d 7 to 21; however, for the overall treatment feeding period (d 0-21), pigs fed the complex diets had improved F/G ($P = 0.037$) compared to pigs fed the simple diets. During the Phase 3 common diet feeding period (d 21 to 42), no differences were observed between pigs previously fed different diet complexity or protein sources. Overall (d 0 to 42), no differences in growth performance were found between treatments. For economics, pigs fed a simple diet tended to have greater IOFC ($P = 0.055$). Feed cost per pound of gain was lower ($P = 0.002$) for pigs fed diets with HP 300 and HP 800 compared to those fed diets with fish meal. In summary, this study suggests that the differences in diet complexity used in this study had minor impacts on growth performance during the phases in which they were fed but not overall. Furthermore, the three specialty protein sources used in this study resulted in similar growth performance.

Key words: diet complexity, nursery pig, protein sources

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Introduction

Soybean meal is one of the most readily available and economical protein sources commonly fed to pigs. Due to a number of anti-nutritional factors, its inclusion in newly weaned pig diets has been limited. Thus, specialty animal proteins, such as animal plasma, blood cells, or fish meal have been commonly added as highly digestible amino acid sources in starter diets. In recent years, the cost and variability of specialty animal proteins has increased while availability of some sources has decreased. Furthermore, biosecurity concerns have led some nutritionists to remove any porcine-derived products from swine diets. As a result, producers have sought more economical and readily available alternatives.

One category of alternative protein sources that has gained significant interest in recent years is further processed soybean meal products. Their benefits include lower levels of common anti-nutritional factors compared to conventional soybean meal (Cervantes-Pahm and Stein, 2010;[4] Goebel and Stein, 2011[5]) as well as a greater concentration of digestible AA (Cervantes-Pahm and Stein, 2010[4]). One such product is HP 300 (Hamlet Protein, Findlay, OH), which is a finely ground hydrolyzed soy protein produced from conventional soybean meal treated to remove anti-nutritional factors (Cervantes-Pahm and Stein, 2010;[4] Goebel and Stein, 2011[5]). Recently, the same supplier has also introduced another further-processed soybean meal product (HP 800), but minimal data are available to determine its effects on growth performance of weanling pigs. Thus, the objective of this study was to compare the performance of nursery pigs fed different protein sources in varying diet complexities in a commercial research setting.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol for this experiment. The study was conducted at the Cooperative Research Farm's Swine Research Nursery (Sycamore, OH), which is owned and managed by Kalmbach Feeds, Inc. Each pen had slatted metal floors and was equipped with a 4-hole stainless steel feeder and one nipple-cup waterer for ad libitum access to feed and water. Pens were 5 × 6 ft to allow 3 ft^2 per pig. Nursery rooms were not power washed or disinfected after the previous group of pigs.

A total of 720 pigs (PIC C-29 × 359, initially 12.5 lb) with 10 pigs per pen and 12 replications per treatment were used in a 42-d growth performance trial evaluating the effects of diet complexity (complex vs. simple) and protein source (fish meal, HP 300, or HP 800) on the growth performance of nursery pigs. Pigs were weaned at approximately 18 to 20 d and allotted to pens based on initial BW and gender to 1 of 6 treatments in a completely randomized block design. Pigs and feeders were weighed every 7 d of the trial to determine ADG, ADFI, and F/G.

Experimental diets (Tables 1 and 2) were fed in two phases, with the first phase being provided at 5 lb per pig. The second phase was fed until pigs reached approximately 25 lb BW (d 21 post-weaning). The complex diet contained 20% and 10% lactose,

[4] Cervantes-Pahm, S. K., and H. H. Stein. 2010. Ileal digestibility of amino acids in conventional, fermented and enzyme-treated soybean meal and in soy protein. J. Anim. Sci. 88:2674-2683.

[5] Goebel, K. P., and H. H. Stein. 2011. Phosphorus digestibility and energy concentration of enzyme-treated and conventional soybean meal fed to weanling pigs. J. Anim. Sci. 89:764-772.

while the simple diet contained 12% and 5% lactose in Phases 1 and 2, respectively. To maintain equal soybean meal and SID lysine levels across treatments within phase, fish meal, HP 300, and HP 800 were adjusted accordingly. In addition, the complex diet contained oat meal, Tak-Tik flavoring (Pancosma, Geneva, Switzerland), BioPlus2B (Chr. Hansen BioSystems, Hoersholm, Denmark), and KemGest (Kemin Industries, Des Moines, IA) in both Phases 1 and 2. A common diet was fed for 3 wk following the treatment diets (d 21 to 42; Table 3). The common diet formulated for this trial was a standard nursery diet fed in commercial production. All experimental diets were fed in pellet form.

Samples of the protein sources were collected at the feed mill during diet manufacture. Complete diet samples were obtained from each dietary treatment each wk during the study and composited. Composite samples of protein sources and diets were analyzed for DM, CP, ADF, NDF, crude fiber, Ca, P, Cl, salt, ether extract, and starch (Ward Laboratory, Kearney, NE).

An economic analysis performed at the conclusion of the trial determined the financial impact of diet type and protein sources. For all economic calculations, ingredient prices for June 2015 were used, with corn valued at $3.58/bu ($141/ton), soybean meal at $397/ton, DDGS at $158/ton, lactose at $600/ton, fish meal at $1,992/ton, HP 300 at $930/ton and HP 800 at $1,004/ton. The total feed cost per pig was calculated by multiplying the ADFI by the diet cost and the number of days it was fed for the respective period. Cost per pound of gain was calculated by dividing the total feed cost per pig by the overall pounds gained. Revenue per pig was calculated by multiplying ADG times the total days in the trial times an assumed live price of $65.00 per cwt. To calculate IOFC, total feed cost was subtracted from revenue per pig.

Data were analyzed using the PROC GLIMMIX procedure in SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Dietary treatments were the fixed effect and block and room served as the random effect in the analysis. A P-value ≤ 0.05 was considered significant and $0.05 < P \leq 0.10$ was considered a tendency.

Results and Discussion

Complete diet and protein source analyses (Tables 4 and 5) were similar to formulated values.

No interactions were observed between diet complexity and protein source (Table 6) or differences between specialty protein source (Table 8) for growth performance for any phase or overall. From d 0 to 7, pigs fed the complex diet had a tendency for improved ADG ($P = 0.078$) and d 7 BW ($P = 0.053$) compared to pigs fed the simple diet (Table 7). During Phase 2, (d 7 to 21), there were no differences in growth performance found between treatment diets. From d 0 to 21, pigs fed the complex diets had improved F/G ($P = 0.037$) compared to pigs fed the simple diets.

During Phase 3 when a common diet was fed (d 21 to 42), no differences were observed between pigs previously fed different diet complexity or protein sources. Overall (d 0 – 42), no differences in growth performance were observed between treatments.

For the economic analysis, feed cost per pig and cost per pound of gain increased ($P < 0.01$) for pigs fed a complex diet; however, no differences were detected for revenue per pig. As a result, IOFC tended to be lower ($P = 0.055$; \$0.48/pig) for pigs fed the complex diets. Feed cost per pound of gain was lower ($P = 0.002$) for pigs fed diets with HP 300 and HP 800 compared to those fed diets with fish meal; however, no differences were observed between protein sources for revenue per pig or IOFC.

In conclusion, regardless of the specialty protein and diet complexity used in this study, overall, pigs performed similarly during the trial. While minor differences were detected in diet complexity when fed, a greater magnitude was expected due to changes in lactose level and other ingredients used in the complex diet. One possible explanation for the lack of response observed could be attributed to the low feed intake and growth across all treatments for the first 7 d. The low feed intake might be indicative of an unknown health challenge or an ingredient quality issue such as the DDGS used. Additional research is warranted to confirm the responses observed in this experiment.

Table 1. Phase 1 diet composition (as fed basis)[1]

	Complex			Simple		
Ingredient, %	Fish meal	HP 300	HP 800	Fish meal	HP 300	HP 800
Corn	23.80	20.00	19.85	42.00	38.25	38.10
Soybean meal, 46.5% CP	21.50	21.50	21.50	21.50	21.50	21.50
Lactose	20.00	20.00	20.00	12.00	12.00	12.00
Corn DDGS[2]	10.00	10.00	10.00	10.00	10.00	10.00
Oat meal	10.00	10.00	10.00	---	---	---
Spray dried plasma	2.00	2.00	2.00	2.00	2.00	2.00
Tallow	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	0.76	1.22	1.21	0.75	1.22	1.20
Monocalcium P, 21% P	0.44	1.25	1.25	0.46	1.28	1.28
Sodium chloride	0.15	0.15	0.15	0.15	0.15	0.15
L-Lys HCl	0.35	0.36	0.36	0.36	0.37	0.37
DL-Met	0.17	0.18	0.18	0.15	0.17	0.16
L-Thr	0.17	0.14	0.15	0.17	0.14	0.14
L-Trp	0.05	0.02	0.02	0.06	0.03	0.02
Phytase[3]	0.01	0.01	0.01	0.01	0.01	0.01
Zinc oxide	0.40	0.40	0.40	0.40	0.40	0.40
Choline chloride, 70% liq.	0.04	0.04	0.04	0.04	0.04	0.04
Selenium, 0.6%	0.02	0.02	0.02	0.02	0.02	0.02
Trace mineral premix	0.09	0.09	0.09	0.09	0.09	0.09
Vitamin premix	0.10	0.10	0.10	0.10	0.10	0.10
Tak-Tik[4]	0.02	0.02	0.02	---	---	---
Bioplus 2B[5]	0.01	0.01	0.01	---	---	---
Kem-gest[6]	0.20	0.20	0.20	---	---	---
Fish meal	7.75	---	---	7.75	---	---
HP 300[7]	---	10.25	---	---	10.25	---
HP 800[7]	---	---	10.45	---	---	10.45
Total	100	100	100	100	100	100

continued

Table 1. Phase 1 diet composition (as fed basis)[1]

	Complex			Simple		
Ingredient, %	Fish meal	HP 300	HP 800	Fish meal	HP 300	HP 800
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lys	1.40	1.40	1.40	1.40	1.40	1.40
Met:Lys	37	35	34	37	34	34
Met and Cys:Lys	58	58	58	58	58	58
Thr:Lys	65	65	65	65	65	65
Trp:Lys	20	20	20	20	20	20
Val:Lys	65	69	68	67	71	69
ME, kcal/lb	1,582	1,573	1,573	1,568	1,558	1,558
CP, %	23.10	23.70	23.70	23.30	23.80	23.80
Ca, %	0.96	0.96	0.96	0.96	0.96	0.96
P, %	0.82	0.84	0.84	0.83	0.85	0.85
Available P, %	0.59	0.59	0.59	0.59	0.59	0.59

[1]Phase 1 diets were fed from weaning to approximately 15 lb BW (5 lb/pig).
[2]Dried distillers grains with solubles.
[3]Quantum Blue (AB-Vista Americas, Plantation, FL) provided 227 phytase units (FTU)/lb of diet, with a release of 0.13% available P.
[4]Pancosma, Geneva, Switzerland.
[5]Chr. Hansen BioSystems, Hoersholm, Denmark.
[6]Kemin Industries, Des Moines, IA.
[7]Hamlet Protein, Findlay, OH.

Table 2. Phase 2 diet composition (as fed basis)[1]

	Complex			Simple		
Ingredient, %	Fish meal	HP 300	HP 800	Fish meal	HP 300	HP 800
Corn	34.18	31.06	30.93	49.39	46.23	46.10
Soybean meal, 46.5% CP	25.00	25.00	25.00	25.00	25.00	25.00
Lactose	10.00	10.00	10.00	5.00	5.00	5.00
Corn DDGS[2]	10.00	10.00	10.00	10.00	10.00	10.00
Oat meal	10.00	10.00	10.00	---	---	---
Spray dried plasma	---	---	---	---	---	---
Tallow	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	0.83	1.19	1.18	0.83	1.19	1.18
Monocalcium P, 21% P	0.33	0.97	0.96	0.37	1.00	1.00
Sodium chloride	0.15	0.15	0.15	0.15	0.15	0.15
L-Lys	0.38	0.38	0.38	0.39	0.39	0.39
DL-Met	0.15	0.17	0.15	0.15	0.16	0.15
L-Thr	0.18	0.15	0.16	0.18	0.15	---
L-Trp	0.02	---	---	0.03	---	---
Phytase[3]	0.01	0.01	0.01	0.01	0.01	0.01
Zinc oxide	0.27	0.27	0.27	0.27	0.27	0.27
Selenium, 0.6%	0.02	0.02	0.02	0.02	0.02	0.02
Trace mineral premix	0.09	0.09	0.09	0.09	0.09	0.09
Vitamin premix	0.13	0.13	0.13	0.13	0.13	0.13
Tak-Tik[4]	0.02	0.02	0.02	---	---	---
Bioplus 2B[5]	0.01	0.01	0.01	---	---	---
Kem-Gest[6]	0.20	0.20	0.20	---	---	---
Fish meal	6.00	---	---	6.00	---	---
HP 300[7]	---	8.21	---	---	8.20	---
HP 800[7]	---	---	8.35	---	---	8.37
Total	100	100	100	100	100	100

continued

Table 2. Phase 2 diet composition (as fed basis)[1]

	Complex			Simple		
Ingredient, %	Fish meal	HP 300	HP 800	Fish meal	HP 300	HP 800
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lys	1.35	1.35	1.35	1.35	1.35	1.35
Met:Lys	38	36	36	38	36	35
Met and Cys:Lys	58	58	58	58	58	58
Thr:Lys	65	65	65	65	65	65
Trp:Lys	18	18	18	18	18	18
Val:Lys	65	69	67	67	70	69
ME, kcal/lb	1,557	1,550	1,550	1,548	1,541	1,541
CP, %	23.1	23.6	23.6	22.9	23.5	23.5
Ca, %	0.91	0.91	0.91	0.91	0.91	0.91
P, %	0.82	0.84	0.84	0.83	0.85	0.85
Available P, %	0.59	0.59	0.59	0.59	0.59	0.59

[1]Phase 2 diets were fed from 15 lb to approximately 25 lb BW.
[2]Dried distillers grain with solubles.
[3]Quantum Blue (AB-Vista Americas, Plantation, FL) provided 227 phytase units (FTU)/lb of feed, with a release of 0.13% available P.
[4]Pancosma, Geneva, Switzerland.
[5]Chr. Hansen BioSystems, Hoersholm, Denmark.
[6]Kemin Industries, Des Moines, IA.
[7]Hamlet Protein, Findlay, OH.

Table 3. Phase 3 diet composition (as-fed basis)[1]

Ingredient, %	Common diet
Corn	61.15
Soybean meal, 46.5% CP	32.65
Tallow	2.50
Limestone	1.05
Monocalcium P, 21% P	0.82
Sodium chloride	0.50
L-lysine HCl	0.35
DL-methionine	0.16
L-threonine	0.14
Selenium, 0.6%	0.02
Trace mineral premix	0.05
Vitamin premix	0.09
Ameribond (2X)[2]	0.40
Total	100
Calculated analysis	
Standardized ileal digestible (SID) amino acids, %	
Lys	1.25
Met:lys	35
Met and cys:lys	58
Thr:lys	63
Trp:lys	18
Val:lys	66
ME, kcal/lb	1,523
CP, %	21.0
Ca, %	0.69
P, %	0.72
Available P, %	0.40

[1]Phase 3 diet was fed from 25 lb to approximately 50 lb BW.
[2]Borregaard LignoTech, Sarpsborg, Norway.

Table 4. Laboratory analysis of Phases 1 and 2 experimental diets[1,2,3]

	Complex			Simple		
Item, %	Fish meal	HP 300	HP 800	Fish meal	HP 300	HP 800
Phase 1 diets						
DM	91.05	91.03	91.14	89.81	89.58	90.00
CP	22.30	22.70	22.90	23.10	23.40	23.30
ADF	3.90	3.90	3.90	4.30	4.10	4.30
NDF	6.80	7.40	7.60	9.00	9.30	8.50
Crude fiber	1.90	2.30	2.20	2.00	2.70	2.60
Ca	0.93	0.84	0.81	0.85	0.89	0.89
P	0.66	0.68	0.68	0.65	0.71	0.67
Cl	0.35	0.25	0.24	0.31	0.25	0.23
Salt	0.57	0.40	0.40	0.51	0.40	0.39
Ether extract	5.10	4.60	4.60	5.20	4.40	4.80
Ash	5.59	5.31	5.30	5.59	5.43	5.61
Starch	21.00	18.40	19.60	26.70	24.40	24.30
Phase 2 diets						
DM	89.96	90.65	89.40	88.72	89.22	89.27
CP	22.60	23.10	23.20	22.80	23.70	23.30
ADF	3.70	4.40	4.30	4.60	4.90	4.20
NDF	8.70	8.60	9.20	10.50	9.00	10.80
Crude fiber	2.50	2.50	2.50	2.60	2.90	2.80
Ca	0.82	0.79	0.80	0.79	0.75	0.72
P	0.60	0.61	0.63	0.59	0.59	0.62
Cl	0.30	0.26	0.24	0.29	0.23	0.24
Salt	0.50	0.42	0.39	0.48	0.39	0.39
Ether extract	5.40	4.80	4.70	5.10	5.30	5.00
Ash	5.21	5.06	5.22	5.03	5.22	5.06
Starch	26.20	24.30	25.40	29.90	29.50	28.10

[1]Complete diet samples were obtained from each dietary treatment each week during the study and composited. Samples of the diets were then submitted to Ward Laboratories, Inc. (Kearny, NE) for analysis.
[2]Omega Special Select (Omega Protein, Houston, TX).
[3]HP 300 and HP 800 (Hamlet Protein, Findlay, OH).

Table 5. Laboratory analysis of fishmeal, HP 300, and HP 800[1,2]

Item, %	Fish meal[3]	HP 300[4]	HP 800[4]
DM	91.63 (93.70)	91.67 (92.0)	93.65 (92.00)
CP	63.27 (63.28)	54.50 (56.0)	55.30 (55.00)
ADF	7.10 (0.00)	11.10 (3.7)	10.50 (3.70)
NDF	14.20 (N/A)	13.80 (4.7)	9.00 (4.70)
Crude fiber	0.90 (0.24)	3.90 (3.5)	4.60 (3.50)
Ca	4.62 (4.28)	0.29 (0.25)	0.29 (0.30)
P	2.76 (2.93)	0.71 (0.80)	0.81 (0.80)
Cl	1.23 (N/A)	0.03 (0.06)	0.03 (0.60)
Salt	0.93 (N/A)	0.06 (N/A)	0.04 (N/A)
Ether extract	7.50 (9.71)	1.20 (2.50)	1.40 (2.50)
Ash	18.76 (16.07)	6.06 (6.80)	6.46 (6.50)
Starch	0.20 (0.00)	1.10 (3.80)	1.70 (3.50)

[1]Proximate analysis for proteins sources were analyzed by Ward Laboratories, Kearney, NE.
[2]Values in parenthesis indicate expected analyzed chemical composition values based on the NRC 2012 and Hamlet Protein's nutrient specifications.
[3]Omega Special Select (Omega Protein, Houston, TX).
[4]Hamlet Protein, Findlay, OH.

Table 6. Effect of diet complexity and specialty protein source on nursery pig performance[1]

	Complex diet			Simple diet				Probability, $P <$		
	Fish meal[2]	HP 300[3]	HP 800[3]	Fish meal	HP 300	HP 800	SEM	Diet type × protein source	Diet type	Protein source
BW, lb										
d 0	12.9	12.9	12.8	12.9	12.9	12.9	0.35	0.206	0.751	0.369
d 7	13.3	13.4	13.2	13.2	13.2	13.1	0.44	0.968	0.053	0.185
d 21	21.5	21.5	21.1	21.1	21.1	21.0	0.66	0.699	0.158	0.607
d 42	47.2	47.1	47.1	46.5	46.7	47.4	0.71	0.718	0.618	0.832
d 0 to 7										
ADG, lb	0.07	0.07	0.05	0.05	0.06	0.04	0.015	0.923	0.078	0.341
ADFI, lb	0.19	0.19	0.19	0.18	0.19	0.19	0.008	0.741	0.500	0.482
F/G[4]	-	-	-	-	-	-	-	-	-	-
d 7 to 21										
ADG, lb	0.58	0.58	0.56	0.56	0.56	0.57	0.020	0.651	0.293	0.834
ADFI, lb	0.72	0.74	0.73	0.72	0.75	0.73	0.029	0.963	0.920	0.335
F/G	1.24	1.28	1.30	1.29	1.34	1.29	0.028	0.408	0.111	0.216
d 0 to 21										
ADG, lb	0.41	0.41	0.39	0.39	0.39	0.39	0.017	0.734	0.136	0.598
ADFI, lb	0.54	0.56	0.55	0.54	0.56	0.55	0.022	0.897	0.957	0.291
F/G	1.33	1.37	1.40	1.39	1.44	1.41	0.027	0.510	0.037	0.158
d 21 to 42										
ADG, lb	1.22	1.22	1.23	1.21	1.22	1.26	0.048	0.763	0.817	0.517
ADFI, lb	1.72	1.67	1.69	1.66	1.68	1.72	0.041	0.294	0.697	0.548
F/G	1.41	1.37	1.38	1.37	1.38	1.37	0.027	0.305	0.239	0.306
d 0 to 42										
ADG, lb	0.82	0.82	0.81	0.80	0.81	0.82	0.021	0.661	0.674	0.874
ADFI, lb	1.13	1.12	1.12	1.10	1.12	1.13	0.019	0.362	0.742	0.846
F/G	1.39	1.37	1.38	1.38	1.39	1.38	0.021	0.314	0.842	0.916
Economics, $/pig										
Feed cost	10.20	9.80	9.88	9.34	9.23	9.41	0.161	0.456	0.001	0.289
Feed cost/lb gain[5]	0.30	0.29	0.29	0.28	0.27	0.27	0.004	0.496	0.001	0.002
Total revenue/pig[6,7]	22.30	22.30	22.14	21.82	22.02	22.43	0.562	0.661	0.674	0.874
IOFC[8]	12.09	12.50	12.26	12.48	12.79	13.03	0.433	0.706	0.055	0.395

[1]A total of 720 pigs were used in a 3-phase nursery trial with 10 pigs per pen and 12 replications per treatment. All experimental diets were fed in two phases (d 0 to 7, and d 7 to 21) with a common diet fed in Phase 3 (d 21 to 42).
[2]Omega Special Select Fish meal (Omega Protein, Houston, TX).
[3]HP 300 and HP 800 (Hamlet Protein, Findlay, OH).
[4]Several pens lost weight during Phase 1, thus F/G for this phase is not reported.
[5]Feed cost/lb gain = total feed cost divided by total gain per pig.
[6]One lb of live weight gain was considered to be worth $0.65.
[7]Total revenue/pig = total gain/pig × $0.65.
[8]Income over feed cost = total revenue/pig – feed cost/pig.

Table 7. Main effects of diet complexity on nursery pig performance[1]

	Complex	Simple	SEM	Probability, $P <$
BW, lb				
d 0	12.9	12.9	0.35	0.751
d 7	13.3	13.2	0.43	0.053
d 21	21.4	21.1	0.62	0.158
d 42	47.2	46.9	0.41	0.618
d 0 to 7				
ADG, lb	0.06	0.05	0.013	0.078
ADFI, lb	0.19	0.18	0.005	0.500
F/G[2]	---	---	---	---
d 7 to 21				
ADG, lb	0.58	0.56	0.015	0.293
ADFI, lb	0.73	0.73	0.025	0.920
F/G	1.27	1.31	0.019	0.111
d 0 to 21				
ADG, lb	0.41	0.39	0.013	0.136
ADFI, lb	0.55	0.55	0.019	0.957
F/G	1.37	1.41	0.016	0.037
d 21 to 42				
ADG	1.22	1.23	0.044	0.817
ADFI	1.70	1.69	0.033	0.697
F/G	1.39	1.37	0.025	0.239
d 0 to 42				
ADG, lb	0.81	0.81	0.016	0.674
ADFI, lb	1.12	1.12	0.011	0.742
F/G	1.38	1.38	0.019	0.842
Economics, $/pig				
Feed cost	9.96	9.33	0.093	0.001
Feed cost/lb gain[3]	0.29	0.27	0.004	0.001
Total revenue/pig[4,5]	22.24	22.09	0.433	0.674
IOFC[6]	12.28	12.76	0.357	0.055

[1]A total of 720 nursery pigs (PIC C-29 × 359) were used in a 3-phase nursery trial with 10 pigs per pen and 24 replications per treatment for main effects. All experimental diets were fed in two phases (d 0 to 7 and 7 to 21) with a common diet being fed in Phase 3 (d 21 to 42).
[2]Several pens lost weight during Phase 1, thus F/G for this phase is not reported.
[3]Feed cost/lb gain = total feed cost divided by total gain per pig.
[4]One lb of live weight gain was considered to be worth $0.65.
[5]Total revenue/pig = total gain/pig × $0.65.
[6]Income over feed cost = total revenue/pig – feed cost/pig.

Table 8. Main effects of specialty protein source on nursery pig performance [1,2]

	Fishmeal[3]	HP 300[4]	HP 800[4]	SEM	Probability, *P* <
BW, lb					
d 0	12.9	12.9	12.9	0.35	0.369
d 7	13.3	13.3	13.2	0.43	0.185
d 21	21.3	21.3	21.1	0.63	0.607
d 42	46.8	46.9	47.3	0.50	0.832
d 0 to 7					
ADG, lb	0.06	0.06	0.05	0.014	0.341
ADFI, lb	0.18	0.19	0.19	0.006	0.482
F/G[5]	-	-	-	-	-
d 7 to 21					
ADG, lb	0.57	0.57	0.56	0.016	0.834
ADFI, lb	0.72	0.75	0.73	0.026	0.335
F/G	1.26	1.31	1.30	0.021	0.216
d 0 to 21					
ADG, lb	0.40	0.40	0.39	0.014	0.598
ADFI, lb	0.54	0.56	0.55	0.020	0.291
F/G	1.36	1.40	1.41	0.019	0.158
d 21 to 42					
ADG	1.22	1.22	1.24	0.045	0.517
ADFI	1.69	1.67	1.71	0.035	0.548
F/G	1.39	1.37	1.37	0.026	0.306
d 0 to 42					
ADG, lb	0.81	0.81	0.82	0.017	0.874
ADFI, lb	1.11	1.12	1.13	0.013	0.846
F/G	1.38	1.38	1.38	0.020	0.916
Economics, $/pig					
Feed cost	9.77	9.52	9.64	0.114	0.289
Feed cost/lb gain[6]	0.29[a]	0.28[b]	0.28[b]	0.004	0.002
Total revenue/pig[7,8]	22.06	22.16	22.28	0.469	0.874
IOFC[9]	12.28	12.64	12.64	0.377	0.395

[1]A total of 720 pigs were used in a 3-phase nursery trial with 10 pigs per pen and 24 replications per treatment for main effects.
[2]All experimental diets were fed in two phases (d 0 to 7, and d 7 to 21) with a common diet being fed in Phase 3 (d 21 to 42).
[3]Omega Special Select Fish meal (Omega Protein, Houston, TX).
[4]HP 300 and HP 800 (Hamlet Protein, Findlay, OH).
[5]Several pens lost weight during Phase 1, thus F/G for this phase is not reported.
[6]Feed cost/lb gain = total feed cost divided by total gain per pig.
[7]One lb of live weight gain was considered to be worth $0.65.
[8]Total revenue/pig = total gain/pig × $0.65.
[9]Income over feed cost = total revenue/pig – feed cost/pig.