Evaluating the Effects of Replacing Fish Meal with HP 300 on Nursery Pig Performance

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Summary

A total of 350 barrows (Line 200 × 400 DNA, Columbus, NE; initially 13.6 lb) were used in a 21-d growth trial with 5 pigs per pen and 14 pens per treatment. Pigs were weaned at approximately 21-d of age, placed in nursery pens according to BW and fed a common pelleted starter diet for 3 d, at which time, pigs were weighed and then pens were blocked by BW to 1 of 5 dietary treatments in a randomized complete block design. A composite sample of fish meal and HP 300 was collected and analyzed for AA content and proximate analysis prior to formulation to determine nutrient loading values. Dietary treatments were corn-soybean-meal-based with 10% spray-dried whey and formulated to contain 1.35% standardized ileal digestible (SID) Lys and balanced on an NE basis. The 5 corn-soybean meal-based treatment diets were: 1) soybean meal control (no specialty protein products); 2) diet with 6% fish meal; 3) diet with 9.1% HP 300 replacing fish meal on a Lys basis; 4) diet with 6% HP 300 replacing fish meal on a lb/lb basis; and 5) diet with 15% HP 300 included at the expense of SBM and fish meal. All diets were fed in meal form. Overall (d 0 to 21), ADG and ADFI increased ($P < 0.10$ and $P < 0.05$, respectively) when pigs were fed the fish meal control diet compared to pigs fed HP 300 replacing fish meal on an SID Lys basis and 15% HP 300 diet, with pigs fed HP 300 replacing fish meal on lb/lb basis intermediate. In addition, ADG marginally decreased ($P < 0.10$) when pigs were fed the soybean meal control diet compared with pigs fed the fish meal diet. Furthermore, pigs fed the control diet had the poorest F/G among the dietary treatments. In addition, pigs fed the fish meal diet had improved ($P < 0.05$) final BW (d 21) compared to pigs fed the soybean meal control, HP 300 replacing fish meal on an SID Lys basis, and 15% HP 300 diet, with pigs fed diets with HP 300 replacing fish meal on a lb/lb basis intermediate. In conclusion, nursery pigs fed diets with fish meal had improved performance compared with the control diet, but 9% or greater HP 300 resulted in poorer feed intake and gain.

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Introduction

Conventionally-processed soybean meal (SBM) is the most commonly used protein source fed to swine in the United States.[2] However, SBM contains anti-nutritional factors that when fed in adequate amounts produces what is known as SBM transient hypersensitivity. This form of transient hypersensitivity results in abnormalities specifically at the cellular level in the gastrointestinal tract (GIT) that include decreased villous height and hypertrophy of intestinal crypts that can result in poorer growth performance.[3,4] However, producer and nutritionist concerns with cost and bio-security related to the transmission of porcine epidemic diarrhea virus (PEDv) in ingredients, such as spray-dried porcine plasma, has led many producers to seek other alternatives.[5,6]

One protein source that has shown potential for use to replace SBM is HP 300 (Hamlet Protein, Findlay, OH). HP 300 is a finely ground soy protein produced from soybean meal that has been treated with a proprietary blend of enzymes resulting in the reduction of anti-nutritional factors that may be found in conventional soybean meal.[7] In addition to potentially enhancing its nutritional value, it may also be less expensive than fish meal. Therefore, the objective of our study was to evaluate the growth performance of nursery pigs fed diets with HP 300 as a replacement for fish meal.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol for this experiment. The study was conducted at the K-State Segregated Early Weaning facilities (Manhattan, KS). Each pen (3.9 × 4.0 ft) had metal tri-bar flooring and was equipped with a 4-hole, stainless-steel, dry self-feeder, and a cup waterer for ad libitum access to feed and water.

A total of 350 maternal line barrows (Line 200 × 400 DNA, Columbus, NE; initially 13.6 lb) was used in a 21-d growth trial with 5 pigs per pen and 14 pens per treatment. Pigs were weaned at approximately 21-d of age, placed in nursery pens according to BW and fed a common pelleted starter diet for 3 d, at which time, pigs were weighed and then pens were blocked by BW to 1 of 5 dietary treatments in a randomized complete block design. Dietary treatments were standard corn-soybean-meal-based diet with 10%

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spray-dried whey and formulated to contain 1.35% standardized ileal digestible (SID) Lys and balanced on an NE basis. The 5 treatment diets (Table 2) were 1) soybean meal control (no specialty protein products); 2) diet with 6% fish meal; 3) diet with 9.1% HP 300 replacing fish meal on a Lys basis; 4) diet with 6% HP 300 replacing fish meal on a lb/lb basis; and 5) diet with 15% HP 300 included at the expense of SBM and fish meal. A composite sample of fish meal and HP 300 was collected and analyzed for AA content and proximate analysis prior to formulation to determine nutrient loading values (Table 1). All diets were fed in meal form and prepared at the K-State O.H. Kruse Feed Technology and Innovation Center located in Manhattan, KS. Pigs and feeders were weighed weekly during the 21-d trial to determine ADG, ADFI, and F/G.

Complete diet samples were obtained from feeders, composited, and frozen at -4°F until subsequent analysis. Samples of HP 300 and fish meal were collected at the mill. Composite samples of diets, HP 300, and fish meal were split using a riffle splitter (Humboldt Mfg. Co., Norridge, IL) and processed through a 1 mm screen in a Willey Mill (Thomas Scientific, Swedesboro, NJ) prior to analysis. All samples of diets and protein sources were submitted (Ward Laboratories Inc., Kearney, NE) for analysis of DM, CP, ether extract, Ca, P, and ash. Samples of HP 300 and fish meal were analyzed for their complete AA profile by the University of Missouri-Columbia College of Agriculture Experiment Station Chemical Laboratories (Columbia, MO).

Data were analyzed using the PROC GLIMMIX procedure in SAS version 9.4 (SAS Institute, Inc., Cary, NC) with pen as the experimental unit, dietary treatment as a fixed effect, and block serving as the random effect in the model. Treatment means were analyzed using the LSMEANS statement of SAS, with least squares means calculated for each independent variable. Results were considered significant at $P \leq 0.05$ and marginally significant between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

Chemical analysis of experimental diets (Table 3) indicated that most nutrients were similar to formulated values. However, analyzed values for Ca were higher than formulated values across all dietary treatments.

Overall (d 0 to 21), ADG and ADFI increased ($P < 0.10$ and $P < 0.05$, respectively) when pigs were fed the fish meal diet compared to pigs fed HP 300 replacing fish meal on an SID Lys basis and the 15% HP 300 diet, with pigs fed HP 300 replacing fish meal on lb/lb basis intermediate. In addition, ADG marginally decreased ($P < 0.10$) when pigs were fed the soybean meal control diet compared with pigs fed the fish meal diet. Furthermore, pigs fed the soybean meal control diet had the poorest F/G among the dietary treatments. In addition, pigs fed the fish meal control diet had improved final BW (d 21) compared to pigs fed the soybean meal control, HP 300 replacing fish meal on an SID Lys basis, and 15% HP 300 diet, with pigs fed diets with HP 300 replacing fish meal on a lb/lb basis intermediate.

In conclusion, pigs fed fish meal had improved performance over those fed a high soybean meal-based diet containing no specialty protein source and pigs fed 15% HP 300 replacing SBM and fish meal. It is unclear, why 9% or greater HP 300 resulted in poorer feed intake and gain. However, a possible explanation for the poorer ADFI when pigs were fed high amounts of HP 300 could be attributed to palatability. Further research is needed to understand the relationship between the dietary inclusion level of HP 300 and feed intake.

Table 1. Chemical analysis of HP 300 and menhaden fish meal (as-fed basis)[1,2]

Item	HP 300[3]	Menhaden fish meal[4]
Proximate analysis, %		
DM	93.94	93.01
CP	55.74	63.25
Ca	0.40	5.17
P	0.67	2.61
Ether extract	1.55	10.70
Ash	6.31	19.11
Total AA, %		
Arg	3.88	3.69
Cys	0.76	0.48
His	1.40	1.51
Ile	2.71	2.52
Leu	4.36	4.28
Lys	3.29	4.82
Met	0.76	1.68
Phe	2.84	2.40
Thr	2.11	2.40
Trp	0.81	0.61
Tyr	1.96	1.79
Val	2.86	3.09

[1] Proximate analysis by Ward Laboratories Inc., (Kearney, NE).

[2] Amino acid analysis by the University of Missouri-Columbia College of Agriculture, Food and Natural Resources – Agriculture Experiment Station Chemical Laboratories (Columbia, MO).

[3] Hamlet Protein (Findlay, OH).

[4] LT Prime Menhaden Fishmeal (Daybrook Fisheries, Inc., New Orleans, LA).

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

Ingredient, %	SBM[2] control	Fish meal control	HP 300 replacing fish meal: SID Lys basis	HP 300 replacing fish meal: lb for lb	15% HP 300 diet
Corn	40.29	48.33	43.51	46.53	45.71
Soybean meal, 46.5% CP	32.77	21.35	21.35	21.35	13.82
Corn DDGS[3]	10.00	10.00	10.00	10.00	10.00
Spray-dried whey	10.00	10.00	10.00	10.00	10.00
Fish meal[4]	---	6.00	---	---	---
HP 300[5]	---	---	9.10	6.00	15.00
Choice white grease	3.00	1.25	2.10	1.85	1.50
Limestone	1.07	0.62	1.10	1.10	1.13
Monocalcium P, 21% P	1.05	0.45	1.00	1.05	0.98
Sodium chloride	0.50	0.50	0.50	0.50	0.50
L-Lys HCl	0.35	0.39	0.39	0.50	0.43
DL-Met	0.15	0.16	0.15	0.19	0.16
L-Thr	0.11	0.17	0.12	0.17	0.12
L-Trp	---	0.04	---	0.02	---
L-Val	0.05	0.09	0.02	0.09	---
Phytase[6]	0.02	0.02	0.02	0.02	0.02
Zinc oxide	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

continued

Table 2, *continued*. Diet composition, (as-fed basis)[1]

	SBM[2] control	Fish meal control	HP 300 replacing fish meal SID Lys basis	HP 300 replacing fish meal lb for lb	15% HP 300 diet
Calculated analysis					
Standardized ileal digestible (SID) amino acids, %					
Lys	1.35	1.35	1.35	1.35	1.35
Ile:Lys	64	58	64	59	65
Leu:Lys	131	124	132	125	132
Met:Lys	35	38	35	36	36
Met and Cys:Lys	58	58	58	58	58
Thr:Lys	63	63	63	63	63
Trp:Lys	18.7	18.7	18.7	18.7	18.7
Val:Lys	72	72	72	72	72
Total Lys, %	1.52	1.53	1.53	1.52	1.53
ME, kcal/lb	1,543	1,532	1,543	1,534	1,542
NE, kcal/lb	1,135	1,135	1,135	1,135	1,135
CP, %	23.4	22.6	23.3	22.0	23.2
Ca, %	0.78	0.78	0.78	0.78	0.78
P, %	0.69	0.66	0.67	0.67	0.66
Available P, %	0.51	0.51	0.51	0.51	0.51

[1] Diets were fed for 21 d.
[2] Soybean meal control (no specialty protein sources).
[3] DDGS = dried distillers grain with solubles.
[4] LT Prime Menhaden Fishmeal (Daybrook Fisheries, Inc., New Orleans, LA).
[5] Hamlet Protein (Findlay, OH).
[6] 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. Chemical analysis of diets (as-fed basis)[1,2]

Item, %	Soybean meal control	Fish meal control	HP 300 replacing fish meal SID Lys basis	HP 300 replacing fish meal lb for lb	15% HP 300 diet
DM	90.98	91.11	91.13	91.29	91.98
CP	23.2	22.6	23.9	22.6	24.00
Ca	1.02	0.89	1.02	1.00	0.96
P	0.76	0.67	0.68	0.72	0.73
Ether extract	6.2	5.1	5.2	5.1	4.8

[1] Complete diet samples were obtained from each dietary treatment each week during the study and composited.
[2] Composite samples were submitted to Ward Laboratories (Kearney, NE) for analysis.

Table 4. Effects of replacing fish meal with HP 300 on weanling pig growth performance[1]

Item	SBM[3] control	Fish meal[4]	HP 300[2] replacing fish meal: SID Lys basis	HP 300[2] replacing fish meal: lb for lb	15% HP 300 diet	SEM	Probability, $P <$
BW, lb							
d 0	13.6	13.6	13.6	13.6	13.6	---	1.000
d 21	25.4[b]	27.1[a]	25.7[b]	26.7[ab]	25.3[b]	0.53	0.042
d 0 to 21							
ADG	0.55[yz]	0.61[x]	0.56[yz]	0.59[xy]	0.54[z]	0.023	0.081
ADFI	0.84[ab]	0.90[a]	0.78[bc]	0.84[abc]	0.78[c]	0.024	0.003
F/G	1.55[b]	1.46[a]	1.41[a]	1.41[a]	1.45[a]	0.025	<0.001

[abc] Means within the same row with different superscripts differ ($P < 0.05$).

[xyz] Means within the same row with different superscripts differ ($P < 0.10$).

[1] A total of 350 barrows (Line 200 × 400 DNA, Columbus, NE; initially 13.6 lb) with 5 pigs per pen and 14 replications per treatment were used.

[2] HP 300 (Hamlet Protein, Findlay, OH).

[3] Soybean meal control contained no specialty protein sources.

[4] LT Prime Menhaden Fishmeal (Daybrook Fisheries, Inc., New Orleans, LA).