Evaluation of Heparin Production By-Products in Nursery Pig Diets[1]

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Summary

A total of 1,152 weanling pigs (Newsham GPK35 × PIC380, initially 12.3 ± 1.30 lb, 20 ± 2 d of age) were used in a 39-d study to evaluate the effects of select menhaden fish meal (SMFM), poultry meal, PEP2+, Peptone 50, and PEP-NS on nursery pig performance. PEP2+, Peptone 50, and PEP-NS are all porcine intestinal mucosa products, but they differ in the carriers with which they are co-dried. PEP2+ is co-dried with enzymatically processed vegetable proteins and amino acid (AA) dried fermentation biomass. Peptone 50 is co-dried with a vegetable protein, whereas PEP-NS uses by-products from corn wet-milling as well as dried fermentation biomass.

Pigs were randomly allotted to 1 of 6 dietary treatments with 32 pigs per pen and 6 replications per treatment. Treatment diets were fed in 2 phases (d 0 to 7 and d 7 to 21) with a common diet fed to all pigs in the third phase (d 21 to 39). Treatments consisted of a negative control (NC) diet containing 4.5% SDAP in Phase 1 and no specialty protein sources in Phase 2 or the NC diet with 6% poultry meal (PM), PEP2+, Peptone 50, or PEP-NS. From d 0 to 21, pigs fed diets containing 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) ADG and ADFI compared with those fed the negative control diet. Pigs fed diets containing 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) F/G compared with pigs fed 6% Peptone 50.

From d 21 to 39, pigs previously fed diets containing 6% PEP2+ or PEP-NS had improved ($P < 0.05$) ADG and ADFI compared with those previously fed the negative control diet. Overall (d 0 to 39), pigs fed diets containing 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) ADG and ADFI compared with pigs fed the negative control diet. No significant differences were observed among treatments for F/G; therefore, PEP2+ and PEP-NS are suitable replacements for fish meal and poultry meal in nursery diets from d 7 to 21 postweaning.

Key words: fish meal, PEP2+, Peptone 50, PEP-NS, spray-dried animal plasma, nursery pig

Introduction

Numerous protein sources have been investigated for their efficacy in stimulating both feed intake and growth performance in the weanling pig. Research has indicated that

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[2] Swine Nutrition Service, Anchor, IL.
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[4] TechMix, LLC, Stewart, MN.

porcine intestinal mucosa, by-products of heparin production, may be suitable replacements for fish meal in nursery pig diets (Jones et al., 2008[5]; Myers et al., 2010[6]). Porcine digest is derived when mucosa linings from the intestines collected at pork packing plants are removed and hydrolyzed, and the remaining material consists of small-chain peptides. PEP2+, Peptone 50, and PEP-NS (Tech Mix, LLC, Stewart, MN) are by-products of heparin production. Although all of these products originate from intestinal mucosa lining, they vary in that they are co-dried with different carriers to create a final product. PEP2+ is co-dried with enzymatically processed vegetable protein and AA fermentation biomass whereas Peptone 50 is co-dried with an unprocessed vegetable protein. PEP-NS is co-dried with a corn-wet milling by-product and AA dried fermentation biomass.

Other specialty protein sources are routinely used in nursery pig diets. Fish meal is a commonly used protein source in nursery pig diets due to its digestibility and desirable AA profile. Furthermore, studies evaluating poultry meal in nursery pig diets have indicated that it can replace fish meal in nursery pig diets without adversely affecting performance. Thus, our objective was to evaluate the effects of Peptone products (PEP2+, Peptone 50, and PEP-NS), select menhaden fish meal, and poultry meal on the growth performance of nursery pigs.

Procedures

All practices and procedures used in these experiments were approved by the Kansas State University Institutional Animal Care and Use Committee.

A total of 1,152 nursery pigs (Newsham GPK35 × PIC380; initial BW of 12.3 ± 1.30 lb and 20 ± 2 d of age) were used in a 39-d study to evaluate the effects of Peptone products on the growth performance of nursery pigs. The study was conducted at a commercial research wean-to-finish facility in Anchor, IL. The facility was an environmentally controlled, fully slatted, wean-to-finish barn. Pigs were provided ad libitum access to feed and water via a 4-hole dry self-feeder (60 in. long) and 2 cup waterers. Each pen was 220.8 ft^2 and provided 6.9 ft^2/pig floor space. At weaning, pigs were weighed by pen and were randomly allotted to 1 of 6 dietary treatments based upon average pen weight, with 32 pigs per pen and 6 replicate pens per treatment. The number of barrows and gilts were equalized across pens.

The 6 dietary treatments were (1) a negative control containing 4.5% SDAP in Phase 1 (d 0 to 7) followed by no specialty protein sources in Phase 2 (d 7 to 21), or (2) the negative control with 6% SMFM, poultry meal, PEP2+, Peptone 50, or PEP-NS. The specialty protein source and crystalline AA replaced soybean meal in the negative control diet. Nutrient profiles, including standardized ileal digestible (SID) values of AA for PEP2+, Peptone 50, and PEP-NS, were provided by the manufacturer (Tech-Mix, LLC, Stewart, MN) and used in diet formulation (Table 1). Spray-dried animal plasma digestibility coefficients obtained from the manufacturer (APC, Ames, IA) and SID AA digestibility values for SMFM and poultry meal used in diet formulation were obtained from NRC (1998).

[5] Jones et al., Swine Day 2008, Report of Progress 1001, pp. 52-61.
[6] Myers et al., Swine Day 2010, Report of Progress 1038, pp. 27-34.

Phase 1 diets were fed in pellet form from d 0 to 7 postweaning (Table 2). Phase 2 diets were fed in meal form from d 7 to 21 (Table 3). A common Phase 3 diet was fed in meal form from d 21 to 39. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 0, 7, 21, and 39.

Data were analyzed as a completely randomized design with pen as the experimental unit. Analysis of variance was performed using the MIXED procedure in SAS (SAS Institute, Inc., Cary, NC). Means were separated using least significant difference (LSD). Results were considered significant at $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

Results and Discussion

From d 0 to 21, pigs fed diets containing 6% SMFM, poultry meal (PM), PEP2+, or PEP-NS had improved ($P < 0.05$) ADG compared with those fed the negative control diet or diets containing 6% Peptone 50. Pigs fed 6% PEP-NS had increased ($P < 0.05$) ADG compared with those fed 6% PM. Furthermore, pigs fed 6% SMFM, PM, PEP2+, or PEP-NS had increased ($P < 0.05$) ADFI compared with those fed the negative control diet. Pigs fed 6% SMFM, PEP2+, and PEP-NS had increased ($P < 0.01$) ADFI compared with pigs fed diets containing 6% Peptone 50. Pigs fed diets containing 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) F/G compared with pigs fed 6% Peptone 50 (Table 4).

During Phase 3 (d 21 to 39), pigs previously fed diets containing 6% PEP2+ or PEP-NS had improved ($P < 0.05$) ADG compared with those previously fed the negative control diet. Pigs previously fed 6% SMFM, PM, PEP2+, or PEP-NS had increased ($P < 0.05$) feed intake than pigs previously fed the negative control diet or diets containing 6% Peptone 50. Pigs previously fed the negative control diet and diets containing 6% Peptone 50 had improved ($P < 0.05$) F/G over those fed 6% SMFM or 6% PEP-NS.

Overall (d 0 to 39), pigs fed diets containing 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) ADG and ADFI compared with pigs fed the negative control diet. Pigs fed diets containing 6% SMFM, PEP2+, or PEP-NS had improved ($P < 0.05$) ADG and ADFI compared with pigs fed diets containing 6% Peptone 50. No significant differences were observed among treatments for F/G.

In conclusion, PEP2+ and PEP-NS are suitable replacements for fish meal and poultry meal in nursery diets from d 7 to 21 postweaning.

Table 1. Nutrient composition of ingredients (as-fed basis)

Item	SMFM[1, 4]	Poultry meal[2, 4]	PEP2+[3, 5]	Peptone 50[3, 5]	PEP-NS[3, 5]
CP, %	62.90	64.10	58.00	52.20	47.50
Amino acids, %					
Isoleucine	2.57 (94)[6]	2.01 (81)	2.67 (88)	2.35 (91)	2.06 (83)
Leucine	4.54 (94)	3.89 (80)	4.55 (89)	3.98 (91)	3.78 (72)
Lysine	4.81 (95)	3.32 (80)	4.51 (88)	3.53 (91)	3.75 (83)
Methionine	1.77 (94)	1.11 (77)	0.97 (88)	0.75 (93)	0.95 (86)
Threonine	2.64 (88)	2.18 (77)	2.47 (83)	2.13 (88)	2.06 (77)
Tryptophan	0.66 (88)	0.48 (75)	0.68 (87)	0.67 (90)	0.67 (83)
Valine	3.03 (93)	2.51 (74)	3.03 (86)	2.55 (89)	2.60 (81)
Cysteine	0.57 (88)	0.65 (72)	0.68 (77)	0.61 (88)	0.49 (68)

[1] Special select menhaden fish meal; Omega Protein Corp., Houston, TX.
[2] Poultry meal obtained from Hubbard Feeds, Mankato, MN.
[3] TechMix, LLC, Stewart, MN.
[4] Nutrient values from NRC (1998).
[5] Nutrient values provided by the manufacturer.
[6] Parentheses indicate standardized ileal digestible amino acid coefficients (%) used in diet formulation.

Table 2. Composition of diets, Phase 1 (as-fed basis)[1]

Item	Negative control	6% Poultry meal[2]	SMFM[3]	PEP2+[4]	Peptone 50[5]	PEP-NS[6]
Ingredient, %						
Corn	43.60	44.31	44.78	43.54	43.36	43.48
Soybean meal, (46.5% CP)	22.45	16.68	16.69	16.70	16.69	16.70
Spray-dried animal plasma	4.50	4.50	4.50	4.50	4.50	4.50
Select menhaden fish meal	---	---	6.00	---	---	---
Poultry meal	---	6.00	---	---	---	---
PEP2+	---	---	---	6.00	---	---
Peptone 50	---	---	---	---	6.00	---
PEP-NS	---	---	---	---	---	6.00
Spray-dried whey	25.00	25.00	25.00	25.00	25.00	25.00
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00
Monocalcium P, (21% P)	0.85	0.30	0.10	0.75	0.80	0.65
Limestone	1.00	0.63	0.60	1.05	1.07	1.13
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Zinc oxide	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix[7]	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[7]	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine HCl	0.28	0.27	0.12	0.17	0.24	0.23
DL-Methionine	0.17	0.16	0.11	0.16	0.18	0.17
L-Threonine	0.10	0.10	0.05	0.08	0.11	0.09
Phytase[7]	0.05	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100	100

continued

Table 2. Composition of diets, Phase 1 (as-fed basis)[1]

Item	Negative control	6% Poultry meal[2]	SMFM[3]	PEP2+[4]	Peptone 50[5]	PEP-NS[6]
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lysine	1.40	1.40	1.40	1.40	1.40	1.40
Isoleucine:lysine	55	58	54	57	55	56
Methionine:lysine	31	31	32	32	33	32
Met & Cys:lysine	58	58	58	58	58	58
Threonine:lysine	65	65	65	65	65	65
Tryptophan:lysine	18	18	17	18	18	18
Valine:lysine	65	69	65	68	66	67
Total lysine, %	1.54	1.54	1.56	1.56	1.56	1.54
CP, %	21.1	22.1	22.3	21.8	21.2	21.5
ME kcal/kg	1,511	1,527	1,511	1,505	1,510	1,506
Ca, %	0.82	0.82	0.82	0.82	0.82	0.82
P, %	0.71	0.70	0.70	0.70	0.70	0.69
Available P, %	0.56	0.56	0.56	0.55	0.56	0.56

[1] Phase 1 diets were fed from d 0 to 7 and were in meal form.
[2] Poultry meal; Hubbard Feeds, Mankato, MN.
[3] Special select menhaden fish meal; Omega Protein Corp., Houston, TX.
[4] PEP2; TechMix, LLC, Stewart, MN.
[5] Peptone 50; TechMix, LLC, Stewart, MN.
[6] PEP-NS; TechMix, LLC, Stewart, MN.
[7] Natuphos (BASF Animal Nutrition; Mount Olive, NJ) provided 509 FTU/kg, with a release of 0.10 available P.

Table 3. Composition of diets, Phase 2 (as-fed basis) [1]

Item	Negative control	6% Poultry meal[2]	6% SMFM[3]	6% PEP2+[4]	6% Peptone 50[5]	6% PEP-NS[6]
Ingredient, %						
Corn	54.46	54.35	54.81	53.55	53.41	53.53
Soybean meal, (46.5% CP)	30.76	25.92	25.89	25.91	25.89	25.88
Select menhaden fish meal	---	---	6.00	---	---	---
Poultry meal	---	6.00	---	---	---	---
PEP2+	---	---	---	6.00	---	---
Peptone 50	---	---	---	---	6.00	---
PEP-NS	---	---	---	---	---	6.00
Spray-dried whey	10.00	10.00	10.00	10.00	10.00	10.00
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00
Monocalcium P, (21% P)	1.20	0.60	0.43	1.10	1.15	1.00
Limestone	0.88	0.50	0.48	0.93	0.93	1.07
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Zinc oxide	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix[7]	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[7]	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine HCl	0.35	0.32	0.17	0.22	0.28	0.28
DL-Methionine	0.16	0.15	0.10	0.15	0.16	0.15
L-Threonine	0.14	0.12	0.08	0.10	0.13	0.11
Phytase[8]	0.05	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100	100

continued

Table 3. Composition of diets, Phase 2 (as-fed basis) [1]

Item	Negative control	6% Poultry meal[2]	6% SMFM[3]	6% PEP2+[4]	6% Peptone 50[5]	6% PEP-NS[6]
Calculated analysis						
Standardized ileal digestible amino acids, %						
Lysine	1.30	1.30	1.30	1.30	1.30	1.30
Isoleucine:lysine	60	64	60	63	60	62
Methionine:lysine	34	35	35	35	35	34
Met & Cys:lysine	58	58	58	58	58	58
Threonine:lysine	63	63	63	63	63	63
Tryptophan:lysine	17	18	17	18	17	18
Valine:lysine	65	71	66	69	67	68
Total lysine, %	1.44	1.44	1.46	1.45	1.46	1.44
CP, %	20.7	22.0	22.2	21.7	21.1	21.4
ME kcal/kg	1,512	1,529	1,513	1,383	1,511	1,383
Ca, %	0.75	0.75	0.75	0.75	0.75	0.75
P, %	0.69	0.68	0.67	0.68	0.68	0.67
Available P, %	0.47	0.47	0.47	0.47	0.47	0.47

[1] Phase 2 diets were fed from d 11 to 25 and were in meal form.
[2] Poultry meal; Hubbard Feeds, Mankato, MN.
[3] Special select menhaden fish meal; Omega Protein Corp., Houston, TX.
[4] PEP2+; TechMix, LLC, Stewart, MN.
[5] Peptone 50; TechMix, LLC, Stewart, MN.
[6] PEP-NS; TechMix, LLC Stewart, MN.
[7] Natuphos (BASF Animal Nutrition; Mount Olive, NJ) provided 509 FTU/kg, with a release of 0.10 available P.

Table 4. Effects of protein source on nursery pig performance[1,2]

Item	Control[3]	6% SMFM[4]	6% poultry[5]	6% PEP2+[6]	6% PEP-NS[7]	6% Peptone 50[8]	SEM
Initial wt, lb	12.5	12.4	12.6	12.5	12.4	12.5	---
d 0 to 21							
ADG, lb	0.44^{a}	0.53^{bc}	0.51^{b}	0.54^{bc}	0.57^{c}	0.44^{a}	0.02
ADFI, lb	0.64^{a}	0.76^{c}	0.71^{bc}	0.76^{c}	0.77^{c}	0.65^{ab}	0.02
F/G	1.45^{ab}	1.42^{a}	1.40^{a}	1.40^{a}	1.36^{a}	1.51^{b}	0.03
d 21 to 39[9]							
ADG, lb	1.11^{a}	1.17^{ab}	1.18^{ab}	1.20^{b}	1.19^{b}	1.15^{ab}	0.03
ADFI, lb	1.77^{a}	1.94^{b}	1.92^{b}	1.96^{b}	2.01^{b}	1.79^{a}	0.04
F/G	1.59^{ab}	1.67^{c}	1.63^{ac}	1.64^{bc}	1.68^{c}	1.57^{a}	0.02
d 0 to 39							
ADG, lb	0.74^{a}	0.82^{c}	0.81^{bc}	0.84^{c}	0.85^{c}	0.76^{ab}	0.02
ADFI, lb	1.21^{a}	1.32^{c}	1.31^{bc}	1.34^{c}	1.39^{c}	1.23^{ab}	0.03
F/G	1.64	1.60	1.61	1.59	1.59	1.63	0.02

^{a,b,c} Within a row, means without a common superscript differ at $P < 0.05$.

[1] A total of 1,152 nursery pigs (initial BW 12.5 lb) were used in a 39-d trial. Pigs were randomly allotted to 1 of 6 dietary treatments with 32 pigs per pen and 6 pens per treatment.

[2] Used d 0 body weight as covariate in analysis.

[3] 4.5% spray dried animal plasma (APC, Ames, IA) from d 0 to 11 and no specialty protein sources from d 11 to 21.

[4] Select menhaden fish meal; Hubbard Feeds, Mankato, MN.

[5] Poultry meal; Hubbard Feeds.

[6] PEP2; TechMix, LLC, Stewart, MN.

[7] Peptone 50; TechMix, LLC.

[8] PEP-NS; TechMix, LLC.

[9] Common diet was fed from d 21 to 39.