

# Kansas Agricultural Experiment Station Research Reports

Volume 0  
Issue 10 *Swine Day (1968-2014)*

Article 30

2010

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A J. Myers

J Moline

G Xu

*See next page for additional authors*

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### Recommended Citation

Myers, A J.; Moline, J; Xu, G; Ratliff, B W.; McKilligan, D M.; Tokach, Michael D.; Goodband, Robert D.; DeRouchey, Joel M.; Nelssen, Jim L.; and Dritz, Steven S. (2010) "An evaluation of peptone products and fish meal on nursery pig performance," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. <https://doi.org/10.4148/2378-5977.3450>

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## **An evaluation of peptone products and fish meal on nursery pig performance**

### **Authors**

A J. Myers, J Moline, G Xu, B W. Ratliff, D M. McKilligan, Michael D. Tokach, Robert D. Goodband, Joel M. DeRouchey, Jim L. Nelssen, and Steven S. Dritz

# An Evaluation of Peptone Products and Fish Meal on Nursery Pig Performance<sup>1</sup>

*A. J. Myers, M. D. Tokach, R. D. Goodband, S. S. Dritz<sup>2</sup>,  
J. M. DeRouchey, J. L. Nelssen, J. Moline<sup>3</sup>, G. Xu<sup>3</sup>, B. W. Ratliff,<sup>4</sup>  
and D. M. McKilligan<sup>4</sup>*

## Summary

A total of 360 nursery pigs (PIC C327 × 1050, initially 11.8 lb and 21 d of age) were used in a 35-d study to evaluate the effects of select menhaden fish meal (SMFM), PEP2+ (also known as Ferm O Tide), Peptone 50, and PEP-NS on nursery pig performance. PEP2+, Peptone 50, and PEP-NS are all porcine intestinal mucosa products, but differ based on the carriers with which they are co-dried. PEP2+ is co-dried with enzymatically processed vegetable proteins. Peptone 50 is co-dried with a vegetable protein, while PEP-NS uses by-products from corn wet-milling. Phase 1 diets were fed in pellet form from d 0 to 8. Phase 2 diets were fed in meal form from d 8 to 21. A common corn-soybean meal diet was fed from d 21 to 35. There were 6 dietary treatments: (1) a negative control diet containing 2.5% spray-dried animal plasma (SDAP) in Phase 1 followed by no specialty protein sources in Phase 2; (2) a diet containing 5% SDAP in Phase 1 and 3% SMFM in Phase 2; (3) a blend of 5% SDAP and 3% SMFM during Phase 1 and 6% SMFM during Phase 2; (4) a blend of 5% SDAP and 3% PEP2+ during Phase 1 and 6% PEP2+ during Phase 2; (5) a blend of 5% SDAP and 3% PEP 50 during Phase 1 and 6% PEP50 during Phase 2, and (6) a blend of 5% SDAP and 3% PEP-NS during Phase 1 and 6% PEP-NS during Phase 2. During Phase 1, there were no differences in F/G among pigs fed any of the dietary treatments. During Phase 2 (d 8 to 21), pigs fed 6% PEP2+ had greater ( $P < 0.05$ ) ADG compared to those fed the negative control diet, 3% or 6% fish meal, with pigs fed PEP50 and PEP NS intermediate. Furthermore, pigs fed 6% PEP2+ had the greatest improvement ( $P < 0.02$ ) in F/G compared to pigs fed all other experimental diets. Overall, pigs fed diets containing PEP2+ had increased ( $P < 0.03$ ) ADG and ADFI compared to pigs fed the negative control diet. Pigs fed 3% PEP2+ during Phase 1 and 6% PEP2+ during Phase 2 had greater ( $P < 0.05$ ) ADFI compared to those fed 3% SMFM during Phase 1 and 6% SMFM during Phase 2. In conclusion, PEP2+, Peptone 50, and PEP-NS can be used as specialty protein sources to replace select menhaden fish meal in Phase 2 nursery pig diets. In addition pigs fed PEP2+ had greater ADG than those fed fish meal.

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

## Introduction

Recently, porcine intestinal mucosa products have been gaining attention for use in nursery pig diets, specifically as replacements for fish meal. Porcine intestinal mucosa

<sup>1</sup> Appreciation is expressed to Tech Mix Inc., Stewart, MN, and Midwest Ag Enterprises, Marshall, MN, for providing the PEP products and partial financial support.

<sup>2</sup> Food Animal Health and Management Center, College of Veterinary Medicine, Kansas State University.

<sup>3</sup> Midwest Ag Enterprises, Inc., Marshall, MN

<sup>4</sup> TechMix, Inc., Stewart, MN

products are derived from small intestines collected at pork processing plants. The intestines are first cleaned of any digestive contents and then pressed to remove the mucosa lining. The mucosa is subsequently hydrolyzed, and resin beads are used to extract heparin for use in the human health industry. The remaining material consists of small chain peptides and has an excellent amino acid profile. In addition to the mucosa, unique coproducts are added and co-dried to create a final product. Previous research (Myers et al., 2010<sup>5</sup>) found that 4% PEP2 could be fed in Phase 2 nursery pig diets, replacing select menhaden fish meal, and actually improving ADG and F/G. This study looked at three different porcine intestinal products: PEP2+, Peptone 50, and PEP-NS. PEP2+ is a combination of porcine intestinal mucosa and enzymatically processed vegetable proteins. Peptone 50 is another porcine intestinal mucosa product co-dried onto vegetable protein. Finally, PEP-NS is unique from the other two PEP products in that it does not contain soy products as a carrier. Instead PEP-NS uses by-products from corn wet-milling as its carrier. The objective of this study was to evaluate the influence of PEP2+, Peptone 50, PEP-NS, and fish meal on nursery pig growth performance.

## Procedures

The Kansas State University (K-State) International Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the K-State Segregated Early Weaning Facility in Manhattan, KS.

Samples of PEP2+, Peptone 50, and PEP-NS were collected and analyzed for CP, crude fat, mineral, and amino acid content (Table 1). The nutrient profiles for PEP2+, Peptone 50, PEP-NS and their digestible amino acid values were provided by the manufacturer and used in diet formulation.

A total of 360 nursery pigs (PIC C327 × 1050, initially 11.8 lb and 21 d of age) were used in a 35-d study to evaluate the effects on nursery pig performance of select menhaden fishmeal (SMFM), PEP2+, Peptone 50, and PEP-NS. After arrival at the segregated early weaning facility, pigs were allotted to 1 of 6 dietary treatments. There were 5 pigs per pen and 12 pens per treatment. Pigs were provided ad libitum access to feed and water via a 4-hole dry self-feeder and a cup waterer in each pen (4 x 4 ft).

The 6 dietary treatments were: (1) negative control containing 2.5% spray-dried animal plasma (SDAP) in Phase 1 followed by no specialty protein sources in Phase 2, (2) positive control containing 5% SDAP in Phase 1 and 3% select menhaden fish meal in Phase 2; and the diets containing specialty protein sources (3 through 6) contained 5% SDAP and either 3% fish meal, PEP2+, Peptone 50, and PEP-NS in Phase 1, and 6% fish meal, PEP2+, Peptone 50, PEP-NS in Phase 2, respectively. Phase 1 diets were fed in pellet form from d 0 to 8 after weaning (Table 2). Phase 2 diets were fed in meal form from d 7 to 21 (Table 3). A common Phase 3 diet was fed from d 21-35. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 0, 8, 16, 21 and 35 (Table 4).

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 the LSD procedure.

<sup>5</sup> Myers et al., Swine Day 2010, Report of Progress 1038, pp. 27-34.

## Results and Discussion

During Phase 1 (d 0 to 8), there were no differences among pigs fed any of the dietary treatments for ADG, ADFI, or F/G.

From d 8 to 21, pigs fed diets containing 6% PEP2+, Peptone 50, or PEP-NS had improved ( $P < 0.02$ ) ADG compared to those fed the negative control. Pigs fed 6% PEP2+ had ( $P < 0.05$ ) increased ADG compared to those fed 3% fish meal, 6% fish meal, or 6% Peptone 50. Furthermore, pigs fed 6% PEP2+, Peptone 50, or PEP-NS had improved ( $P < 0.03$ ) feed intake compared to pigs fed the negative control diet. Pigs fed diets containing 6% PEP2+ had improved ( $P < 0.02$ ) F/G compared to all other treatments.

From d 0 to 21, pigs fed 3% PEP2+, Peptone 50, or PEP-NS in Phase 1 and 6% PEP2+, Peptone50, or PEP-NS in Phase 2 had improved ( $P < 0.05$ ) ADG compared to those fed the negative control diet. While, pigs fed 3% PEP2+ in Phase 1 and 6% PEP2+ in Phase 2 had improved ( $P < 0.02$ ) ADG compared to pigs fed 5% SDAP in Phase 1 and 3% SMFM in Phase 2 or 3% SMFM in Phase 1 and 6% SMFM in Phase 2. In addition, pigs fed 3 % PEP2+ or Peptone50 in Phase 1 and 6% PEP2+ or Peptone 50 during Phase 2 had improved ( $P < 0.03$ ) feed intake compared to those fed the negative control. Pigs fed 3% PEP2+ during Phase 1 and 6% PEP2+ had improved ( $P < 0.05$ ) F/G compared to all other dietary treatments.

During Phase 3, d 21-35, when all pigs were fed a common diet, there were no significant differences found among treatments for ADG and ADFI. However, pigs previously fed 5% SDAP in Phase 1 and 3% SMFM in Phase 2 had improved ( $P < 0.04$ ) F/G compared to pigs previously fed 3% PEP2+ during Phase 1 and 6% PEP2+ during Phase 2.

Overall, pigs fed diets containing PEP2+ had improved ( $P < 0.03$ ) ADG compared to pigs fed the negative control diet. Additionally, pigs fed diets containing PEP2+, Peptone50, and PEP-NS had improved ( $P < 0.03$ ) feed intake compared to pigs fed the negative control. While pigs fed 3% PEP2+ during Phase 1 and 6% PEP2+ during Phase 2 had increased ( $P < 0.05$ ) feed intake compared to pigs fed 3% SMFM during Phase 1 and 6% SMFM during Phase 2.

In conclusion, adding 3% PEP products to Phase 1 nursery-pig diets had no adverse effects on growth performance. However, the greatest benefits were seen when 6% PEP2+ was added to Phase 2 diets. During this period, pigs fed diets containing 6% PEP2+ had increased feed intake compared to those fed the 6% fish meal diet. The added benefits of increased feed intake were carried over to feed efficiency: Pigs fed 6% PEP2+ had the greatest improvement in F/G compared to all other treatments.

In conclusion, PEP2+, Peptone 50, and PEP-NS can be used as specialty protein sources to replace select menhaden fish meal in Phase 2 nursery pig diets, with those fed PEP2+ having greater ADG than those fed fish meal.

**Table 1. Analyzed nutrient composition of ingredients**

| Item           | Fish meal                   |          | PEP2+ <sup>1</sup>      |          | Peptone 50 <sup>2</sup> |          | PEP-NS <sup>3</sup>     |          |
|----------------|-----------------------------|----------|-------------------------|----------|-------------------------|----------|-------------------------|----------|
|                | Formulated <sup>4,5,7</sup> | Analyzed | Formulated <sup>6</sup> | Analyzed | Formulated <sup>6</sup> | Analyzed | Formulated <sup>6</sup> | Analyzed |
| CP, %          |                             |          |                         |          |                         |          |                         |          |
| Amino Acids, % |                             |          |                         |          |                         |          |                         |          |
| Isoleucine     | 2.42 (94)                   | 2.42     | 2.63 (88)               | 2.67     | 2.23 (91)               | 2.38     | 2.06 (83)               | 1.99     |
| Leucine        | 4.27 (94)                   | 4.28     | 4.23 (89)               | 4.55     | 3.78 (91)               | 4.03     | 3.44 (72)               | 3.55     |
| Lysine         | 4.57 (95)                   | 4.67     | 4.29 (88)               | 4.51     | 3.12 (91)               | 3.57     | 3.50 (83)               | 3.44     |
| Methionine     | 1.66 (94)                   | 1.55     | 1.09 (88)               | 0.97     | 0.81 (93)               | 0.75     | 0.97 (86)               | 0.80     |
| Threonine      | 2.32 (88)                   | 2.56     | 2.47 (83)               | 2.47     | 2.00 (88)               | 2.15     | 2.06 (77)               | 1.94     |
| Tryptophan     | 0.59 (88)                   | 0.56     | 0.77 (87)               | 0.68     | 0.67 (90)               | 0.68     | 0.59 (83)               | 0.55     |
| Valine         | 2.82 (93)                   | 2.78     | 3.03 (86)               | 3.03     | 2.44 (89)               | 2.59     | 2.56 (81)               | 2.43     |
| Cystine        | 0.50 (88)                   | 0.49     | 0.79 (77)               | 0.68     | 0.80 (88)               | 0.62     | 0.62 (68)               | 0.47     |

<sup>1</sup> PEP2+ (Tech Mix, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN).<sup>2</sup> Peptone 50 (Tech Mix, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN ).<sup>3</sup> PEP-NS (Tech Mix, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN ).<sup>4</sup> Diets were prepared using the formulated values.<sup>5</sup> Nutrient values from NRC (1998).<sup>6</sup> Nutrient values provided by the manufacturer.<sup>7</sup> ( ) indicate standardized ileal digestible amino acid coefficients (%) used in diet formulation.

**Table 2. Composition of diets, Phase 1 (as-fed basis)<sup>1,2</sup>**

| Ingredient, %             | Negative control | 5% Spray dried animal plasma | 3% Select menhaden fish meal | 3% PEP2+ <sup>3</sup> | 3% Peptone 50 <sup>3</sup> | 3% PEP-NS <sup>3</sup> |
|---------------------------|------------------|------------------------------|------------------------------|-----------------------|----------------------------|------------------------|
| Corn                      | 36.19            | 38.50                        | 38.99                        | 38.36                 | 38.35                      | 38.31                  |
| Soybean meal, (46.5% CP)  | 29.62            | 24.98                        | 22.21                        | 22.20                 | 22.19                      | 22.21                  |
| Spray-dried animal plasma | 2.50             | 5.00                         | 5.00                         | 5.00                  | 5.00                       | 5.00                   |
| Select menhaden fish meal | ---              | ---                          | 3.00                         | ---                   | ---                        | ---                    |
| PEP2+                     | ---              | ---                          | ---                          | 3.00                  | ---                        | ---                    |
| Peptone 50                | ---              | ---                          | ---                          | ---                   | 3.00                       | ---                    |
| PEP-NS                    | ---              | ---                          | ---                          | ---                   | ---                        | 3.00                   |
| Spray-dried whey          | 25.00            | 25.00                        | 25.00                        | 25.00                 | 25.00                      | 25.00                  |
| Soybean oil               | 3.00             | 3.00                         | 3.00                         | 3.00                  | 3.00                       | 3.00                   |
| Monocalcium P, ( 21% P)   | 1.30             | 1.18                         | 0.78                         | 1.13                  | 1.05                       | 1.10                   |
| Limestone                 | 0.95             | 1.03                         | 0.83                         | 1.05                  | 1.10                       | 1.08                   |
| 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            | 0.25             | 0.25                         | 0.25                         | 0.25                  | 0.25                       | 0.25                   |
| Trace mineral premix      | 0.15             | 0.15                         | 0.15                         | 0.15                  | 0.15                       | 0.15                   |
| Lysine HCl                | 0.21             | 0.16                         | 0.08                         | 0.11                  | 0.15                       | 0.15                   |
| DL-Methionine             | 0.17             | 0.13                         | 0.11                         | 0.14                  | 0.15                       | 0.14                   |
| L-Threonine               | 0.07             | 0.03                         | 0.01                         | 0.02                  | 0.03                       | 0.03                   |
| Total                     | 100.00           | 100.00                       | 100.00                       | 100.00                | 100.00                     | 100.00                 |

*continued*

**Table 2. Composition of diets, Phase 1 (as-fed basis)<sup>1,2</sup>**

| Ingredient, %                   | Negative control | 5% Spay dried animal plasma | 3% Select menha-den fish meal | 3% PEP2+ <sup>3</sup> | 3% Peptone 50 <sup>3</sup> | 3% PEP-NS <sup>3</sup> |
|---------------------------------|------------------|-----------------------------|-------------------------------|-----------------------|----------------------------|------------------------|
| Calculated analysis             |                  |                             |                               |                       |                            |                        |
| SID amino acids, % <sup>4</sup> |                  |                             |                               |                       |                            |                        |
| Lysine                          | 1.40             | 1.40                        | 1.40                          | 1.40                  | 1.40                       | 1.40                   |
| Isoleucine:lysine               | 60               | 59                          | 60                            | 60                    | 59                         | 59                     |
| Methionine:lysine               | 32               | 29                          | 30                            | 30                    | 30                         | 30                     |
| Met & Cys:lysine                | 58               | 58                          | 58                            | 58                    | 58                         | 58                     |
| Threonine:lysine                | 63               | 63                          | 63                            | 63                    | 63                         | 63                     |
| Tryptophan:lysine               | 18.5             | 18.9                        | 19.1                          | 19.3                  | 19.2                       | 18.8                   |
| Valine:lysine                   | 67               | 69                          | 71                            | 71                    | 70                         | 70                     |
| Total lysine, %                 | 1.55             | 1.55                        | 1.55                          | 1.56                  | 1.55                       | 1.56                   |
| CP, %                           | 22.2             | 22.1                        | 22.6                          | 22.4                  | 22.2                       | 22.2                   |
| ME kcal/lb                      | 1,545            | 1,551                       | 1,560                         | 1,548                 | 1,549                      | 1,551                  |
| Ca, %                           | 0.90             | 0.90                        | 0.90                          | 0.90                  | 0.90                       | 0.90                   |
| P, %                            | 0.80             | 0.79                        | 0.78                          | 0.79                  | 0.78                       | 0.78                   |
| Available P, %                  | 0.55             | 0.55                        | 0.55                          | 0.55                  | 0.55                       | 0.55                   |

<sup>1</sup> A total of 360 nursery pigs (initial BW 11.8 lb) were used in a 35-d trial to determine the effects of fish meal, PEP2+, PEP50, PEP-NS on nursery pig growth performance.

<sup>2</sup> Phase 1 diets were fed from d 0 to 8 and were fed in pellet form.

<sup>3</sup> Tech Mix, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN .

<sup>4</sup> Standardized ileal digestible.



**Table 3. Composition of diets, Phase 2 and 3 (as-fed basis)<sup>1,2</sup>**

| Ingredient, %             | Phase 2          |                              |                              |                       |                            |                        | Phase 3  |
|---------------------------|------------------|------------------------------|------------------------------|-----------------------|----------------------------|------------------------|----------|
|                           | Negative control | 3% Select menhaden fish meal | 6% Select menhaden fish meal | 6% PEP2+ <sup>3</sup> | 6% Peptone 50 <sup>3</sup> | 6% PEP-NS <sup>3</sup> | Corn-SBM |
| Corn                      | 54.46            | 55.81                        | 56.02                        | 54.78                 | 54.70                      | 54.63                  | 62.80    |
| Soybean meal, (46.5% CP)  | 30.76            | 27.07                        | 24.61                        | 24.58                 | 24.59                      | 24.60                  | 32.25    |
| Select menhaden fish meal | ---              | 3.00                         | 6.00                         | ---                   | ---                        | ---                    | ---      |
| PEP2+                     | ---              | ---                          | ---                          | 6.00                  | ---                        | ---                    | ---      |
| PEP50                     | ---              | ---                          | ---                          | ---                   | 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                   | 1.00     |
| Monocalcium P, ( 21% P)   | 1.2              | 0.83                         | 0.43                         | 1.10                  | 1.00                       | 1.13                   | 1.25     |
| Limestone                 | 0.88             | 0.68                         | 0.48                         | 0.93                  | 1.00                       | 0.95                   | 1.05     |
| Salt                      | 0.35             | 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                   | 0.25     |
| Vitamin premix            | 0.25             | 0.25                         | 0.25                         | 0.25                  | 0.25                       | 0.25                   | 0.25     |
| Trace mineral premix      | 0.15             | 0.15                         | 0.15                         | 0.15                  | 0.15                       | 0.15                   | 0.15     |
| Lysine HCl                | 0.35             | 0.30                         | 0.21                         | 0.27                  | 0.34                       | 0.34                   | 0.33     |
| DL-Methionine             | 0.16             | 0.15                         | 0.11                         | 0.17                  | 0.18                       | 0.17                   | 0.14     |
| L-Threonine               | 0.14             | 0.13                         | 0.10                         | 0.12                  | 0.14                       | 0.14                   | 0.13     |
| Phzyme 600                |                  |                              |                              |                       |                            |                        | .05      |
| Total                     | 100              | 100                          | 100                          | 100                   | 100                        | 100                    | 100      |

*continued*

**Table 3. Composition of diets, Phase 2 and 3 (as-fed basis)<sup>1,2</sup>**

| Ingredient, %                   | Phase 2          |                              |                              |                       |                            |                        | Phase 3  |
|---------------------------------|------------------|------------------------------|------------------------------|-----------------------|----------------------------|------------------------|----------|
|                                 | Negative control | 3% Select menhaden fish meal | 6% Select menhaden fish meal | 6% PEP2+ <sup>3</sup> | 6% Peptone 50 <sup>3</sup> | 6% PEP-NS <sup>3</sup> | Corn-SBM |
| Calculated analysis             |                  |                              |                              |                       |                            |                        |          |
| SID amino acids, % <sup>4</sup> |                  |                              |                              |                       |                            |                        |          |
| Lysine                          | 1.30             | 1.30                         | 1.30                         | 1.30                  | 1.30                       | 1.30                   | 1.26     |
| Isoleucine:lysine               | 60               | 60                           | 62                           | 61                    | 60                         | 58                     | 61       |
| Methionine:lysine               | 34               | 35                           | 35                           | 35                    | 35                         | 36                     | 34       |
| Met & Cys:lysine                | 58               | 58                           | 58                           | 58                    | 58                         | 58                     | 59       |
| Threonine:lysine                | 63               | 63                           | 63                           | 63                    | 63                         | 63                     | 63       |
| Tryptophan:lysine               | 17               | 17                           | 17                           | 18                    | 17                         | 17                     | 17.5     |
| Valine:lysine                   | 65               | 66                           | 69                           | 67                    | 65                         | 65                     | 68       |
| Total lysine, %                 | 1.44             | 1.43                         | 1.43                         | 1.45                  | 1.43                       | 1.45                   | 1.39     |
| CP, %                           | 20.7             | 20.9                         | 21.5                         | 21.2                  | 20.8                       | 20.7                   | 20.8     |
| ME kcal/lb                      | 1,512            | 1,521                        | 1,529                        | 1,506                 | 1,508                      | 1,512                  | 1,519    |
| Ca, %                           | 0.75             | 0.75                         | 0.75                         | 0.75                  | 0.75                       | 0.75                   | 0.76     |
| P, %                            | 0.69             | 0.68                         | 0.67                         | 0.68                  | 0.67                       | 0.67                   | 0.66     |
| Available P, %                  | 0.39             | 0.39                         | 0.39                         | 0.39                  | 0.39                       | 0.39                   | 0.34     |

<sup>1</sup> A total of 360 nursery pigs (initial BW 11.8 lb) were used in a 35-d trial to determine the effects of fish meal, PEP2+, PEP50, PEP-NS on nursery pig growth performance.

<sup>2</sup> Phase 1 diets were fed from d 0 to 7 and were in the pellet form.

<sup>3</sup> Tech Mix, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN.

<sup>4</sup> Standardized ileal digestible.

**Table 4. Effects of protein source on nursery pig performance<sup>1</sup>**

| Phase 1 <sup>2</sup> : | 2.5% SDAP <sup>4</sup> | 5% SDAP              | 3% SMFM            | 3% PEP2+           | 3% Peptone 50      | 3% PEP-NS          |      |
|------------------------|------------------------|----------------------|--------------------|--------------------|--------------------|--------------------|------|
| Phase 2:               | Corn-SBM               | 3% SMFM <sup>5</sup> | 6% SMFM            | 6% PEP2+           | 6% Peptone 50      | 3%PEP-NS           |      |
| Phase 3 <sup>3</sup> : | Corn-SBM               | Corn-SBM             | Corn-SBM           | Corn-SBM           | Corn-SBM           | Corn-SBM           | SEM  |
| d 0 to 8               |                        |                      |                    |                    |                    |                    |      |
| ADG, lb                | 0.42                   | 0.42                 | 0.42               | 0.43               | 0.44               | 0.41               | 0.02 |
| ADFI, lb               | 0.35                   | 0.36                 | 0.36               | 0.36               | 0.37               | 0.35               | 0.03 |
| F/G                    | 0.86                   | 0.87                 | 0.87               | 0.85               | 0.85               | 0.86               | 0.03 |
| d 8 to 21              |                        |                      |                    |                    |                    |                    |      |
| ADG, lb                | 0.64 <sup>c</sup>      | 0.67 <sup>bc</sup>   | 0.69 <sup>bc</sup> | 0.80 <sup>a</sup>  | 0.73 <sup>b</sup>  | 0.73 <sup>ab</sup> | 0.04 |
| ADFI, lb               | 0.93 <sup>c</sup>      | 0.97 <sup>bc</sup>   | 0.97 <sup>bc</sup> | 1.05 <sup>ab</sup> | 1.06 <sup>b</sup>  | 1.04 <sup>ab</sup> | 0.05 |
| F/G                    | 1.46 <sup>a</sup>      | 1.45 <sup>a</sup>    | 1.40 <sup>a</sup>  | 1.32 <sup>b</sup>  | 1.47 <sup>a</sup>  | 1.43 <sup>a</sup>  | 0.03 |
| d 0 to 21              |                        |                      |                    |                    |                    |                    |      |
| ADG, lb                | 0.55 <sup>c</sup>      | 0.57 <sup>bc</sup>   | 0.59 <sup>bc</sup> | 0.66 <sup>a</sup>  | 0.62 <sup>ab</sup> | 0.61 <sup>ab</sup> | 0.03 |
| ADFI, lb               | 0.71 <sup>b</sup>      | 0.74 <sup>ab</sup>   | 0.74 <sup>ab</sup> | 0.79 <sup>a</sup>  | 0.79 <sup>a</sup>  | 0.78 <sup>ab</sup> | 0.04 |
| F/G                    | 1.23 <sup>a</sup>      | 1.29 <sup>a</sup>    | 1.26 <sup>a</sup>  | 1.20 <sup>b</sup>  | 1.29 <sup>a</sup>  | 1.28 <sup>a</sup>  | 0.02 |
| d 21 to 35             |                        |                      |                    |                    |                    |                    |      |
| ADG, lb                | 0.97                   | 1.03                 | 0.98               | 0.97               | 0.99               | 1.01               | 0.03 |
| ADFI, lb               | 1.74                   | 1.81                 | 1.76               | 1.82               | 1.79               | 1.80               | 0.04 |
| F/G                    | 1.81 <sup>ab</sup>     | 1.76 <sup>b</sup>    | 1.83 <sup>ab</sup> | 1.89 <sup>a</sup>  | 1.82 <sup>ab</sup> | 1.80 <sup>ab</sup> | 0.05 |
| d 0 to 35              |                        |                      |                    |                    |                    |                    |      |
| ADG, lb                | 0.72 <sup>b</sup>      | 0.76 <sup>ab</sup>   | 0.74 <sup>ab</sup> | 0.78 <sup>a</sup>  | 0.76 <sup>ab</sup> | 0.77 <sup>ab</sup> | 0.03 |
| ADFI, lb               | 1.12 <sup>c</sup>      | 1.17 <sup>abc</sup>  | 1.15 <sup>bc</sup> | 1.20 <sup>a</sup>  | 1.19 <sup>ab</sup> | 1.19 <sup>ab</sup> | 0.03 |
| F/G                    | 1.56                   | 1.55                 | 1.55               | 1.54               | 1.56               | 1.55               | 0.03 |

<sup>a,b,c</sup> Within a row, means without a common superscript differ  $P < 0.05$ .

<sup>1</sup> A total of 360 nursery pigs (initial BW 11.8 lb) were used in a 35-d trial to determine the effects of fish meal, PEP2+, Peptone 50, and PEP-NS on nursery pig growth performance.

<sup>2</sup> Fed from d 0 to 8 in pellet form.

<sup>3</sup> Fed from d 8 to 21 in meal form.

<sup>4</sup> Spray dried animal plasma.

<sup>5</sup> Select menhaden fish meal.