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## Effect of replacing fish meal with crystalline amino acids on growth performance of nursery pigs from 15 to 25 lb

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# Effect of Replacing Fish Meal with Crystalline Amino Acids on Growth Performance of Nursery Pigs from 15 to 25 lb<sup>1</sup>

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## Summary

A total of 282 nursery pigs (PIC TR4 × 1050, initially 16.1 lb, 3 d postweaning) were used in a 28-d growth trial to evaluate the effects of replacing fish meal with crystalline amino acids on growth performance. Pigs were allotted to 1 of 6 dietary treatments with 7 replications per treatment. There were 5 replications with 7 pigs per pen and 2 replications with 6 pigs per pen. Pigs and feeders were weighed on d 0, 7, 14, 21, and 28 to calculate ADG, ADFI, and F/G. A 2-phase diet series was used, with treatment diets fed from d 0 to 14 and a common diet fed from d 14 to 28. All diets were in meal form. For the 6 dietary treatments, the fish meal was included at: 4.50, 3.60, 2.70, 1.80, 0.90, and 0.00% respectively. Crystalline lysine, methionine, threonine, tryptophan, isoleucine, and valine all increased as fish meal decreased to maintain minimum amino acid ratios. Also, increasing amounts of glutamine and glycine were used in diets containing 3.60% to 0.00% fish meal to maintain a lysine-to-CP ratio. From d 0 to 14, there was no difference ( $P > 0.29$ ) in ADG, ADFI, or F/G as the level of fish meal decreased and crystalline amino acids increased. From d 14 to 28 (common diet period), no clear effects ( $P > 0.09$ ) on growth performance were detected. Overall (d 0 to 28), there was no difference ( $P > 0.16$ ) in ADG or ADFI. For F/G, a quadratic effect ( $P < 0.04$ ) was detected, which was the result of small improvements in F/G at the intermediate fish meal levels (2.70 and 1.80). In conclusion, these data suggest that crystalline amino acids, when balanced for minimum amino acid ratios, can be used to replace fish meal in diets for 15- to 25-lb pigs.

Key words: fish meal, crystalline amino acids, amino acid requirements

## Introduction

Several experiments have been conducted in which expensive specialty protein sources (fish meal, blood products, poultry meal, etc.) were replaced with crystalline amino acids in the diet for 15- to 25-lb pigs. These experiments have yielded mixed results. Recently at Kansas State University (K-State), a series of experiments has been conducted to determine the reason for inconsistency. The experiments also will help determine the minimum ratio for other amino acids relative to lysine in order to allow formulation with higher levels of crystalline amino acids and removal of dietary specialty protein sources. The objective of this study was to determine the effects of replacing fish meal with crystalline amino acids on growth performance of nursery pigs from 15 to 25 lb.

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## Procedure

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this study. The study was conducted at the K-State Swine Teaching and Research Center in Manhattan, KS.

A total of 282 nursery pigs (PIC TR4 × 1050, initially 16.1 lb) were used in a 28-d trial to evaluate the effect on growth performance of replacing dietary fish meal with crystalline amino acids. Pigs were weaned at approximately 21 d of age and allotted to pens by initial BW to achieve the same average pen weight. Pigs were fed a common pelleted SEW diet for 3 d. On d 3 postweaning, pens were allotted to 1 of 6 dietary treatments with 7 replications per treatment. Thus, d 3 postweaning was d 0 of the experiment. Each treatment had 5 replications with 7 pigs per pen and 2 replications with 6 pigs per pen.

A 2-phase diet series was used, with treatment diets fed from d 0 to 14 and a common diet fed from d 14 to 28 (Table 1). For the 6 dietary treatments, 4.50, 3.60, 2.70, 1.80, 0.90, and 0.00% fish meal was added, respectively. Crystalline lysine, methionine, threonine, tryptophan, isoleucine, and valine all increased as fish meal decreased to maintain minimum amino acid ratios. Also, increasing amounts of glutamine and glycine were used in diets containing 3.60% to 0.00% fish meal to maintain a lysine-to-CP ratio of no more than 7:1. Large batches of the 4.50 and 0.00% fish meal diets were first manufactured then blended to achieve the intermediate diets. Treatment diets were corn-soybean meal-based and contained 10% dried whey. The common diet was corn-soybean meal-based diet formulated to contain 1.26% standardized ileal digestible lysine. All experimental diets were in meal form and were prepared at the K-State Animal Science Feed Mill. Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pigs and feeders were weighed on d 0, 7, 14, 21, and 28 to calculate ADG, ADFI, and F/G.

Data were analyzed using orthogonal polynomial contrasts to determine the effect of decreasing dietary fish meal. The PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) was used for statistical analysis. Pen was the experimental unit for all data analysis.

## Results and Discussion

From d 0 to 14 (treatment diet period), there was no difference ( $P > 0.29$ , Table 2) in ADG, ADFI, or F/G as dietary fish meal decreased and crystalline amino acids increased. From d 14 to 28 (common diet period), no clear effects ( $P > 0.09$ ) on growth performance were detected.

Overall (d 0 to 28), there were no differences ( $P > 0.16$ ) in ADG or ADFI. For F/G, a quadratic effect ( $P < 0.04$ ) was detected, which was the result of small improvements in F/G at the intermediate fish meal levels (2.70 and 1.80% fish meal).

The diet formulation used in this experiment suggests that crystalline amino acids can be used to replace fish meal in diets for 15- to 25-lb pigs.

**Table 1. Diet composition (as fed)**

|  |               | Phase 1 <sup>1</sup> |       |       |       |       |       | Common<br>phase 2 <sup>2</sup> |
|--|---------------|----------------------|-------|-------|-------|-------|-------|--------------------------------|
| Item   | Fish meal, %: | 4.50                 | 3.60  | 2.70  | 1.80  | 0.90  | 0.00  |                                |
| Ingredient, %                                |               |                      |       |       |       |       |       |                                |
| Corn   |               | 56.58                | 56.83 | 57.07 | 57.53 | 57.57 | 57.81 | 65.05                          |
| Soybean meal (46.5% CP)                      |               | 25.21                | 25.21 | 25.20 | 25.20 | 25.20 | 25.19 | 30.73                          |
| Spray-dried whey                             |               | 10.00                | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | -                              |
| Select menhaden fish meal                    |               | 4.50                 | 3.60  | 2.70  | 1.80  | 0.90  | -     | -                              |
| Soybean oil                                  |               | 1.00                 | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | -                              |
| Monocalcium P (21% P)                        |               | 0.51                 | 0.63  | 0.75  | 0.86  | 0.98  | 1.10  | 1.08                           |
| Limestone                                    |               | 0.55                 | 0.62  | 0.69  | 0.76  | 0.83  | 0.90  | 0.95                           |
| Salt   |               | 0.30                 | 0.31  | 0.32  | 0.33  | 0.34  | 0.35  | 0.35                           |
| Zinc oxide                                   |               | 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                           |
| Vitamin premix                               |               | 0.25                 | 0.25  | 0.25  | 0.25  | 0.25  | 0.25  | 0.25                           |
| L-lysine HCl                                 |               | 0.275                | 0.327 | 0.379 | 0.430 | 0.482 | 0.534 | 0.360                          |
| DL-methionine                                |               | 0.124                | 0.143 | 0.162 | 0.182 | 0.201 | 0.220 | 0.130                          |
| L-threonine                                  |               | 0.136                | 0.155 | 0.174 | 0.192 | 0.211 | 0.230 | 0.130                          |
| L-tryptophan                                 |               | 0.046                | 0.051 | 0.056 | 0.060 | 0.065 | 0.070 | -                              |
| L-isoleucine                                 |               | -                    | 0.02  | 0.04  | 0.06  | 0.08  | 0.10  | -                              |
| L-valine                                     |               | 0.037                | 0.062 | 0.086 | 0.111 | 0.135 | 0.160 | -                              |
| Glutamine                                    |               | -                    | 0.16  | 0.32  | 0.48  | 0.64  | 0.80  | -                              |
| Glycine                                      |               | -                    | 0.16  | 0.32  | 0.48  | 0.64  | 0.80  | -                              |
| Phytase <sup>3</sup>                         |               | 0.085                | 0.085 | 0.085 | 0.085 | 0.085 | 0.085 | 0.165                          |
| TOTAL  |               | 100                  | 100   | 100   | 100   | 100   | 100   | 100                            |
| Calculated analysis                          |               |                      |       |       |       |       |       |                                |
| Standardized ileal digestible amino acids, % |               |                      |       |       |       |       |       |                                |
| Lysine                                       |               | 1.30                 | 1.30  | 1.30  | 1.30  | 1.30  | 1.30  | 1.26                           |
| Isoleucine:lysine                            |               | 60                   | 60    | 60    | 60    | 60    | 60    | 61                             |
| Leucine:lysine                               |               | 125                  | 122   | 119   | 116   | 114   | 111   | 129                            |
| Methionine:lysine                            |               | 35                   | 35    | 35    | 36    | 36    | 36    | 33                             |
| Met & Cys:lysine                             |               | 58                   | 58    | 58    | 58    | 58    | 58    | 58                             |
| Threonine:lysine                             |               | 64                   | 64    | 64    | 64    | 64    | 64    | 63                             |
| Tryptophan:lysine                            |               | 20                   | 20    | 20    | 20    | 20    | 20    | 17.4                           |
| Valine:lysine                                |               | 70                   | 70    | 70    | 70    | 70    | 70    | 68                             |
| Total lysine, %                              |               | 1.43                 | 1.43  | 1.43  | 1.42  | 1.42  | 1.42  | 1.39                           |
| ME, kcal/lb                                  |               | 1,528                | 1,527 | 1,525 | 1,523 | 1,522 | 1,520 | 1,503                          |
| SID lysine:ME, g/Mcal                        |               | 3.86                 | 3.86  | 3.87  | 3.87  | 3.87  | 3.88  | 3.80                           |
| CP, %  |               | 21.1                 | 20.9  | 20.8  | 20.6  | 20.5  | 20.3  | 20.8                           |
| Ca, %  |               | 0.72                 | 0.72  | 0.72  | 0.72  | 0.72  | 0.72  | 0.69                           |
| P, %   |               | 0.65                 | 0.65  | 0.64  | 0.64  | 0.64  | 0.64  | 0.62                           |
| Available P, %                               |               | 0.47                 | 0.47  | 0.47  | 0.47  | 0.47  | 0.47  | 0.42                           |

<sup>1</sup> Treatment diets were fed from d 0 to 14.<sup>2</sup> Common diet was fed from d 14 to 28.<sup>3</sup> Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 231 FTU/lb, with a release of 0.10% available P.

**Table 2. Evaluation of replacing fish meal with crystalline amino acids on growth performance in nursery pig diets<sup>1,2</sup>**

| Item       | Fish meal, % |      |      |      |      |      | SEM   | Probability, $P <$ |        |           |
|------------|--------------|------|------|------|------|------|-------|--------------------|--------|-----------|
|            | 4.50         | 3.60 | 2.70 | 1.80 | 0.90 | 0.00 |       | Treatment          | Linear | Quadratic |
| d 0 to 14  |              |      |      |      |      |      |       |                    |        |           |
| ADG, lb    | 0.83         | 0.82 | 0.86 | 0.83 | 0.84 | 0.84 | 0.024 | 0.92               | 0.71   | 0.73      |
| ADFI, lb   | 1.17         | 1.14 | 1.18 | 1.16 | 1.17 | 1.20 | 0.035 | 0.86               | 0.38   | 0.62      |
| F/G        | 1.41         | 1.39 | 1.38 | 1.40 | 1.40 | 1.44 | 0.034 | 0.88               | 0.49   | 0.29      |
| d 14 to 28 |              |      |      |      |      |      |       |                    |        |           |
| ADG, lb    | 1.28         | 1.22 | 1.28 | 1.16 | 1.24 | 1.21 | 0.029 | 0.07               | 0.11   | 0.45      |
| ADFI, lb   | 2.10         | 2.00 | 2.08 | 1.90 | 2.06 | 2.03 | 0.042 | 0.02               | 0.31   | 0.09      |
| F/G        | 1.65         | 1.64 | 1.63 | 1.64 | 1.67 | 1.68 | 0.024 | 0.65               | 0.21   | 0.23      |
| d 0 to 28  |              |      |      |      |      |      |       |                    |        |           |
| ADG, lb    | 1.05         | 1.02 | 1.07 | 1.00 | 1.04 | 1.02 | 0.020 | 0.19               | 0.34   | 0.71      |
| ADFI, lb   | 1.63         | 1.57 | 1.63 | 1.53 | 1.62 | 1.62 | 0.032 | 0.16               | 0.86   | 0.16      |
| F/G        | 1.55         | 1.54 | 1.53 | 1.53 | 1.56 | 1.58 | 0.016 | 0.22               | 0.12   | 0.04      |
| wt, lb     |              |      |      |      |      |      |       |                    |        |           |
| d 0        | 16.0         | 16.1 | 16.0 | 16.2 | 16.2 | 16.1 | 0.17  | 0.96               | 0.68   | 0.70      |
| d 14       | 27.6         | 27.6 | 28.0 | 27.8 | 27.9 | 27.8 | 0.40  | 0.98               | 0.64   | 0.66      |
| d 28       | 45.5         | 44.7 | 45.7 | 44.1 | 45.2 | 44.7 | 0.66  | 0.56               | 0.50   | 0.74      |

<sup>1</sup> A total of 282 nursery pigs (initially 16.1 lb) were used in a 28-d trial to evaluate the effects of replacing fish meal with crystalline amino acids on growth performance.

<sup>2</sup> Treatment diets were fed from d 0 to 14 and a common diet fed from d 14 to 28.