# DETERMINING THE OPTIMAL THREONINE:LYSINE RATIO FOR THE 25 TO 50 LB PIG[1]

*J. R. Bergström, J. L. Nelssen, M. D. Tokach, R. D. Goodband, S. S. Dritz, J. A. Loughmiller, R. E. Musser, and W. B. Nessmith, Jr.*


## Summary

A 21-day growth trial was conducted to determine the threonine:lysine ratio necessary to optimize growth performance of the 25 to 50 lb pig reared in a high-health, segregated early-weaning (SEW) system. Ten experimental diets, including two levels of lysine (.75% and 1.10% apparent digestible lysine) and five apparent digestible threonine:lysine ratios (40, 47.5, 55, 62.5, and 70%), were used in a 2 × 5 factorial arrangement. Growth performance was improved by feeding 1.10% rather than .75% digestible lysine. Also, results indicated that the apparent digestible threonine requirement for the SEW-reared, 25 to 50 lb pig is approximately 55% of digestible lysine.


(Key Words: Early-Weaned Pigs, Amino Acids, Threonine.)

## Introduction

Two previous experiments were conducted to determine the appropriate threonine:lysine ratio necessary to optimize the growth performance of the segregated early-weaned (SEW) pig weighing approximately 10 to 18 lb. The threonine ratio supporting optimum growth was determined to be no more than 45% of lysine on an apparent digestible basis. Because a pig's needs for a particular amino acid may change as the animal grows, the objective of this experiment was to determine the appropriate threonine:lysine ratio necessary to optimize growth performance of the SEW-reared pig weighing 25 to 50 lb.

## Procedures

Two hundred and sixty high-lean growth pigs (Newsham Hybrids) were blocked by weight (initially 24.3 ± 1.8 lb and 33 ± 2 d of age) and allotted to one of 10 experimental diets, with a total of four or five pigs/pen (equal number of pigs/pen within a block) and six pens/treatment. The 10 experimental diets consisted of two levels of lysine (.75% and 1.10% digestible lysine) and five apparent digestible threonine:lysine ratios (40, 47.5, 55, 62.5, and 70%) in a 2 × 5 factorial arrangement (Table 1). The pigs had been used in a previous trial to determine the optimal threonine:lysine ratio for the 10 to 18 lb pig and then were placed on a common phase II diet for 5 days prior to being reallotted for this study.

The .75% and 1.10% digestible lysine basal diets were corn-soybean meal based. Crystalline isoleucine, methionine, cystine, valine, and tryptophan (L-isoleucine, DL-methionine, L-cystine, L-valine, and L-tryptophan) were included in the basal diets to ensure that they contained all the essential amino acids suggested by the Illinois ideal amino acid ratio adjusted for an apparent digestible basis. Crystalline threonine (L-threonine) was added to the basal diets at the expense of corn starch to provide the five levels of threonine. The levels of digestible threonine in the .75% digestible lysine diets

[1]The authors extend appreciation to Newsham Hybrids of Colorado Springs, CO for providing the pigs used in this research. We also thank Heartland Lysine for providing the crystalline amino acids.

were .300, .356, .413, .469, and .525%. The levels of digestible threonine in the 1.10% digestible lysine diets were .440, .523, .605, .688, and .770%. The experimental diets were fed in a meal form for 21 d.

Pigs were housed in the Kansas State University SEW nurseries in 4 × 4 ft pens for the duration of the trial. Pens were equipped with one self-feeder and a nipple waterer to provide *ad libitum* access to feed and water.

The pigs were weighed and feed disappearance was determined on d 7, 14, and 21 of the experiment. On d 14, the pigs were withheld from feed for 2 h, after which two pigs/pen were bled for plasma urea nitrogen (PUN) determination. Average daily gain (ADG), ADFI, F/G, and d 14 PUN were the response criteria.

The data were analyzed as a randomized complete block design, with pen as the experimental unit. Pigs were blocked on the basis of initial weight. Analysis of variance was performed using the GLM procedure of SAS. Linear, quadratic, and cubic polynomials were evaluated for dietary threonine levels.

## Results and Discussion

Average daily gain and F/G were improved ($P<.01$) from d 0 to 7 by feeding the diets containing 1.10% rather than .75% apparent digestible lysine (Table 2). Additionally, ADFI was greater for pigs fed the diets containing 1.10% digestible lysine. Average daily gain and F/G also were improved (linear, $P<.01$; quadratic, $P<.03$; and linear, $P<.01$; quadratic, $P<.08$; respectively) as the digestible threonine:lysine ratio increased up to 55%.

During the d 7 to 14 period, ADG and F/G were improved ($P<.01$) by feeding 1.10% digestible lysine. Increasing the threonine:lysine ratio up to 55% improved ADG (linear, $P<.01$; quadratic, $P<.03$) and F/G (linear, $P<.01$). However, there was a lysine × threonine interaction ($P<.02$) for ADFI. This resulted from the greatly reduced feed intake observed among pigs fed the .75% digestible lysine diet formulated to 40% digestible threonine:lysine. In addition, d 14 PUN was greater ($P<.01$) for pigs fed 1.10% rather than .75% digestible lysine. Increasing the digestible threonine:lysine ratio to 62.5% resulted in a decrease (linear, $P<.01$; quadratic, $P<.03$) in PUN.

As observed during the first 2 weeks, ADG and F/G were improved ($P<.01$) from d 14 to 21 when pigs were fed the diets containing 1.10% digestible lysine. Also, ADG and F/G were improved (linear, $P<.01$; quadratic, $P<.03$; and linear, $P<.01$; respectively) by increasing the threonine:lysine ratio to 55%. There was also a lysine × threonine interaction ($P<.01$) for ADFI, because of the reduced feed intake observed among pigs fed the low lysine diet formulated to 40% digestible threonine:lysine.

Overall, from d 0 to 21, ADG and F/G were improved by feeding 1.1% rather than .75% apparent digestible lysine. Average daily gain and F/G also were improved (linear, $P<.01$; quadratic, $P<.03$) by increasing the digestible threonine:lysine ratio to 55%. There was also a lysine × threonine interaction ($P<.02$) for ADFI. This occurred as a result of the low feed intake observed among pigs fed the .75% digestible lysine diet formulated to the 40% threonine:lysine ratio.

In conclusion, these data indicate that the SEW-reared, 25 to 50 lb pig requires an apparent digestible threonine:lysine ratio of at least 55% to optimize growth performance. This corresponds to a threonine:lysine ratio of approximately 63% to 65% when expressed on a total basis.

**Table 1. Composition of the Basal Diets[a]**

| | Digestible Lysine, % | |
|---|---|---|
| Ingredient, % | .75% | 1.10% |
| Corn | 84.96 | 72.53 |
| Soybean meal (46.5% CP) | 6.72 | 18.60 |
| Soy oil | 2.40 | 2.72 |
| Monocalcium phosphate | 2.00 | 1.79 |
| Antibiotic[b] | 1.00 | 1.00 |
| Limestone | 1.02 | 1.05 |
| L-lysine HCl | 0.56 | 0.65 |
| Copper sulfate | 0.08 | 0.08 |
| Corn starch[c] | 0.23 | 0.33 |
| Vitamin premix | 0.25 | 0.25 |
| L-isoleucine | 0.09 | 0.12 |
| DL-methionine | 0.05 | 0.10 |
| Trace mineral premix | 0.15 | 0.15 |
| L-cystine | 0.03 | 0.08 |
| L-valine | 0.07 | 0.14 |
| L-tryptophan | 0.07 | 0.08 |
| Salt | 0.35 | 0.35 |
| TOTAL | 100.00 | 100.00 |

[a]Diets were formulated to contain all essential amino acids (except threonine) at the University of Illinois ideal amino acid ratio adjusted for an apparent digestible basis. Diets also were formulated to contain .9% Ca and .8% P.

[b]Provided 50 g/ton carbadox.

[c]L-threonine replaced corn starch in the .75% and 1.10% digestible lysine basal diets to provide .300, .356, .413, .469, and .525% digestible threonine and .440, .523, .605, .688, and .770% digestible threonine, respectively. This provided 10 experimental diets in a 2 × 5 factorial arrangement, with two levels of lysine and five levels of digestible threonine:lysine (40, 47.5, 55, 62.5, and 70%).

**Table 2. Influence of Increasing the Digestible Threonine:Lysine Ratio (40 to 70%) on Pig Performance[a]**

| | .75% Digestible Lysine | | | | | 1.10% Digestible Lysine | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | 40 | 47.5 | 55 | 62.5 | 70 | 40 | 47.5 | 55 | 62.5 | 70 | CV |
| d 0 to 7 | | | | | | | | | | | |
| ADG, lb[bc] | .55 | .59 | .73 | .69 | .78 | .98 | 1.12 | 1.20 | 1.23 | 1.18 | 11.8 |
| ADFI, lb[d] | 1.72 | 1.74 | 1.86 | 1.82 | 1.89 | 1.88 | 1.84 | 2.00 | 1.90 | 1.83 | 7.5 |
| F/G[be] | 3.23 | 2.94 | 2.50 | 2.63 | 2.44 | 1.92 | 1.64 | 1.67 | 1.54 | 1.56 | 10.7 |
| d 7 to 14 | | | | | | | | | | | |
| ADG, lb[bc] | .93 | 1.08 | 1.15 | 1.21 | 1.14 | 1.37 | 1.49 | 1.57 | 1.42 | 1.53 | 10.2 |
| ADFI, lb[f] | 2.19 | 2.48 | 2.54 | 2.48 | 2.56 | 2.57 | 2.63 | 2.57 | 2.45 | 2.44 | 7.2 |
| F/G[bg] | 2.38 | 2.27 | 2.22 | 2.04 | 2.27 | 1.89 | 1.75 | 1.64 | 1.72 | 1.59 | 10.3 |
| d 14 to 21 | | | | | | | | | | | |
| ADG, lb[bc] | 1.01 | 1.27 | 1.40 | 1.38 | 1.38 | 1.64 | 1.81 | 1.67 | 1.77 | 1.74 | 10.7 |
| ADFI, lb[h] | 2.56 | 2.84 | 2.99 | 2.96 | 3.01 | 2.98 | 3.06 | 2.89 | 2.91 | 2.93 | 6.0 |
| F/G[bg] | 2.56 | 2.22 | 2.13 | 2.13 | 2.17 | 1.82 | 1.69 | 1.72 | 1.64 | 1.69 | 8.8 |
| d 0 to 21 | | | | | | | | | | | |
| ADG, lb[bc] | .83 | .98 | 1.10 | 1.10 | 1.10 | 1.33 | 1.47 | 1.48 | 1.47 | 1.48 | 6.4 |
| ADFI, lb[f] | 2.16 | 2.35 | 2.46 | 2.42 | 2.49 | 2.47 | 2.50 | 2.49 | 2.42 | 2.40 | 6.0 |
| F/G[bc] | 2.63 | 2.38 | 2.22 | 2.22 | 2.27 | 1.85 | 1.69 | 1.67 | 1.64 | 1.61 | 5.5 |
| d 14 | | | | | | | | | | | |
| PUN, mg/dL[bc] | 4.48 | 3.54 | 2.29 | 1.36 | 1.89 | 6.19 | 5.17 | 3.68 | 2.62 | 3.67 | 38.5 |

[a]Two hundred and sixty pigs were used (initially 24.3 lb and 33 d of age), 4 or 5 pigs/pen (depending upon the block) , 6 pens/treatment.
[b]Lysine effect ($P<.0001$)
[c]Threonine effect (linear, $P<.003$; quadratic, $P<.03$)
[d]Lysine effect ($P<.03$)
[e]Threonine effect (linear, $P<.0001$; quadratic, $P<.08$)
[f]Lysine × threonine interaction ($P<.02$)
[g]Threonine effect (linear, $P<.01$)
[h]Lysine × threonine interaction ($P<.002$)