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Determining the optimal threonine:lysine ratio in starter diets for the segregated early-weaned pig (1996)

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DETERMINING THE OPTIMAL THREONINE:LYSINE RATIO IN STARTER DIETS FOR THE SEGREGATED EARLY-WEANED PIG[1]

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Summary

A 14-day growth trial was conducted to determine the threonine:lysine ratio necessary to optimize growth performance of the segregated early-weaned (SEW) pig. Twelve experimental diets included two levels of lysine (1.15% and 1.5% apparent digestible lysine) and six apparent digestible threonine:lysine ratios (40, 45, 50, 55, 60, and 65%) in a 2 × 6 factorial arrangement. Growth performance was improved by feeding 1.5% rather than 1.15% digestible lysine. Growth performance decreased linearly as the digestible threonine:lysine ratio increased. Although a significant quadratic response was not observed, this reduction in growth performance did not appear to occur until the threonine ratio exceeded 45% of lysine on an apparent digestible basis. These data indicate that the threonine requirement for the SEW pig is approximately 45% of digestible lysine.

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

Introduction

The development of high nutrient-dense diets for early-weaned pigs has facilitated the implementation of segregated early weaning (SEW) as a common management practice. However, much remains to be discovered regarding optimum nutrition of the early-weaned pig. Although several studies have focussed on the lysine and methionine requirements of SEW-reared pigs, the appropriate level of the other amino acids necessary to optimize growth performance has been an area of considerable debate. The ideal amino acid ratio developed by the University of Illinois indicates that methionine and threonine are deficient in typical diets formulated to meet the lysine requirement of the SEW pig, unless they are added as synthetic amino acids. Recent research at Kansas State University agrees closely with the University of Illinois ideal amino acid ratio for methionine. However, in a study conducted recently to determine the threonine requirement of the SEW pig, growth performance was not affected by increasing the digestible threonine:lysine ratio above 50%. Therefore, the objective of this experiment was to confirm our previous results and evaluate threonine:lysine ratios below 50%.

Procedures

Three hundred high-lean growth pigs (Newsham Hybrids) were weaned at 14 ± 2 d of age and delivered to the segregated early weaning (SEW) facilities at Kansas State University. The pigs were blocked by weight (initially 10.0 ± 2 lb) and allotted to one of 12 experimental diets, with a total of five pigs/pen and five pens/treatment. The 12 experimental diets consisted of two levels of lysine (1.15% and 1.5% digestible lysine) and six digestible threonine:lysine ratios (40, 45, 50, 55, 60, and 65%) in a 2 × 6 factorial arrangement (Table 1). The 1.15% digestible lysine diets (1.31% total lysine) were

[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.

corn-soybean meal based and contained 10% dried whey, 15% lactose, 6% spray-dried plasma protein, and 3% select menhaden fish meal. The six 1.15% digestible lysine diets were calculated to contain .460, .518, .575, .633, .690, and .748% apparent digestible threonine. The level of soybean meal was increased in order to achieve the 1.5% digestible lysine diets (1.7% total lysine). The six 1.50% digestible lysine diets were calculated to contain .600, .675, .750, .825, .900, and .975% digestible threonine.

Crystalline isoleucine, methionine, cystine, valine, and tryptophan (L-isoleucine, DL-methionine, L-cystine, L-valine, 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 six levels of threonine. The experimental diets were pelleted and fed from d 0 to 14 postweaning.

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 and 14 postweaning. Average daily gain, ADFI, and F/G were the response criteria. Also, the pigs were withheld from feed for 2 h on d 14, and blood was collected from two pigs/pen for plasma urea nitrogen (PUN) determination.

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

No dietary threonine × lysine interactions were observed during the trial (Table 2). From d 0 to 7 postweaning, ADG and F/G were improved ($P < .0001$) by feeding the diets containing 1.5% digestible lysine rather than 1.15% digestible lysine. Feed intake was not affected by either lysine or threonine level of the diet during this period. Also, no differences occurred in growth performance with increasing threonine:lysine ratio.

From d 7 to 14 postweaning, ADG and F/G were improved ($P < .0001$) by feeding the 1.5% digestible lysine diets. Although ADFI was not affected by dietary lysine, ADFI and ADG decreased linearly ($P < .002$) as the threonine:lysine ratio increased. Feed efficiency was not affected by increasing the threonine:lysine ratio during this period.

For the entire trial (d 0 to 14 postweaning), pigs fed 1.5% apparent digestible lysine had greater ($P < .0001$) ADG and F/G than pigs fed 1.15% apparent digestible lysine. Also, ADG decreased linearly ($P < .01$) as the digestible threonine:lysine ratio increased. Although a significant quadratic response was not observed, this reduction in growth performance did not appear to occur until the threonine ratio exceeded 45% of lysine on an apparent digestible basis. No differences in ADFI occurred.

On d 14, PUN was greater ($P < .0001$) for pigs fed 1.5% digestible lysine. A quadratic decrease ($P < .05$) in PUN also occurred as the threonine:lysine ratio increased.

The results of this study agree with previous research (see Kansas State University Swine Day 1995, Report of Progress 746). Pigs that were fed 1.5% apparent digestible lysine (1.7% total lysine) gained faster and more efficiently than pigs fed 1.15% apparent digestible lysine (1.31% total lysine). Also, a previous study found that increasing the digestible threonine:lysine ratio above the basal level of 50% did not affect growth

performance. In this study, growth performance was numerically greatest for pigs fed 45% threonine:lysine and decreased linearly as the ratio increased. Additionally, PUN was reduced by feeding the 45% threonine:lysine ratio.

In conclusion, these data suggest that the optimum level of threonine for the SEW pig is 45% of lysine on an apparent digestible basis. This corresponds to a ratio of approximately 53% threonine:lysine on a total amino acid basis.

Table 1. Composition of Basal Diets[a]

	Digestible Lysine, %	
Ingredient, %	1.15	1.50
Corn	52.58	40.56
Dried whey	10.00	10.00
Lactose	15.00	15.00
Spray-dried plasma protein	6.00	6.00
Soy oil	6.00	6.00
Select menhaden fish meal	3.00	3.00
Soybean meal (46.5% CP)	1.12	12.93
Monocalcium phosphate	1.89	1.68
Antibiotic[b]	1.00	1.00
Limestone	0.74	0.77
L-lysine HCl	0.63	0.72
Zinc oxide	0.38	0.38
L-isoleucine	0.29	0.32
Corn starch[c]	0.29	0.38
Vitamin premix	0.25	0.25
DL-methionine	0.18	0.24
Trace mineral premix	0.15	0.15
L-cystine	0.14	0.19
L-valine	0.17	0.25
L-tryptophan	0.10	0.10
Salt	0.10	0.10
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 1.15% and 1.50% digestible lysine basal diets to provide .460, .518, .575, .633, .690, and .748% digestible threonine and .600, .675, .750, .825, .900, and .975% digestible threonine, respectively. This provided 12 experimental diets in a 2 × 6 factorial arrangement, with two levels of lysine and six levels of digestible threonine:lysine (40, 45, 50, 55, 60, and 65%).

Table 2. Influence of Increasing the Level of Digestible Threonine:Lysine on SEW Pig Performance[a]

	Digestible Threonine: Lysine Ratio, %						Digestible Lysine, %		
Item	40	45	50	55	60	65	1.15	1.50	CV
d 0 to 7									
ADG, lb[b]	.29	.32	.27	.30	.27	.28	.24	.34	22.1
ADFI, lb	.29	.29	.30	.30	.28	.30	.29	.30	18.1
F/G[b]	.98	.90	1.10	1.02	1.05	1.06	1.19	.88	16.5
d 7 to 14									
ADG, lb[bc]	.59	.59	.61	.56	.49	.51	.51	.61	15.5
ADFI, lb[c]	.81	.81	.81	.77	.68	.71	.78	.75	13.2
F/G[b]	1.37	1.35	1.32	1.39	1.37	1.37	1.53	1.22	9.0
d 0 to 14									
ADG, lb[bd]	.44	.46	.44	.43	.38	.40	.37	.47	14.5
ADFI, lb	.55	.55	.55	.54	.48	.50	.54	.52	13.1
F/G[b]	1.23	1.20	1.25	1.27	1.25	1.27	1.43	1.10	7.0
d 14									
PUN, mg/dL[be]	3.22	1.52	1.95	2.05	2.05	2.33	1.33	3.03	63.7

[a]Three hundred weanling pigs were used (initially 10.0 lb and 14 d of age), five pigs/pen, five pens/treatment.
[b]Lysine effect ($P < .0001$).
[c]Threonine effect (linear, $P < .002$).
[d]Threonine effect (linear, $P < .01$).
[e]Threonine effect (quadratic, $P < .05$).