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Abstract

A 14-d growth trial was conducted to evaluate effects of increasing isoleucine: lysine ratios on growth performance of the segregated early-weaned pig. Twelve experimental diets included two levels of lysine (1.15%and 1.50% digestible lysine) and six digestible isoleucine: lysine ratios (40, 45,50, 55, 60, and 65% relative to lysine) in a 2 x 6 factorial arrangement. From d 0 to 14, growth performance was improved by feeding 1.50% digestible lysine. A linear improven1ent in growth performance occurred from d 0 to 7 as the isoleucine:lysine ratio increased. Although a significant quadratic response was not observed, little improvement in pig performance occurred above the 60% apparent digestible isoleucine: lysine ratio. Increasing isoleucine had no effect on the overall growth perforn1ance from d 0 to 14, but plasma urea nitrogen (PUN) was linearly reduced on d 14. These data suggest that the isoleucine requirement for the SEW pig is approximately 60% of lysine on an apparent digestible basis. However, because this response was observed only in the first week postweaning, further research is required to confirm this high a requirement for isoleucine.; Swine Day, Manhattan, KS, November 21, 1996

Keywords

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

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Summary

A 14-d growth trial was conducted to evaluate effects of increasing isoleucine: lysine ratios on growth performance of the segregated early-weaned pig. Twelve experimental diets included two levels of lysine (1.15% and 1.50% digestible lysine) and six digestible isoleucine:lysine ratios (40, 45, 50, 55, 60, and 65% relative to lysine) in a 2 × 6 factorial arrangement. From d 0 to 14, growth performance was improved by feeding 1.50% digestible lysine. A linear improvement in growth performance occurred from d 0 to 7 as the isoleucine:lysine ratio increased. Although a significant quadratic response was not observed, little improvement in pig performance occurred above the 60% apparent digestible isoleucine:lysine ratio. Increasing isoleucine had no effect on the overall growth performance from d 0 to 14, but plasma urea nitrogen (PUN) was linearly reduced on d 14. These data suggest that the isoleucine requirement for the SEW pig is approximately 60% of lysine on an apparent digestible basis. However, because this response was observed only in the first week postweaning, further research is required to confirm this high a requirement for isoleucine.

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

Introduction

The development of nutrient-dense diets for early-weaned pigs has facilitated the implementation of segregated early-weaning (SEW) as a common management practice. A current limitation in the nutrition of the early-weaned pig is the lack of a thorough understanding of appropriate dietary amino acid levels. Recent research at Iowa State University and Kansas State University has determined the dietary lysine requirement of the SEW pig to be approximately 1.65% to 1.80%. Additionally, research conducted at Kansas State University has agreed closely with the University of Illinois recommendation of 30% for the methionine:lysine ratio, and recent research at Kansas State University has determined the threonine requirement of the SEW pig to be approximately 45% of lysine on an apparent digestible basis. The University of Illinois ideal amino acid ratio suggests that isoleucine may be the third limiting amino acid in plasma-based diets for the SEW pig. Therefore, the objective of this experiment was to determine the apparent digestible isoleucine:lysine ratio necessary to optimize growth performance of the SEW pig.

Procedures

Three hundred and sixty, high-lean growth pigs (PIC, 326 × C15) were

[1]The authors extend appreciation to Keesecker Agribusiness of Washington, KS for providing the pigs used in this research. We also thank Heartland Lysine for donation of synthetic amino acids.

weaned at 14 ± 2 d of age and delivered to the SEW facilities at Kansas State University. The pigs were blocked by weight (initially 12.2 ± 2.3 lb) and allotted to one of 12 experimental diets, with a total of five pigs/pen and six pens/treatment. The 12 experimental diets consisted of two levels of lysine (1.15% and 1.50% digestible lysine) and six digestible isoleucine:lysine ratios (40, 45, 50, 55, 60, and 65%) in a 2 × 6 factorial arrangement (Table 1).

The 1.15% digestible lysine diets (1.32% total lysine) were corn-soybean meal based and contained 20% dried whey, 15% lactose, 6.5% spray-dried plasma protein, 3% select menhaden fish meal, and 2% spray-dried blood meal. The levels of digestible isoleucine in the six 1.15% lysine diets were .460, .518, .575, .633, .690, and .748%.

The amount of soybean meal in the 1.15% lysine basal diet was increased from .89% to 10.23% of the diet in order to achieve the 1.50% digestible lysine basal diet (1.72% total lysine). The level of all other protein sources remained constant across all treatments. The levels of digestible isoleucine in the six 1.50% lysine diets were .600, .675, .750, .825, .900, and .975%.

Crystalline threonine, methionine, cystine, valine, and tryptophan (L-threonine, 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 isoleucine (L-isoleucine) was added to the basal diets at the expense of corn starch to provide the six levels of isoleucine. 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. Also, two pigs/pen were bled on d 14 postweaning for determination of PUN. 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, and linear and quadratic polynomials were evaluated for dietary isoleucine levels.

Results and Discussion

No dietary isoleucine by lysine interactions were observed during this study. From d 0 to 7 postweaning, ADG and F/G were improved ($P < .01$) for pigs fed 1.50% apparent digestible lysine (Table 2). Average daily gain and F/G also improved (linear, $P < .02$) as the digestible isoleucine:lysine ratio increased. Although a significant quadratic response was not observed, little improvement in pig performance occurred above the 60% apparent digestible isoleucine:lysine ratio. However, ADFI was not affected by either the lysine or isoleucine level in the diet.

During the d 7 to 14 postweaning period, ADG and F/G were improved ($P < .01$) by feeding 1.50% digestible lysine. Also, ADFI tended ($P < .10$) to be greater for pigs fed the high lysine diets. Pigs fed 1.50% digestible lysine also had greater ($P < .03$) PUN on d 14 than pigs fed 1.15% digestible lysine. Altering the ratio of isoleucine:lysine in the diets had no effect on growth performance during this period. However, increasing the isoleucine ratio of the diet resulted in a linear decrease ($P < .03$) in d 14 PUN, with pigs fed 60% apparent digestible isoleucine:lysine having the lowest PUN.

During the entire d 0 to 14 postweaning period, pigs fed 1.50% apparent digestible lysine had improved ($P < .01$) ADG and F/G. Also, ADFI tended ($P < .09$) to be greater for pigs fed 1.50% rather than 1.15% digestible

lysine. However, overall ADG, ADFI, and F/G were not affected by the level of isoleucine in the diet.

In conclusion, the linear improvement in growth performance observed from d 0 to 7 postweaning and the linear reduction of PUN on d 14 suggest that the optimum ratio of isoleucine:lysine for the SEW pig is approximately 60% on an apparent digestible basis. However, because this response was observed only in the first week postweaning, further research is required to confirm this high a requirement for isoleucine.

Table 1. Composition of the Basal Diets[a]

	Digestible Lysine, %	
Ingredient, %	1.15%	1.50%
Corn	41.47	31.75
Dried whey	20.00	20.00
Lactose	15.00	15.00
Spray-dried plasma protein	6.50	6.50
Soy oil	6.00	6.00
Select menhaden fish meal	3.00	3.00
Soybean meal (46.5% CP)	0.89	10.23
Spray-dried blood meal	2.00	2.00
Monocalcium phosphate	1.62	1.46
Antibiotic[b]	1.00	1.00
Limestone	0.64	0.66
L-lysine HCl	0.36	0.52
Zinc oxide	0.38	0.38
Corn starch[c]	0.25	0.25
Vitamin premix	0.25	0.25
L-threonine	0.09	0.18
DL-methionine	0.16	0.23
Trace mineral premix	0.15	0.15
L-cystine	0.09	0.15
L-valine	-	0.11
L-tryptophan	0.07	0.09
Salt	0.10	0.10
Total	100.00	100.00

[a]Diets were formulated to contain all essential amino acids (except isoleucine) 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-isoleucine replaced corn starch in the 1.15% and 1.50% digestible lysine basal diets to provide .460, .518, .575, .633, .690, and .748% digestible isoleucine and .600, .675, .750, .825, .900, and .975% digestible isoleucine, respectively. This provided 12 experimental diets in a 2 × 6 factorial arrangement, with two levels of lysine and six levels of digestible isoleucine:lysine (40, 45, 50, 55, 60, and 65%).

Table 2. Main Effects of Increasing the Digestible Isoleucine:Lysine Ratio on SEW Pig Performance[a]

	Digestible Isoleucine: Lysine Ratio, %						Digestible Lysine, %		
Item	40	45	50	55	60	65	1.15	1.50	CV
d 0 to 7									
ADG, lb[bc]	.27	.24	.29	.30	.33	.32	.25	.33	28.3
ADFI, lb	.37	.34	.36	.37	.38	.38	.35	.37	20.0
F/G[bc]	1.35	1.41	1.25	1.25	1.15	1.19	1.41	1.14	19.1
d 7 to 14									
ADG, lb[b]	.54	.58	.58	.52	.56	.57	.50	.62	17.7
ADFI, lb	.64	.67	.72	.70	.71	.69	.67	.71	14.6
F/G[b]	1.20	1.14	1.23	1.37	1.27	1.20	1.32	1.15	16.6
d 0 to 14									
ADG, lb[b]	.41	.41	.44	.41	.45	.45	.38	.47	14.6
ADFI, lb	.50	.50	.54	.54	.54	.53	.51	.54	13.2
F/G[b]	1.25	1.22	1.23	1.32	1.20	1.19	1.35	1.14	9.7
d 14									
PUN, mg/dL[bc]	3.22	2.59	2.52	2.94	2.32	2.48	2.46	2.89	28.1

[a]Three hundred and sixty weanling pigs were used (initially 12.2 lb and 14 d of age), five pigs/pen, six pens/treatment.
[b]Lysine effect ($P < .03$).
[c]Isoleucine effect (linear, $P < .03$).