Effect of Increasing Standardized Ileal Digestible Valine to Lysine Ratio on Growth Performance of 15- to 25-lb Nursery Pigs[1]

J. E. Nemechek, M. D. Tokach, S. S. Dritz[2], R. D. Goodband, J. M. DeRouchey, J. L. Nelssen, and J. Usry[3]

Summary

A total of 294 nursery pigs (PIC TR4 × 1050, initially 15.1 lb, 3 d postweaning) were used in a 28-d growth trial to evaluate the effects of increasing standardized ileal digestible valine:lysine ratio on growth performance. Pigs were allotted to 1 of 6 dietary treatments. 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. The 6 standardized ileal digestible (SID) valine:lysine ratios were 57.4, 59.9, 62.3, 64.7, 67.2, and 69.6%. The SID lysine level of the diet was 1.30%. There were 7 pigs per pen and 7 pens per treatment. Pigs and feeders were weighed on d 0, 7, 14, 21, and 28 to calculate ADG, ADFI, and F/G. From d 0 to 14, ADG and ADFI increased (quadratic, $P < 0.01$) as the valine:lysine ratio increased from 57.4 to 64.7%, with little improvement observed thereafter. Feed efficiency improved (linear, $P < 0.02$) with increasing valine:lysine ratio, but like ADG and ADFI, there was little improvement observed beyond the 64.7% valine:lysine ratio. From d 14 to 28, when the common diet was fed, there were no differences ($P > 0.27$) in ADG and ADFI; however, F/G became poorer (quadratic; $P < 0.02$) in pigs previously fed increasing valine:lysine ratio. The linear response in ADG and ADFI from Phase 1 carried over to the overall data (d 0 to 28), resulting in increased (linear; $P < 0.003$) ADG and ADFI with increasing valine:lysine ratio; however, no improvement was observed beyond the 64.7% valine:lysine ratio. There were no differences ($P > 0.20$) in overall F/G. Therefore, a minimum valine:lysine ratio of 64.7% was required for optimal growth of 15- to 25-lb pigs.

Key words: amino acid ratio, amino acid requirement, lysine, valine

Introduction

Several experiments have been conducted to evaluate replacing expensive specialty protein sources (fish meal, blood products, poultry meal, etc.) with crystalline amino acids in the diet for 15- to 25-lb pigs. The amino acids have resulted in performance similar to that of the specialty protein sources in several trials, but not in others. We conducted a series of experiments to determine the reason for the inconsistent response. One step in this process is to further define the minimum ratio for the key amino acids relative to lysine. Doing so will allow diet formulations with higher levels of crystalline amino acids and removal of specialty protein sources.

[1] The authors wish to thank Ajinomoto Heartland LLC, Chicago, IL, for providing the crystalline amino acids used in diet formulation and for partial financial support.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[3] Ajinomoto Heartland LLC, Chicago, IL.

Results from other experiments included in this publication have allowed several conclusions to be drawn about amino acid requirements of nursery pigs from 15 to 25 lb. A lysine titration was first conducted to determine the standardized ileal digestible (SID) lysine level for optimal growth, which resulted in a value of 1.30%. This lysine level was then used to perform an experiment that suggests crystalline amino acids can replace fish meal when balanced for minimum amino acid requirements. Using this low crude protein and high amino acid-fortified diet, follow-up research indicated that a valine:lysine ratio greater than 57% was required for maximum growth performance. Based on these observations, the object of this study is to determine the valine:lysine ratio required for optimal growth performance of nursery pigs from 15 to 25 lb.

Procedures

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

A total of 294 nursery pigs (PIC TR4 × 1050, initially 15.1 lb, 3 d postweaning) were used in a 28-d growth trial to evaluate the effects of increasing (SID) valine:lysine ratio on growth performance. Pigs were weaned at approximately 21 d of age and allotted to pens by initial BW. Pigs were fed a common diet for 3 d. On d 3 postweaning, pens were allotted to 1 of 6 dietary treatments. Thus, d 3 after weaning was d 0 of the experiment. There were 7 pigs per pen and 7 pens per treatment. 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.

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). The SID lysine level of the diet was 1.30%. The 6 valine:lysine ratios were 57.4, 59.9, 62.3, 64.7, 67.2, and 69.6%. Large batches of the 57.4% and 69.6% valine diets were manufactured and then blended to achieve the intermediate diets. Treatment diets were corn-soybean meal-based and contained 10% dried whey. The common Phase-2 diet was a corn-soybean meal-based diet formulated to 1.26% SID lysine. All experimental diets were in meal form and were prepared at the K-State Animal Science Feed Mill.

At the conclusion of the experiment, data were analyzed for linear and quadratic effects of increasing SID valine:lysine ratio using the PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC). Pen was the experimental unit for all data analysis.

Results and Discussion

From d 0 to 14, ADG and ADFI increased (quadratic, $P < 0.01$; Table 2) as the valine:lysine ratio increased from 57.4 to 64.7%, with little improvement observed thereafter. Feed efficiency improved (linear; $P < 0.02$) with increasing valine:lysine ratio, but as with ADG and ADFI, there was little improvement observed beyond the 64.7% ratio.

From d 14 to 28, when the common diet was fed, there was no difference ($P > 0.27$) in ADG and ADFI; however, F/G became poorer (quadratic; $P < 0.02$) in pigs previously fed increasing valine:lysine ratio. This suggests that the valine level fed from d 0 to 14

had no impact on subsequent ADG and ADFI, but did influence F/G. Thus, there was a slight compensatory response for F/G, but not for ADG or ADFI.

Because of the improvement in ADG and ADFI from d 0 to 14, ADG and ADFI increased (linear; $P < 0.003$) for the overall trial (d 0 to 28) as valine:lysine increased. Again, the greatest improvement in ADG and ADFI was observed in pigs fed the diet containing 64.7% valine:lysine ratio during Phase 1. There were no differences ($P > 0.20$) in F/G for the overall trial.

In conclusion, a valine:lysine ratio of 64.7% was required for optimal growth of 15- to 25-lb pigs.

Table 1. Diet composition (as-fed basis)

Item	Valine:lysine ratio, %[1]						Common phase 2[2]
	57.4	59.9	62.3	64.7	67.2	69.6	
Ingredient, %							
Corn	58.26	58.26	58.26	58.26	58.26	58.26	65.05
Soybean meal (46.5% CP)	25.19	25.19	25.19	25.19	25.19	25.19	30.73
Spray-dried whey	10.00	10.00	10.00	10.00	10.00	10.00	---
Corn starch	0.160	0.128	0.096	0.064	0.032	---	---
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00	---
Monocalcium phosphate (21% P)	1.10	1.10	1.10	1.10	1.10	1.10	1.08
Limestone	0.90	0.90	0.90	0.90	0.90	0.90	0.95
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	---
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	0.533	0.533	0.533	0.533	0.533	0.533	0.360
DL-methionine	0.220	0.220	0.220	0.220	0.220	0.220	0.130
L-threonine	0.230	0.230	0.230	0.230	0.230	0.230	0.130
L-tryptophan	0.070	0.070	0.070	0.070	0.070	0.070	---
L-valine	---	0.032	0.064	0.096	0.128	0.160	---
Glutamine	0.630	0.630	0.630	0.630	0.630	0.630	---
Glycine	0.630	0.630	0.630	0.630	0.630	0.630	---
Phytase[3]	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 (SID) amino acids, %							
Lysine	1.30	1.30	1.30	1.30	1.30	1.30	1.26
Isoleucine:lysine	52	52	52	52	52	52	61
Leucine:lysine	111	111	111	111	111	111	129
Methionine:lysine	36	36	36	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	57.4	59.9	62.3	64.7	67.2	69.6	68
Total lysine, %	1.42	1.42	1.42	1.42	1.42	1.42	1.39
ME, kcal/lb	1,516	1,516	1,516	1,516	1,516	1,516	1,503
SID lysine:ME, g/Mcal	3.89	3.89	3.89	3.89	3.89	3.89	3.80
CP, %	20.2	20.3	20.3	20.3	20.3	20.4	20.8
Ca, %	0.72	0.72	0.72	0.72	0.72	0.72	0.69
P, %	0.64	0.64	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

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

Table 2. Evaluation of valine:lysine ratio on growth performance of nursery pigs[1]

	Valine:lysine ratio,%							Probability, *P* <	
	57.4	59.9	62.3	64.7	67.2	69.9	SEM	Linear	Quadratic
d 0 to 14									
ADG, lb	0.44	0.53	0.59	0.64	0.65	0.66	0.023	<0.0001	0.005
ADFI, lb	0.70	0.79	0.92	0.94	0.97	0.94	0.035	<0.0001	0.01
F/G	1.60	1.51	1.58	1.46	1.49	1.46	0.042	0.02	0.84
d 14 to 28									
ADG, lb	1.06	1.06	1.08	1.07	1.02	1.07	0.038	0.82	0.86
ADFI, lb	1.68	1.73	1.78	1.82	1.73	1.77	0.057	0.33	0.27
F/G	1.59	1.63	1.65	1.70	1.69	1.65	0.023	0.01	0.02
d 0 to 28									
ADG, lb	0.75	0.79	0.83	0.86	0.84	0.86	0.027	0.003	0.18
ADFI, lb	1.19	1.26	1.35	1.38	1.35	1.36	0.042	0.002	0.06
F/G	1.59	1.59	1.62	1.61	1.61	1.58	0.024	0.98	0.20
wt, lb									
d 0	15.1	15.1	15.1	15.1	15.1	15.1	0.76	0.97	0.93
d 14	21.2	22.4	23.3	24.1	24.2	24.3	2.61	<0.0001	0.014
d 28	36.0	37.3	38.4	39.1	38.5	39.2	5.58	0.004	0.19

[1] A total of 294 nursery pigs (initially 15.1 lb, 3 d postweaning) were used in a 28-d growth trial to evaluate the effects of valine:lysine ratio on growth performance. There were 7 pigs per pen and 7 pens per treatment. Treatment diets were fed from d 0 to 14, and a common diet was fed from d 14 to 28.