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Abstract

A total of 210 nursery pigs (initially 19.6 lb and approximately 28 d of age) were used in a 21-d growth assay to determine the optimal ratio of valine to lysine to maximize growth performance. The seven treatments consisted of a basal diet (14.2% CP; 1.07% apparent digestible lysine) with increasing ratios of valine:lysine (48, 53, 58, 63, 69, and 74%) and a negative control containing 0.97% lysine and 0.79% apparent digestible valine. Results indicate that the optimal apparent digestible valine:lysine ratio for the nursery pig is 58 and 64% for ADG and F/G, respectively. Therefore, most typical nursery diets will contain adequate amounts of valine to maximize growth performance of nursery pigs.; Swine Day, Manhattan, KS, November 15, 2001

Keywords

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THE OPTIMAL RATIO OF APPARENT DIGESTIBLE VALINE TO LYSINE TO MAXIMIZE GROWTH PERFORMANCE OF THE NURSERY PIG

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Summary

A total of 210 nursery pigs (initially 19.6 lb and approximately 28 d of age) were used in a 21-d growth assay to determine the optimal ratio of valine to lysine to maximize growth performance. The seven treatments consisted of a basal diet (14.2% CP; 1.07% apparent digestible lysine) with increasing ratios of valine:lysine (48, 53, 58, 63, 69, and 74%) and a negative control containing 0.97% lysine and 0.79% apparent digestible valine. Results indicate that the optimal apparent digestible valine:lysine ratio for the nursery pig is 58 and 64% for ADG and F/G, respectively. Therefore, most typical nursery diets will contain adequate amounts of valine to maximize growth performance of nursery pigs.

(Key Words: Valine, Lysine, Nursery Pigs.)

Introduction

Lysine, traditionally considered to be the first-limiting amino acid in young pig diets, has been intensively investigated. The methionine requirement for nursery pigs has also been thoroughly examined. However, research evaluating the requirements of other amino acids has been less extensive. Nutrient profiles of ingredients and amino acid requirements differ between the 1988 and 1998 NRC publications and have resulted in increases in the valine requirement for nursery pigs.

It has been reported that valine was as limiting as tryptophan, threonine, or methionine in a 13.5% protein, corn-soybean meal diet for 22 lb pigs. Further research suggested that the true ileal digestible valine requirement for 22 to 44 lb pigs was 75 and 71% of lysine for ADG and F/G, respectively. This estimate is higher than proposed by the NRC (1998), suggesting more research is warranted. The objective of this experiment was to determine the optimal ratio of valine to lysine in diets to maximize growth performance of the nursery pig.

Procedures

Two hundred ten (Line 327 sire × C22 dams; PIC) nursery pigs with an average initial weight of 19.6 lb and 28 d of age were used in a 21-d growth assay. Pigs were blocked by initial weight and ancestry and allotted randomly to each of the seven dietary treatments. Each treatment had six replications (pens) and five pigs per pen.

Corn, soybean meal, and spray-dried whey were analyzed for amino acid concentrations before diet formulation. The analyzed total amino acid levels and the apparent amino acid digestibility percentages from NRC (1998) were used to calculate the apparent digestible amino acid levels in each ingredient for diet formulation. Diets were corn-soybean meal-based and contained 8% spray-dried whey and 1.78% L-lactose (Table 1). Crystalline L-valine was added to the basal diet (1.07% apparent digestible lysine, 14.2% CP) to provide 48, 53, 58, 63, 69, and 74% apparent digestible valine:lysine. All amino acids, except valine, were formulated to meet or exceed the recommended NRC

[1]Food Animal Health and Management Center.

requirements (Table 2). The negative control diet contained less L-lysine·HCl to provide 0.97% apparent digestible lysine and 0.81 apparent digestible valine:lysine to ensure that lysine was not above the pigs' requirement in the experimental diets. All diets were fed in meal form.

Pigs were housed in an environmentally controlled nursery. Temperature was maintained at 90°F for the 1st week and reduced by 5°F each week to maintain pig comfort. Each pen (4 ft^2 with slatted metal flooring) contained a stainless steel self-feeder and one nipple waterer to allow ad libitum consumption of feed and water.

Table 1. Basal Diet Composition (as-fed basis)[a]

Ingredient	%
Corn	66.92
Cornstarch[b]	0.28
L-lactose	1.78
Dried whey	8.00
Soybean meal (46.5% CP)	14.52
Choice white grease	3.00
Monocalcium phosphate (21% P)	1.05
Medication[c]	1.00
Zinc oxide	0.25
Limestone	1.00
Vitamin premix	0.30
Salt	0.30
Trace mineral premix	0.15
L-lysine·HCl	0.67
DL-methionine	0.17
L-threonine	0.26
L-isoleucine	0.17
L-phenylalanine	0.09
L-tryptophan	0.06
L-histidine·HCl	0.03

[a]Diet was formulated to 48% apparent digestible valine:lysine with all other amino acids meeting or exceeding 1998 NRC requirements. [b]L-Valine replaced cornstarch to provide 0.51, 0.57, 0.62, 0.68, 0.73, 0.79, and 0.79% apparent digestible valine. This provided apparent digestible valine:lysine ratios of 48, 53, 58, 63, 69, 74, and 81%. [c]Provided 55 mg/kg carbadox.

Table 2. Calculated Composition of Basal Diet[a,b]

Item	%
CP (N × 6.25)	14.17
Calcium	0.69
Phosphorus	0.57
Total	
Arginine	0.78
Histidine	0.55
Isoleucine	0.71
Leucine	1.34
Lysine	1.21
Methionine	0.42
Phenylalanine	0.75
Threonine	0.79
Tryptophan	0.22
Valine	0.63
Apparent digestible	
Arginine	0.68
Histidine	0.34
Isoleucine	0.61
Leucine	1.15
Lysine	1.07
Methionine	0.38
Phenylalanine	0.64
Threonine	0.65
Tryptophan	0.18
Valine	0.51
True digestible[c]	
Arginine	0.71
Histidine	0.35
Isoleucine	0.64
Leucine	1.21
Lysine	1.12
Methionine	0.39
Phenylalanine	0.68
Threonine	0.70
Tryptophan	0.20
Valine	0.54

[a]Values were calculated from analyzed composition of corn, soybean meal, and spray-dried whey.
[b]All amino acids in the negative control diet were the same with the exception of decreased lysine (1.07 vs 0.97% apparent digestible lysine).

Experimental diets were fed for 21 d. Pigs were weighed and feed disappearance measured every 7 d during the experiments to determine ADG, ADFI, and F/G. Blood samples were obtained by venipuncture on d 14 from two randomly selected pigs in each pen following a 3-h period of feed deprivation. Plasma urea N (PUN) determination was performed on each sample. Plasma from pigs in the same pen was pooled for amino acid analysis.

Data were analyzed in a randomized complete block design using the GLM procedures of SAS with pen as the experimental unit. Linear and quadratic polynomial contrasts were performed to compare the effects of increasing dietary valine. Contrasts were performed to compare the negative control to the diet containing the same level of apparent digestible valine (1.07% vs 0.97% apparent digestible lysine). In each experiment, one-slope and two-slope, broken-line regression models were used to estimate the requirement of valine to lysine. These ratios were estimated from the response curves of the least squares means.

Results and Discussion

Pigs fed the negative control diet gained less (P<0.03) when compared with pigs fed the diet containing the same level of valine (0.79% apparent digestible valine) and 1.07% apparent digestible lysine (Table 3). Average daily gain and ADFI increased with increasing valine and were maximized at 58% apparent digestible valine to lysine. Feed efficiency was improved with increasing valine and was best for pigs fed diets containing 63% apparent digestible valine to lysine.

Plasma urea N, measured on d 14, decreased and then increased (quadratic, P<0.01) with increasing apparent digestible valine (Table 4). Pigs fed the diet containing 58% apparent digestible valine to lysine had the lowest PUN concentration.

Plasma valine concentration increased (linear, P<0.01) with increasing dietary valine. The greatest response occurred as apparent digestible valine increased from 63 to 69% of lysine. The plasma lysine concentration was different (P<0.01) for pigs fed varying levels of apparent digestible valine; however, no linear or quadratic (P>0.44) effects were observed. Plasma methionine, tyrosine, phenylalanine, and histidine concentrations decreased (linear, P≤0.02) with increasing levels of dietary valine; however, plasma isoleucine concentration increased (linear, P<0.01) with increasing levels of dietary valine.

The broken-line method (Table 5) predicted an apparent digestible valine requirement of approximately 54% of lysine for ADG and F/G using the one-slope model. The two-slope model predicted a requirement of approximately 55 and 64% of lysine for ADG and F/G, respectively.

The results of our experiment suggest that the apparent digestible valine:lysine ratio for 22- to 44-lb pigs is approximately 58%. This ratio is lower than the requirement suggested by the NRC (1998) and suggests that typical nursery diets used in commercial production will contain adequate amounts of valine.

Table 3. Effect of Apparent Digestible Valine:Lysine Ratio on Growth Performance of the Nursery Pig[a,b]

	Apparent Digestible Lysine, %											
	1.07						0.97					
		Valine, % of lysine							Probability (P<)			
Item	48	53	58	63	69	74	81	SEM	Lys	Val	Linear	Quad
ADG, lb	0.45	0.75	0.84	0.84	0.83	0.81	0.73	0.03	0.03	0.01	0.01	0.01
ADFI, lb	1.01	1.47	1.63	1.57	1.56	1.57	1.47	0.05	0.17	0.01	0.01	0.01
F/G	2.24	1.96	1.94	1.87	1.88	1.94	2.01	0.05	0.34	0.01	0.01	0.01

[a]Initial BW, 19.6 lb.

[b]Values are means of six replications (pens) and five pigs per pen for the 21-d experiment.

Table 4. Effect of Apparent Digestible Valine:Lysine Ratio on Plasma Amino Acid Profile and PUN of the Nursery Pig[a]

	Apparent Digestible Lysine, %											
	1.07						0.97					
	Valine, % of lysine								Probability (P<)			
Item, µm/L	48	53	58	63	69	74		SEM	Lys	Val	Linear	Quad
Valine	62	86	140	255	378	490	357	26.00	0.01	0.01	0.01	0.01
Arginine	83	70	81	82	82	78	78	5.52	0.95	0.76	0.82	0.98
Histidine	76	53	49	50	49	48	52	5.26	0.55	0.01	0.01	0.01
Isoleucine	94	116	125	138	178	147	170	13.75	0.20	0.01	0.01	0.20
Leucine	164	179	177	182	170	153	203	11.45	0.01	0.06	0.46	0.06
Lysine	228	228	207	235	209	199	108	26.79	0.01	0.02	0.44	0.76
Methionine	54	42	42	41	40	40	44	4.12	0.53	0.14	0.02	0.12
Phenylalanine	77	71	66	64	62	63	74	3.70	0.03	0.02	0.01	0.12
Threonine	567	433	609	548	568	777	430	80.84	0.01	0.04	0.03	0.10
Tryptophan	45	44	41	44	39	41	44	2.82	0.43	0.69	0.20	0.69
Tyrosine	91	85	75	82	73	69	69	6.92	0.99	0.14	0.02	0.82
PUN, mg/dL	2.86	1.26	1.22	1.38	1.25	1.48	1.64	0.27	0.67	0.01	0.01	0.01

[a]Values are means of six replications (pens) of individual samples from two pigs per pen for PUN concentration and pooled samples from two pigs per pen for plasma amino acid concentrations.

Table 5. Predicted Apparent Digestible Valine:Lysine Requirement from Break-Point Analysis

Item	One-Slope[a]	Two-Slope[b]
ADG	54.3	54.6
ADFI	54.2	54.6
F/G	53.9	63.7
Plasma amino acids		
Valine	-	56.1
Lysine	-	63.0
PUN, mg/dL	52.7	63.3

[a]$Y = L + U(R - X_{LR})$, where L = the ordinate of the breakpoint in the curve, R = the abscissa of the breakpoint in the curve (the requirement estimate); X_{LR} = a value of X less than R; U = the slope of the line for X less than R.