THE OPTIMAL TRUE ILEAL DIGESTIBLE LYSINE AND TOTAL SULFUR AMINO ACID REQUIREMENT FOR NURSERY PIGS BETWEEN 20 AND 50 LB[1]

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Summary

An experiment involving 360 pigs (PIC, avg. BW = 22.0 lb) was conducted to determine the appropriate true ileal digestible (TID) lysine and total sulfur amino acid (TSAA) requirement of nursery pigs and, consequently, to determine the optimal TSAA:lysine ratio. This trial was organized as a combination of two simultaneous experiments, with one set of diets consisting of five increasing TID lysine concentrations (1.05, 1.15, 1.25, 1.35, and 1.45%) and the second set of diets consisting of five increasing TID TSAA concentrations (0.61, 0.69, 0.76, 0.83, and 0.90%). The highest concentrations of both lysine and TSAA (1.45% and 0.90%, respectively) were combined as one diet and used in both the lysine and TSAA titrations, to give a total of 10 treatments. Pigs were randomly allotted to eight replications, with five pigs per pen, on the basis of initial BW. Average daily gain and F/G improved (quadratic, $P<0.01$) with increasing TID lysine. The largest improvement in growth rate and feed efficiency for PIC pigs in these facilities occurred as the TID lysine increased to 1.25 and 1.35%, respectively; there was little improvement in performance thereafter. Increasing TID TSAA increased (quadratic, $P<0.01$) ADG and improved (quadratic, $P<0.01$) F/G, although the largest increases in ADG and F/G occurred as TID TSAA increased from 0.61 to 0.76%, with smaller improvements from 0.76 to 0.90%. Average daily gain and F/G values were plotted as the dependent variables in a regression analysis, with the TID lysine and TSAA concentrations on the Y axis. Regression analysis of the response surface resulted in an estimated TID TSAA-to-lysine ratio range of approximately 55 to 56% for optimal ADG and F/G.

(Key Words: Lysine, TSAA, Nursery Pig.)

Introduction

The total sulfur amino acid (TSAA) requirement for the 20- to 50-lb pig has been shown to be adequate for growth in conventional diets that are based on corn soybean meal. In recent years, however, the increasing price of soybean meal (SBM) and the decreasing price of crystalline lysine have increased the usage of crystalline lysine and other amino acids, such as methionine. Thus, it is essential

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[1]The authors thank Novus Int. St. Louis, MO, for providing the Alimet® and other crystalline amino acids used in this study.

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that nutritionists can accurately define the ratio of other amino acids to lysine to properly utilize synthetic amino acids and reduce feed costs.

The National Research Council (NRC) reports TID lysine and TID TSAA requirements of 1.01 and 0.58%, respectively, for the 20- to 50-lb pig. Therefore, this would equate to a TSAA:lysine ratio of 57%. Previous experiments in our lab have estimated the TSAA:lysine ratio for the 20- to 50-lb pig to range from 55 to 61% for ADG and 57 to 61% for F/G, although many other studies have reported a larger range.

The variability in TSAA:lysine requirements ratio reported in other trials may be explained by the use of differing response criteria, weight and genetics of pigs, and the bioavailability and type of diet used in these studies. Also, it may be common to extrapolate lysine requirements from previous studies or the NRC estimates to form a ratio with specific amino acids that are being studied. The aforementioned procedures are commonly performed in experiments to save time, but they are not as precise as determining a requirement simultaneously for lysine and TSAA.

The objective of these experiments was to concurrently determine the optimal dietary lysine and TSAA requirements, and hence, obtain the appropriate TSAA:lysine ratio for maximum growth performance in the nursery pig.

Procedures

Three hundred sixty PIC pigs were blocked by weight (initially 22.0 lb) and allotted to one of the nine dietary treatments. There were five pigs per pen and eight replicate pens per treatment. This trial was organized as a combination of two separate experiments, with one set of diets consisting of five increasing TID lysine concentrations (1.05, 1.15, 1.25, 1.35, and 1.45%); other crystalline amino acids were added to meet minimum ratios and to ensure that lysine was first limiting. The second set of five diets was formulated to 1.45% TID lysine, with increasing TID TSAA (0.61, 0.69, 0.76, 0.83, and 0.90%). The highest concentrations of both lysine and TSAA (1.45% and 0.90%, respectively) were combined as one diet and used in both lysine and TSAA titrations, to give a total of 10 treatments. The diets containing 1.05% TID lysine with 0.65% TID TSAA, 1.45% TID lysine with 0.61% TID TSAA, and 1.45% TID lysine with 0.90% TID TSAA were blended to form all intermediate diets (Table 1).

All experimental diets were based on corn soybean meal and were fed in a meal form throughout the 21-d experiment. Pigs were housed in the Kansas State University Segregated Early Weaning Facility and allowed *ad libitum* access to feed and water through a dry feeder and one nipple waterer per pen. The pigs and feeders were weighed on d 7, 14, and 21 to determine ADG, ADFI, and F/G.

Blood samples were obtained by venipuncture on d 12 from two randomly selected pigs in each pen, after a 3-h period of feed deprivation, and samples were analyzed for plasma urea N (PUN).

Data were analyzed as a randomized complete-block design with pen as the experimental unit. Pigs were blocked based on weight at d 18 postweaning, and analysis of variance was performed by using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Linear and quadratic polynomial contrasts were performed to determine the effects of increasing dietary lysine and TSAA.

Results and Discussion

From d 0 to 21, increasing TID lysine increased (quadratic, P<0.01) ADG and improved (quadratic P<0.01) F/G; the largest increase in ADG and F/G occurred as TID lysine increased from 1.05 to 1.25 and 1.35%, respectively, with little or no improvement thereafter. Increasing TID TSAA increased (quadratic, P<0.01) ADG and improved (quadratic, P<0.01) F/G. There was a large improvement in ADG and F/G when TID TSAA was increased from 0.61 to 0.76 and 0.83%, respectively, but the response receded thereafter.

Blood analysis showed a decrease (linear, P<0.01) in plasma urea N as both TID lysine and TSAA were increased in the experimental diets. This suggests that protein deposition was limited when dietary TSAA was insufficient, resulting in increased amounts of urea in plasma. As dietary methionine increased and approached the pig's requirement, however, N was redirected from urea to protein synthesis. In a typical amino acid dose-titration study, PUN and amino acid concentrations should decrease as the limiting amino acid is increased and approaches the pig's requirement.

A trend line was fit through the data to develop a regression equation to predict the TID lysine and TSAA requirement, which were used to estimate the TID TSAA:lysine ratio. The values for ADG and F/G from the individual lysine and TSAA trials must overlap to allow this approach to work. Average daily gain and F/G were plotted on the Y axis and TID lysine or TSAA was plotted on the X axis to develop a trend line equation (Figure 1 and 2; Table 4). Similar points between TID lysine and TSAA for ADG and F/G were used to form a regression analysis and to determine an optimal lysine:TSAA ratio. Regression analysis of the response surface resulted in an estimated optimal TID TSAA:lysine ratio of approximately 55 to 56% for ADG and F/G. The resulting TSAA:lysine ratio is very similar to the ratio of values reported by the National Research Council of 57%.

The future economic advantage of determining the suitable TSAA:lysine ratio is obvious with the likely increase of additional crystalline lysine in the diet, combined with the questionable stability of protein sources. By establishing the ratio for optimal growth performance, swine diets can be balanced accordingly. This research suggests that the optimal TSAA:lysine ratio for the pig up to 50 lb is from 55 to 56%.

Table 1. Composition of Diets (As-fed Basis)[ab]

	True Ileal Digestible Lysine/TSAA, %		
Item, %	1.05/0.65	1.45/0.90	1.45/0.61
Corn	60.02	60.00	60.00
Soybean meal (46.5% CP)	33.42	33.43	33.44
Soybean oil	1.50	1.50	1.50
Monocalcium P (21% P, 18% Ca)	1.55	1.55	1.55
Limestone	0.95	0.95	0.95
Salt	0.35	0.35	0.35
Vitamin premix	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15
Antibiotic	0.50	0.50	0.50
L-isoleucine	0.02	0.02	0.02
L-valine	0.03	0.08	0.08
L-tryptophan	---	0.03	0.03
L-threonine	0.02	0.27	0.27
Alimet®	0.05	0.33	---
L-lysine HCl	0.02	0.53	0.53
Corn starch	1.17	0.06	0.38
Total	100.00	100.00	100.00

[a]Diets that were formulated to contain 1.05/0.65 TID lysine/TSAA and 1.45/0.90 TID lysine/TSAA were blended to achieve TID lysine concentrations of 1.05, 1.15, 1.25, 1.35, and 1.45%.
[b]Diets that were formulated to contain 1.45/0.61 TID lysine/TSAA and 1.45/0.90 TID lysine/TSAA were blended to achieve TID TSAA concentrations of 0.61, 0.69, 0.76, 083, and 0.90%.

Table 2. Effects of Increasing True Ileal Digestible (TID) Lysine in 20- to 50-lb Nursery Pigs[a]

	TID Lysine, %						Probability, P <	
Item	1.05	1.15	1.25	1.35	1.45	SE	Linear	Quadratic
d 0 to 21								
ADG, lb	1.07	1.18	1.20	1.19	1.21	0.04	0.01	0.01
ADFI, lb	1.68	1.75	1.71	1.67	1.69	0.06	0.45	0.28
F/G	1.57	1.47	1.42	1.40	1.39	0.02	0.01	0.01
Plasma urea N, mg/dL	4.92	4.20	3.66	3.33	3.29	0.31	0.01	0.15

[a]Each value is the mean of eight replications, with 5 pigs (initially 22 lb) per pen.

Table 3. Effects of Increasing True Ileal Digestible (TID) Total Sulfur Amino Acids (TSAA) in 20- to 50-lb Nursery Pigs[a]

	TID TSAA, %						Probability, P <	
Item	0.61	0.69	0.76	0.83	0.90	SE	Linear	Quadratic
d 0 to 21								
ADG, lb	1.12	1.18	1.24	1.23	1.21	0.04	0.01	0.01
ADFI, lb	1.68	1.68	1.73	1.69	1.69	0.06	0.58	0.43
F/G	1.49	1.40	1.38	1.37	1.39	0.02	0.01	0.01
Plasma urea N, mg/dL	4.07	4.15	3.15	2.95	3.29	0.31	0.01	0.22

[a]Each value is the mean of eight replications, with 5 pigs (initially 22 lb) per pen.

Table 4. Regression Analysis of the Response Surface[a]

Response	TID Lysine	TID TSAA	TID TSAA:Lysine Ratio
F/G			
1.50	1.10	0.60	54.9
1.48	1.13	0.62	55.1
1.44	1.24	0.69	55.5
1.40	1.39	0.78	56.0
ADG			
1.21	1.44	0.80	55.8
1.18	1.18	0.76	64.5
1.15	1.01	0.69	67.9
1.12	0.94	0.58	62.1

[a]Values for F/G and ADG were similar for pigs fed diets with increasing TID lysine and TSAA.

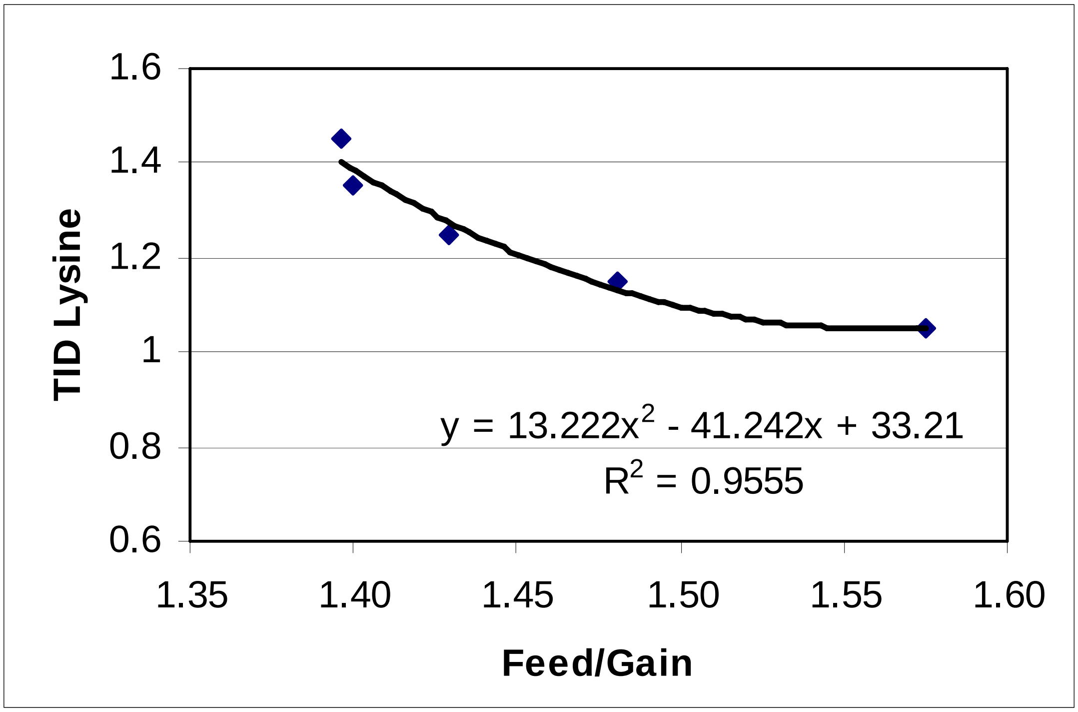

Figure 1. Regression Analysis for Feed Efficiency of Lysine.

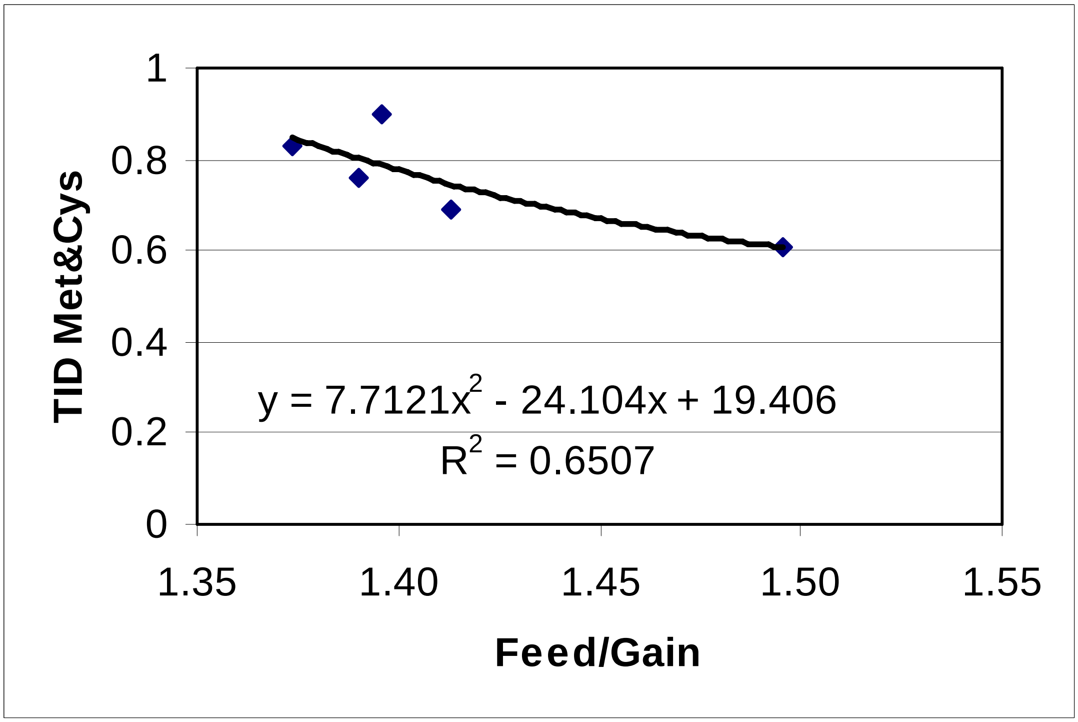

Figure 2. Regression Analysis for Feed Efficiency of TSAA.

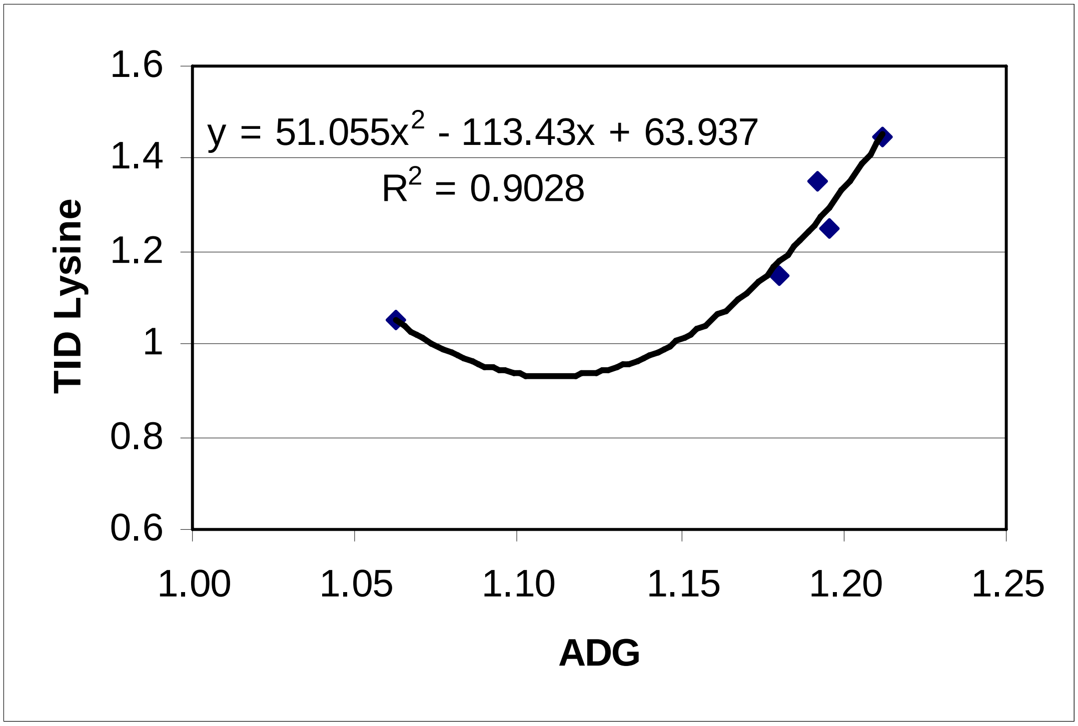

Figure 3. Regression Analysis for ADG of Lysine.

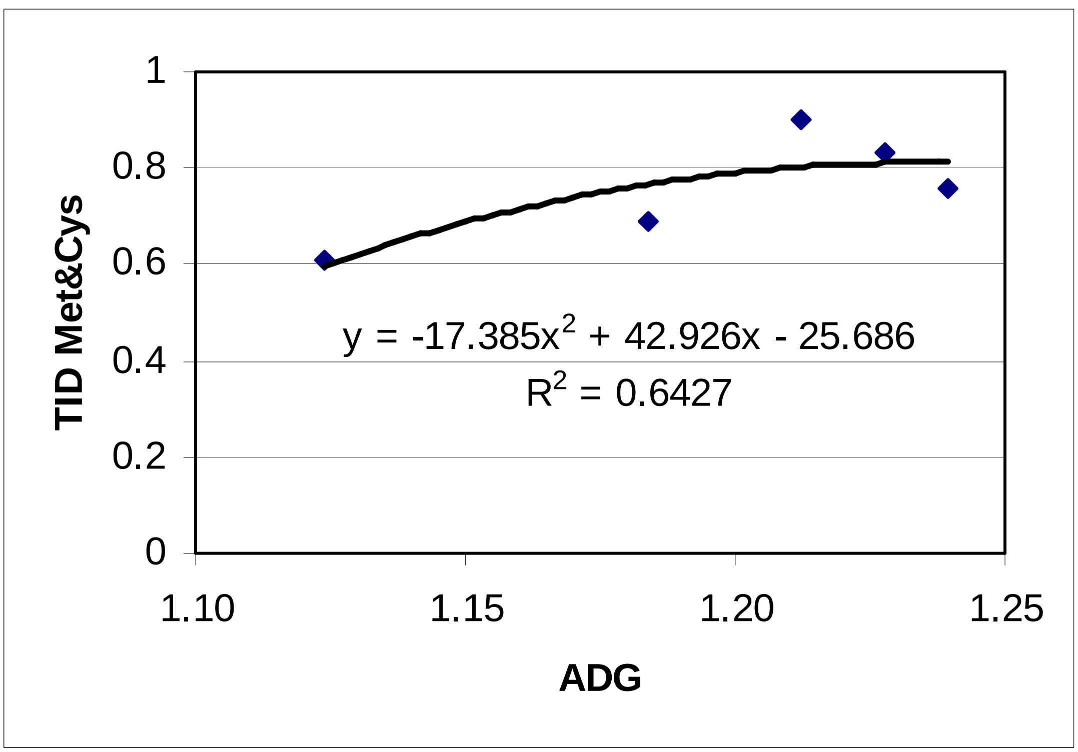

Figure 4. Regression Analysis for ADG of TSAA.