THE OPTIMAL TRUE-ILEAL-DIGESTIBLE LYSINE AND TOTAL SULFUR AMINO ACID REQUIREMENT FOR FINISHING PIGS FED PAYLEAN®[1]

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Summary

A total of 1887 pigs (PIC 337 × C22; 213 lb initial BW) were used in a 28-d growth assay to simultaneously examine both the true-ileal-digestible (TID) lysine and TID total sulfur amino acid (TSAA) requirements. The objective was to determine the appropriate TID TSAA-to-lysine ratio in finishing pigs fed Paylean® (4.5 g/ton) to maximize growth performance and carcass composition. Four TID lysine (0.66. 0.79, 0.92, and 1.05%) and four TID TSAA (0.47, 0.52, 0.57, and 0.63%) concentrations were evaluated. The highest lysine and TSAA concentrations were combined in the same diet, and there were eleven or twelve replicate pens per treatment. The lysine treatments were formulated with a minimum TID TSAA to lysine ratio of 60%, and the TSAA diets were formulated with 1.05% TID lysine. No gender × treatment or treatment × week interactions were observed (P>0.13). Increasing TID lysine increased ADG (linear, P<0.01), with the greatest response at 0.92% TID lysine, but ADG (P>0.76) was not affected by increasing TID TSAA. This resulted in a TID TSAA-to-lysine ratio of not more than 51% for optimum ADG. Increasing TID lysine did not affect ADFI (P>0.60), but ADFI decreased (linear, P<0.04) with increasing TID TSAA. Increasing dietary TID lysine improved feed efficiency (F/G) (linear, P<0.01), and increasing TID TSAA tended to improve F/G (linear, P<0.09). Although the response was linear, the greatest improvement in F/G was observed as the TID TSAA increased from 0.47% to 0.52%, resulting in an optimum TID TSAA-to-lysine ratio of 57%. Regression analysis indicates that the maximum F/G response was obtained with a TID TSAA-to-lysine ratio of 58%. Increasing TID lysine had no effect on any carcass criteria (P>0.11), but increasing TID TSAA from 0.47 to 0.52% tended to improve fat-free lean (quadratic, P<0.10). No other carcass criteria were affected by increasing TID TSAA (P>0.10). In summary, a TID TSAA-to-lysine ratio of 58% optimizes growth performance of finishing pigs fed Paylean.

(Key Words: Finishing Pigs, Lysine, Methionine, Paylean, Pigs, Sulfur Amino Acids.)

Introduction

Methionine is an essential amino acid used for protein synthesis. It is required for several metabolic pathways, and functions as a methyl donor. With other crystalline amino acids becoming more available and affordable, the exact ratios of essential amino acids to lysine must be understood to formulate diets having ideal amounts of amino acids. Using crystalline amino acids to replace intact protein sources will reduce N excretion and may increase dietary net energy.

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[2]Food Animal Health and Management Center.

The current National Research Council estimates a TID TSAA concentration of 0.31% for barrows and 0.35% for gilts, with TID lysine concentrations of 0.52% and 0.59%, respectively, which results in a TID TSAA-to-lysine ratio of 59 to 60% for 176- to 265-lb pigs depositing 350 g/d of lean. The lysine requirement of pigs fed Paylean has been determined to be approximately 1.00% total dietary lysine, but there is no data available on the requirement for other amino acids in pigs fed Paylean. The objective of this experiment was to determine the response to dietary lysine and TSAA simultaneously to calculate a TID ratio that maximizes growth performance and carcass characteristics of finishing pigs fed Paylean.

Procedures

General

Procedures used in these experiments were approved by the Kansas State University Animal Care and Use Committee. A total of 1,887 pigs (PIC line 337 × C22; 213 lb initial BW) were blocked by weight and sex in a 28-d growth assay. They were randomly allotted to one of seven dietary treatments. Four TID lysine (0.66, 0.79, 0.92, and 1.05%) and four TID TSAA (0.47, 0.52, 0.57, and 0.63%) concentrations were evaluated. The highest lysine and TSAA concentrations were combined in the same diet (Table 1). Either L-lysine HCl or methionine hydroxy analogue (Alimet®), along with L-threonine, replaced corn and was used to obtain the increasing dietary concentrations of lysine or TSAA. Alimet was supplemented to provide an equivalent bioactivity on an equal molar basis, or 88% of the bioactivity of DL-methionine on a weight basis. All diets contained 4.5 g/ton Paylean. The values used in diet formulation and TID digestibilities were based on those published by the National Research Council. Diet samples were analyzed for amino acid content (Novus Int., St. Louis, MO). Experimental diets were fed in meal form for 28 d.

Table 1. Diet Composition (As-fed Basis)[abc]

Item	
Ingredient, %	
Corn	75.70
Soybean meal (46.5% CP)	18.50
Choice white grease	2.50
Monocalcium phosphate (21% P)	0.80
Limestone	0.88
Salt	0.35
Vitamin premix with phytase	0.06
Trace mineral premix	0.06
L-Lysine HCl	0.50
Methionine[d]	0.18
L-Threonine	0.28
L-Valine	0.09
L-Isoleucine	0.09
L-Tryptophan	0.04
Paylean®	0.03
Calculated Analysis	
Total lysine, %	1.15
True-ileal-digestible amino acids	
Lysine, %	1.05
Isoleucine:lysine ratio, %	0.60
Leucine:lysine ratio, %	1.23
Methionine:lysine ratio, %	0.36
Met & Cys:lysine ratio, %	0.60
Threonine:lysine ratio, %	0.72
Tryptophan:lysine ratio, %	0.18
Valine:lysine ratio, %	0.68
ME, kcal/lb	1,566
CP, %	15.1
Ca, %	0.57
P, %	0.51
Lysine:calorie ratio, g/mcal	3.33

[a]Diets fed in meal form for 28 d. [b]Methionine was replaced with corn, resulting in four TID TSAA treatments (0.47, 0.52, 0.57, and 0.63%), whereas crystalline lysine and other amino acids were replaced by corn, resulting in four TID lysine treatments (0.66, 0.79, 0.92, and 1.05%). [c]Analyzed values for diets with 0.66, 0.79, 0.92, and 1.05% TID lysine were 0.68, 0.81, 0.98, and 1.14% total lysine, respectively, and the diets containing 0.47, 0.52, 0.57, and 0.63% TID TSAA were 0.52, 0.58, 0.63, and 0.73% TSAA, respectively. [d]Methionine supplied as liquid methionine hydroxy analogue (Alimet®).

Growth Performance and Carcass Composition

Pigs and feeders were weighed on d 0, 14, and 28 to determine ADG, ADFI, and F/G. At the end of the trial period, pigs were weighed before transport to a USDA-inspected processing plant (Swift and Co., Worthington, MN), where carcass data were collected. Before transport, the pigs in each pen were marked with a distinctive tattoo to allow the carcass data to be recorded for each pen. Carcass data were collected by pen to evaluate 10th-rib backfat depth, longissimus depth, lean percentage, fat-free-lean index, yield, and hot-carcass weight. Yield was calculated as hot-carcass weight divided by live weight. Fat depth and longissimus depth were measured with an optical probe inserted at the 10th rib, 7 cm off of the midline of the hot carcass. Lean percentage was provided from the packing plant, according to a proprietary equation, and fat-free-lean index was calculated.

Housing

The experiment was conducted at a commercial research facility in southwestern Minnesota. The facility is made up of four individual barns, each 41 × 250 ft, with 48 totally slatted concrete pens (10 × 18 ft). Each pen was equipped with a four-hole dry self-feeder (Staco, Schaefferstown, PA) and one-cup waterer to allow ad libitum access to feed and water. The finishing facilities were double curtain-sided, deep-pit barns that operate on manual ventilation during the summer and on automatic ventilation during the winter. The study was conducted in two barns; 42 pens from one, and 40 pens from the second were used.

Animals

Each pen contained 24 ± 2 pigs per pen, with number of pigs per pen balanced across treatment and eleven or twelve replicates (pens) per treatment. Two barns were used, one with six complete replications (three barrow and three gilt), and the other with five complete replications (three barrow and two gilt) and one incomplete block that had the 0.79- and 0.92%-TID-lysine treatments deleted because of a limited number of pigs in the barn.

Statistical Analysis

Data were analyzed as a randomized incomplete-block design by using the PROC MIXED procedure of SAS, with pen as the experimental unit. The statistical model included the effects of dietary treatment, gender, and their interaction analyzed as fixed effects, and the effect of weight block was included as a random effect. Also, linear and quadratic polynomial contrasts were performed to determine the effects of increasing dietary lysine and TSAA.

Results and Discussion

No treatment × gender or treatment × week interactions were observed (P>0.13) on growth performance or carcass data. There were differences (P<0.01) between barrows and gilts for ADG (2.34 vs. 2.07 lb), ADFI (6.77 vs. 5.86 lb), backfat (0.76 vs. 0.62 in), % lean (54.03% vs. 56.60%), and fat-free lean (49.43 vs. 51.10%).

From d 0 to 14, increasing TID lysine improved ADG (linear, P<0.01) and F/G (linear, P<0.01), but did not affect ADFI (P>0.40; Table 2). From d 14 to 28, increasing TID lysine had no effect on any response criteria (P>0.11). For the overall study, increasing TID lysine improved ADG (linear, P<0.01) and F/G (linear, P<0.01), but did not affect ADFI (P>0.60).

From d 0 to 14, increasing TID TSAA had no effect on any performance criteria (P>0.28; Table 3). From d 14 to 28, increasing TID TSAA did not affect ADG (P>0.37), but improved F/G (linear, P<0.02) and decreased ADFI (linear, P<0.03). The greatest response to TID TSAA occurred from d 14 to 28. For the overall study, increasing dietary TID TSAA did not affect ADG (P>0.76). According to this result, pigs fed Paylean require no more than 0.47% TSAA and a TID TSAA-to-lysine ratio not greater than 51% for optimum ADG when 0.92% TID lysine is the requirement. Increasing TID TSAA decreased ADFI (linear, $P<0.04$) and tended to improve F/G (linear, $P<0.09$). Although linear, the greatest improvement in F/G was observed as dietary TSAA concentration was increased from 0.47 to 0.52% and as TID lysine was increased to 0.92%. Thus, when a value of 0.52% TSAA is used, a ratio of 57% is optimum for F/G.

Increasing dietary TID lysine had no effect on carcass measurements ($P>0.11$; Table 4).

Increasing TID TSAA tended to improve fat-free lean (quadratic, $P<0.10$), with the maximum value occurring at 0.52% TID TSAA. Feeding more than 0.52% TID TSAA did not further improve carcass traits. No other carcass measurements ($P>0.13$; Table 5) were affected by increasing TID TSAA.

The TID TSAA-to-lysine ratio for finishing pigs fed 4.5 g/ton Paylean in this study is not greater than 51% for ADG and 57% for F/G. To further verify our TSAA-to-lysine ratio, the range of F/G values obtained in the study were used in regression analysis to predict the lysine and TSAA requirements. Thus a ratio for different levels of pig performance was established. Because there was no ADG response to additional TSAA, these values could not be used in the regression analysis to determine a TSAA-to-lysine ratio for optimum ADG. True-ileal-digestible lysine and TSAA concentrations were plotted for the range of F/G values observed from the study, and a trendline was calculated (Figures 1 and 2). On the basis of regression equations, the TSAA-to-lysine ratio necessary to achieve a given level of pig performance was determined (Table 6). These results indicate that F/G is maximized at a TSAA-to-lysine ratio of 58%.

Further research is needed to verify the ideal amino acid pattern for pigs fed Paylean; from our study, however, the TID lysine requirement is 0.92%, and the TID TSAA-to-lysine ratio is not greater than 58%.

Table 2. Effect of Increasing True-ileal-digestible (TID) Lysine in Finishing Pigs Fed Paylean[ab]

	TID Lysine %					P-value	
Item	0.66	0.79	0.92	1.05	SE	Linear	Quadratic
Day 0 to 14							
ADG, lb	2.16	2.29	2.43	2.40	0.104	0.01	0.29
ADFI, lb	6.24	6.35	6.39	6.37	0.155	0.62	0.55
F/G	2.89	2.77	2.63	2.65	0.118	0.01	0.39
Day 14 to 28							
ADG, lb	1.98	1.98	2.00	2.09	0.104	0.26	0.45
ADFI, lb	6.24	6.20	6.17	6.24	0.155	0.90	0.59
F/G	3.15	3.13	3.09	2.99	0.118	0.11	0.60
Day 0 to 28							
ADG, lb	2.07	2.14	2.23	2.25	0.074	0.01	0.75
ADFI, lb	6.24	6.28	6.28	6.31	0.109	0.60	0.93
F/G	3.01	2.93	2.82	2.80	0.084	0.01	0.66

[a]Values for each treatment are the mean of 11 or 12 replications with 24 ± 2 pigs per pen (PIC 337 × C22, initially 213 lb). [b]Note that the values for pigs fed the 1.05% TID lysine are the same as those fed the 0.63% TSAA diet (Table 2) because they were the same dietary treatment.

Table 3. Effect of Increasing the True-ileal-digestible (TID) Total Sulfur-containing Amino Acids (TSAA) in Finishing Pigs Fed Paylean[a]

	TID TSAA, %					P-value	
Item	0.47	0.52	0.57	0.63	SE	Linear	Quadratic
Day 0 to 14							
ADG, lb	2.47	2.45	2.36	2.40	0.099	0.40	0.66
ADFI, lb	6.44	6.35	6.22	6.37	0.148	0.46	0.28
F/G	2.61	2.59	2.64	2.65	0.113	0.63	0.96
Day 14 to 28							
ADG, lb	2.03	2.03	2.12	2.09	0.099	0.37	0.91
ADFI, lb	6.61	6.28	6.37	6.24	0.148	0.03	0.32
F/G	3.26	3.09	3.00	2.99	0.113	0.02	0.49
Day 0 to 28							
ADG, lb	2.26	2.24	2.24	2.26	0.070	0.99	0.76
ADFI, lb	6.52	6.31	6.29	6.30	0.105	0.04	0.14
F/G	2.89	2.82	2.81	2.80	0.080	0.09	0.46

[a]Values for each treatment are the mean of 12 replications with 24 ± 2 pigs per pen (PIC 337 × C22, initially 213 lb).

Table 4. Effect of Increasing True-ileal-digestible (TID) Lysine on Carcass Characteristics of Finishing Pigs Fed Paylean[a]

	TID Lysine %					P-value	
Item	0.66	0.79	0.92	1.05	SE	Linear	Quadratic
10th-rib backfat depth, in	0.70	0.69	0.69	0.68	0.014	0.70	0.53
Loin eye depth, in	2.31	2.32	2.34	2.37	0.035	0.54	0.11
Lean, %[b]	55.14	55.27	55.33	55.54	0.288	0.58	0.24
Fat-free-lean index, %[c]	50.04	50.21	50.17	50.29	0.196	0.74	0.44
Yield, %	75.58	75.80	76.03	76.00	0.399	0.79	0.23
Hot-carcass wt, lb	200.55	202.05	202.10	202.62	0.888	0.99	0.43

[a]Values are the mean of 11 or 12 replications with 24 ± 2 pigs per pen (PIC 337 × C22, initially 213 lb).
[b]Lean percentage was supplied from the packing plant, using a proprietary equation.
[c]Fat-free-lean index was calculated according to National Pork Producers Council (NPPC) 1994 procedures.

Table 5. Effect of Increasing True-ileal-digestible (TID) Total Sulfur-containing Amino Acids (TSAA) on Carcass Characteristics of Finishing Pigs Fed Paylean[a]

	TID TSAA, %					P-value	
Item	0.52	0.58	0.63	0.68	SE	Linear	Quadratic
10th-rib backfat depth, in	0.69	0.67	0.68	0.68	0.014	0.71	0.13
Loin eye depth, in	2.33	2.39	2.37	2.37	0.035	0.36	0.19
Lean, %[b]	55.34	55.83	55.63	55.54	0.288	0.65	0.14
Fat-free-lean index, %[c]	50.18	50.51	50.41	50.29	0.196	0.74	0.10
Yield, %	75.88	75.80	75.96	76.00	0.399	0.68	0.83
Hot-carcass wt, lb	202.60	204.17	204.44	202.63	1.957	0.96	0.21

[a]Values are the mean of 12 replications with 24 ± 2 pigs per pen (PIC 337 × C22, initially 213 lb).
[b]Lean percentage was supplied from the packing plant using a proprietary equation.
[c]Fat-free-lean index was calculated according to National Pork Producers Council (NPPC) 1994 procedures.

Table 6. Estimation of True-ileal-digestible (TID) Lysine and TSAA Requirement, and thus a TSAA-to-Lysine Ratio, Based on Regression Analysis for Different Levels of Pig Performance[a]

Item	Lysine	TSAA	TSAA:lysine	% of max	% of min
Feed Efficiency[b]					
2.80	1.02	0.59	58	100	103.6
2.85	0.93	0.52	57	98.3	101.8
2.90	0.84	0.46	55	96.6	100

[a]The feed efficiencies were plotted against TID lysine and TSAA concentrations used in the experiment to determine a TID lysine and TSAA concentration necessary to achieve a given feed efficiency and thus, a TID TSAA-to-lysine ratio.
[b]Regression equations of $y = 1.45x^2 – 10.027x + 17.729$ and $y = -1.2869x + 4.1925$ were used to determine lysine and TSAA requirements, respectively, for the range of feed-efficiency values.

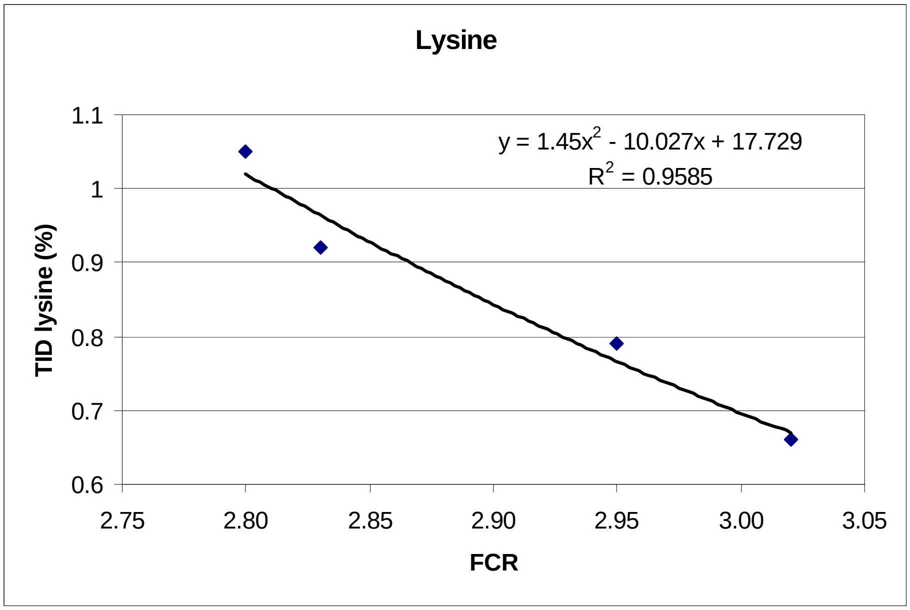

Figure 1. The Effect of TID Lysine on Feed Efficiency (FCR) of Pigs Fed Paylean. A total of 1887 pigs (initially 213 lb) with 24 ± 2 pigs per pen and 11 or 12 pens per treatment. Experimental diets were fed for 28 d. True-ileal-digestible lysine concentrations were 0.66, 0.79, 0.92, and 1.05%. The range of feed-efficiency values were plotted against TID lysine concentrations used in the experiment to determine the lysine concentration necessary to achieve a certain feed efficiency.

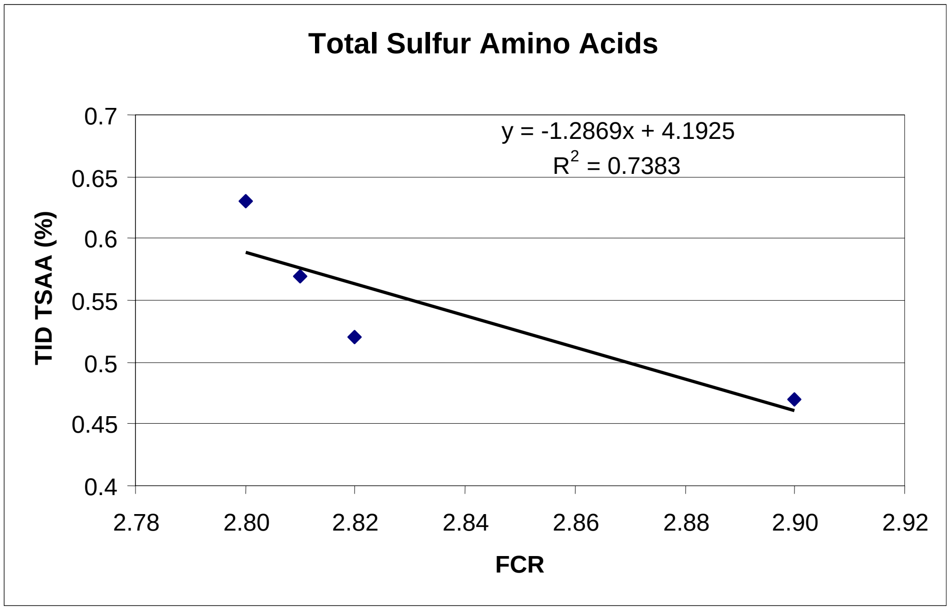

Figure 2. Effects of Increasing TID TSAA on Feed Efficiency (FCR) of Pigs Fed Paylean. A total of 1887 pigs (initially 213 lb) with 24 ± 2 pigs per pen and 11 or 12 pens per treatment. Experimental diets were fed for 28 d. True-ileal-digestible TSAA concentrations were 0.52, 0.58, 0.63, and 0.68%. The range of feed-efficiency values were plotted against TID TSAA concentrations used in the experiment to determine the TSAA-to-lysine ratio necessary to achieve a certain feed efficiency.