EFFECTS OF INCREASING AMOUNTS OF TRUE ILEAL DIGESTIBLE LYSINE ON THE GROWTH PERFORMANCE OF GROWING-FINISHING PIGS REARED IN A COMMERCIAL FACILITY[1]

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Summary

Two 28-d experiments using 2,259 gilts were conducted to determine the growth and economic effects of increasing dietary true ileal digestible (TID) lysine in commercially reared growing-finishing pigs. Both experiments included 6 dietary treatments of incrementally increasing TID lysine in diets containing 6% added fat. The dietary TID lysine ranged from below to above our current requirement estimates to determine if there were any changes in lysine requirements during the past five years. In Exp. 1, pigs were initially 132 lb and averaged 192 lb at the end of the 28-day study. The TID lysine rates were 0.65, 0.75, 0.85, 0.95, 1.05, and 1.15%, which corresponded to lysine:calorie ratios of 1.80, 2.08, 2.35, 2.63, 2.91, and 3.19 g/Mcal, respectively. Increasing TID lysine increased ADG (linear, P<0.01) and improved F/G (quadratic, P<0.06), with optimal performance at 1.05% TID lysine (TID lysine:ME ratio of 2.91 g/Mcal). Pigs fed this diet consumed approximately 22 g of TID lysine per day, and used 21.6 g of TID lysine/kg of gain. Although not significant, margin over feed cost (MOF) was numerically greatest for pigs fed 1.05% TID. In Exp. 2, pigs were initially 177 lb and averaged 241 lb at the end of the 28-d study. The TID lysine rates were 0.52, 0.62, 0.72, 0.82, 0.92, and 1.02%, which corresponded to lysine:calorie ratios of 1.44, 1.71, 1.99, 2.27, 2.55, and 2.83 g/Mcal, respectively. In Exp. 2, the optimal TID lysine rate changed over the course of the experiment. During the first 14 d, pigs fed 0.92% TID lysine had the greatest ADG and lowest F/G, whereas pigs fed 0.72% TID lysine had the numerically highest ADG and lowest F/G from d 14 to 28. Pigs fed these diets required approximately 19.5 g of TID lysine/kg gain. Margin over feed costs increased (quadratic, P<0.03) with increasing dietary TID lysine, with the greatest return at 0.72% TID lysine. In summary, results of the first experiment suggest an increase in dietary TID lysine recommendations, compared with our earlier studies. Even though the optimal lysine rate may be changing over time for this genetic line and production facility, it seems that using the estimate of approximately 20 g TID lysine per kg of gain will provide a good estimate of the pig's lysine requirement.

(Key Words: Finishing Pig, Energy, Lysine, Growth.)

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Introduction

Lysine requirements of growing-finishing pigs have been researched in depth, but as genetics, environment, and herd health in commercial production systems change over time, these requirements also may change. The most recent research on lysine requirement of finishing pigs by Kansas State University was reported in 2002, when Main et al. described the ideal lysine:calorie ratios for growing-finishing barrows and gilts. Continuous evaluation of requirements is time consuming, especially considering rapid changes in many of the factors affecting protein deposition. If there were a way to quickly assess amino acid requirements without periodically conducting titration studies, this would be a valuable procedure to determine lysine requirements within a production system. In previous studies, anecdotal observations have suggested that there might be a constant relationship between ADG and the lysine requirement. It seems that, for every 1 kg of gain, the pig needs to consume approximately 20 g of TID lysine. Therefore, the objectives of this study were to determine if lysine requirements in this production may have changed over the past three years and possibly to provide evidence that the estimate of 20 g TID lysine per kg might be an accurate requirement indicator in growing-finishing gilts reared in a commercial environment.

Procedures

Animals and Housing. A total of 1,130 growing and 1,129 finishing gilts (Exp. 1 and 2, respectively) were used in two 28-d studies. Pigs were randomly allotted to one of 42 pens into two different finishing barns on a commercial research site in southwestern Minnesota. The pigs in each experiment were weighed on d 0 of the experiment, and dietary treatments were assigned to pens blocked by initial weight. There were approximately 27 pigs per pen and 7 pens per treatment.

The trials were conducted in identical double curtain-sided, deep-pit commercial finishing barns that operated on natural ventilation during the summer and mechanical ventilation during the winter. Each barn had totally slatted flooring allowing 7.2 ft^2 per pig. Each pen was equipped with a five-hole dry self feeder and one cup waterer. The experiments were conducted from November 2005 to January 2006.

Dietary Treatments. Each experiment consisted of 6 corn/soybean meal dietary treatments that were formulated over a range of TID lysine values to be below, at, or above the current lysine estimates. In Exp. 1, gilts were initially 132 lb, and the trial was 28 d in duration. The TID lysine rates were 0.65, 0.75, 0.85, 0.95, 1.05, and 1.15%, and correspond to lysine:calorie ratios of 1.80, 2.08, 2.35, 2.63, 2.91, and 3.19 g/Mcal, respectively (Table 1). In this trial, DL-methionine was added in the 1.15% TID lysine diet to ensure that lysine was first limiting. In Exp. 2, initial weight of gilts was 177 lb, and the trial duration was 28-d. The TID lysine rates were 0.52, 0.62, 0.72, 0.82, 0.92, and 1.02, and corresponded to lysine:calorie ratios of 1.44, 1.71, 1.99, 2.27, 2.55, and 2.83 g/Mcal, respectively (Table 2). All diets contained 6% added choice white grease, and increasing TID lysine rates were achieved by changing the amount of corn and soybean meal; diets did not contain crystalline to ensure that all other amino acid ratios, relative to lysine, were above the pig's requirement. Dietary treatments were fed in meal form and were formulated to contain similar amounts of vitamins and minerals.

Response Criteria and Statistical Analysis. Pens of pigs and feeders were weighed on d 0, 14, and 28 to calculate ADG, ADFI, and F/G. Margin over feed cost (MOF) per pig was calculated by using a market hog value of $45/cwt and existing corn ($1.99/bu), soybean meal ($190/ton), and choice white grease ($0.19/lb) costs for southwestern Minnesota as

of January 2006. Data were analyzed as a randomized complete-block design, with pen as the experimental unit. Analysis of variance was performed by using the MIXED procedure of SAS. Linear and quadratic contrasts were used to evaluate the effects of increasing TID lysine on pig performance.

Results

Experiment 1. From d 0 to 14, increasing TID lysine improved ADG, ADFI, and F/G (linear, P<0.02; Table 3). Although the responses were linear, the greatest improvement was observed in pigs fed 1.05% TID lysine (2.91 g TID lysine/Mcal ME), with little improvement thereafter.

From d 14 to 28, increasing TID lysine had no effect on ADG, reduced ADFI (linear, P<0.01), and improved F/G (quadratic, P<0.07).

Overall (d 0 to 28), ADG was increased (linear, P<0.01) and ADFI was reduced (linear, P<0.01) with increasing TID lysine. Feed efficiency was also improved (quadratic, P<0.06). Again the optimal response was at 1.05% TID lysine. Pigs provided the diet formulated to contain 1.05% TID lysine consumed 21.8 g of TID lysine per day and used 21.6 g of TID lysine/kg of gain from d 0 to 28. Margin over feed cost per pig was not affected by increasing TID lysine.

Experiment 2. From d 0 to 14, increasing TID lysine improved ADG and F/G (quadratic, P<0.01), with the greatest growth performance for pigs fed diets containing 0.92% TID lysine (2.55 g TID lysine/Mcal ME; Table 4). Pigs consuming diets containing 0.92 of TID lysine used 22.3 g of TID lysine per day, or 19.5 g of TID lysine/kg of gain.

From d 14 to 28, there were no differences in ADG with increasing TID lysine, but ADFI decreased (linear, P<0.05) and F/G improved (linear, P<0.07). Despite the linear response, there were few improvements in performance in pigs fed more than 0.72% TID lysine. Pigs on this treatment consumed 19.3 g of TID lysine, and used 19.5 g of TID lysine/kg of gain.

Overall (d 0 to 28), ADG and F/G were improved (quadratic, P<0.02) with increasing TID lysine. Optimal performance occurred with pigs provided diets containing 0.72% TID lysine. This corresponded with 18.6 g TID lysine intake per day, and 17.9 g of TID lysine/kg of gain

Margin over feed cost per pig improved (quadratic, P<0.02) with increasing TID lysine, with the greatest MOF observed in pigs provided diets containing 0.72% TID lysine.

Discussion

Current Kansas State University lysine recommendations state that growing gilts (120-170 lb) require 0.85% TID lysine (2.35 g TID lysine/Mcal ME), whereas finishing gilts (180-240 lb) should receive diets containing 0.72% TID lysine (1.99 g TID lysine/Mcal ME). These recommended rates served as the basis for diet formulation for Exp. 1 and 2, respectively. In our study, grower diets formulated to contain 1.05% TID lysine (2.91 g TID lysine/Mcal ME) provided numerically improved growth performance and MOF. This lysine rate is much higher than previously observed in lysine titration studies in this production system.

Ideally, we would like a method to estimate a lysine requirement without the time and expense of conducting titration studies. Previous anecdotal observations suggested that pigs of modern genotypes require approximately 20 g/d of TID lysine per kg of gain. In Exp. 1, this estimate was slightly less than the actual g lysine/kg gain values observed for pigs with the best ADG and F/G. In Exp. 2, finishing pigs' lysine requirements seemed very similar to that in previous studies (0.72% TID lysine), and the 19.5 g of lysine

per kg of gain required in each two-week period for the optimal response was similar to the 20 g/kg suggested requirement. These findings may suggest that 20 g lysine per kg gain may be used as a potential estimate for lysine requirements in commercial facilities.

Table 1. Diet Composition (Exp. 1, As-fed Basis)

	True Ileal Digestible Lysine, %[a]					
Ingredient, %	0.65	0.75	0.85	0.95	1.05	1.15
Corn	73.49	69.57	65.60	61.67	57.70	53.59
Soybean meal, 46.5% CP	18.43	22.40	26.38	30.35	34.33	38.31
Choice white grease	6.00	6.00	6.00	6.00	6.00	6.00
Monocalcium phosphate, 21% P	0.65	0.60	0.60	0.55	0.55	0.65
Limestone	0.90	0.90	0.90	0.90	0.90	0.90
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.08	0.08	0.08	0.08	0.08	0.08
Trace mineral premix	0.10	0.10	0.10	0.10	0.10	0.10
DL-methionine	0.00	0.00	0.00	0.00	0.00	0.03
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
Total lysine, %	0.75	0.86	0.97	1.08	1.19	1.30
True ileal digestible amino acids						
Lysine, %	0.65	0.75	0.85	0.95	1.05	1.15
Isoleucine:lysine ratio, %	82	80	78	77	76	75
Leucine:lysine ratio, %	195	182	171	163	157	151
Methionine:lysine ratio, %	35	32	31	29	28	30
Met & cys:lysine ratio, %	71	67	63	61	58	59
Threonine:lysine ratio, %	73	70	68	67	66	65
Tryptophan:lysine ratio, %	22	22	22	22	22	22
Valine:lysine ratio, %	95	91	88	86	84	82
TID Lys:ME, g/Mcal	1.80	2.08	2.35	2.63	2.91	3.19
ME, kcal/lb	1,639	1,639	1,639	1,639	1,638	1,636
CP, %	14.8	16.3	17.8	19.4	20.9	22.4
Ca, %	0.55	0.55	0.56	0.57	0.58	0.61
P, %	0.47	0.48	0.49	0.50	0.51	0.55
Available P, %	0.19	0.19	0.19	0.19	0.19	0.22

[a]Nutrient values used in diet formulation from NRC, 1998.

Table 2. Diet Composition (Exp. 2, As-fed Basis)

Ingredient, %	True Ileal Digestible Lysine, %[a]					
	0.52	0.62	0.72	0.82	0.92	1.02
Corn	70.76	66.79	62.81	58.84	83.25	85.64
Soybean meal, 46.5% CP	21.21	25.19	29.16	33.14	14.85	12.46
Choice white grease	6.00	6.00	6.00	6.00	0.00	0.00
Monocalcium phosphate, 21% P	0.65	0.65	0.65	0.65	0.55	0.60
Limestone	0.85	0.85	0.85	0.85	0.80	0.80
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.08	0.08	0.08	0.08	0.10	0.08
Trace mineral premix	0.10	0.10	0.10	0.10	0.10	0.08
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
Total lysine, %	0.61	0.71	0.82	0.93	1.04	1.15
True ileal digestible amino acids						
Lysine, %	0.52	0.62	0.72	0.82	0.92	1.02
Isoleucine:lysine ratio, %	86	83	81	79	78	77
Leucine:lysine ratio, %	221	200	185	174	165	158
Methionine:lysine ratio, %	39	35	33	31	30	29
Met & cys:lysine ratio, %	80	73	68	64	61	59
Threonine:lysine ratio, %	77	73	71	69	67	66
Tryptophan:lysine ratio, %	23	22	22	22	22	22
Valine:lysine ratio, %	102	96	92	89	86	84
TID Lys:ME, g/Mcal	1.44	1.71	1.99	2.27	2.55	2.83
ME, kcal/lb	1,641	1,640	1,639	1,639	1,638	1,637
CP, %	12.9	14.4	15.9	17.4	18.9	20.4
Ca, %	0.51	0.52	0.54	0.55	0.56	0.57
P, %	0.45	0.46	0.48	0.50	0.51	0.53
Available P, %	0.19	0.19	0.20	0.20	0.21	0.21

[a]Nutrient values used in diet formulation from NRC, 1998.

Table 3. Influence of Increasing True Ileal Digestible Lysine Growth Performance of Pigs from 132 to 194 lb (Exp. 1)[a]

	True Ileal Digestible Lysine, %						Probability, P<			
Item	0.65	0.75	0.85	0.95	1.05	1.15	Trt	Linear	Quadratic	SE
d 0 to 14										
ADG, lb	2.05	2.01	2.10	2.13	2.24	2.21	0.01	0.01	0.79	0.066
ADFI, lb	4.61	4.51	4.36	4.43	4.47	4.31	0.08	0.02	0.49	0.100
F/G	2.25	2.25	2.08	2.08	2.00	1.95	0.01	0.01	0.73	0.058
TID lysine, g/d	13.6	15.3	16.8	19.1	21.3	22.5	0.01	0.01	0.97	0.390
TID lysine, g/kg gain	14.6	16.8	17.6	19.8	21.0	22.4	0.01	0.01	0.56	0.563
d 14 to 28										
ADG, lb	2.06	2.11	2.09	2.13	2.19	2.03	0.68	0.81	0.27	0.099
ADFI, lb	5.12	4.75	4.63	4.66	4.68	4.42	0.01	0.01	0.15	0.115
F/G	2.48	2.26	2.23	2.21	2.15	2.21	0.06	0.01	0.07	0.106
TID lysine, g/d	15.1	16.2	17.9	20.1	22.3	23.1	0.01	0.01	0.83	0.473
TID lysine, g/kg gain	16.2	16.9	18.8	20.8	22.4	25.0	0.01	0.01	0.22	1.071
d 0 to 28										
ADG, lb	2.05	2.06	2.10	2.13	2.22	2.12	0.11	0.01	0.46	0.061
ADFI, lb	4.86	4.63	4.50	4.54	4.57	4.36	0.01	0.01	0.24	0.102
F/G	2.37	2.25	2.15	2.14	2.06	2.06	0.01	0.01	0.06	0.053
TID lysine, g/d	14.3	15.8	17.4	19.6	21.8	22.7	0.01	0.01	0.88	0.403
TID lysine, g/kg gain	15.4	16.9	18.2	20.2	21.6	23.7	0.01	0.01	0.46	0.514
MOF/pig[b]	$17.31	$17.45	$17.93	$17.92	$18.66	$17.59	0.44	0.23	0.27	0.694
TID Lys:ME, g/Mcal	1.80	2.08	2.35	2.63	2.91	3.19				

[a]A total of 1,130 gilts (initially 132.6 lb, PIC).
[b]Margin over feed cost based on a market hog value of $45/cwt and current costs for corn, soybean meal, and choice white grease in southwestern Minnesota as of January 2006.

Table 4. Influence of Increasing True Ileal Digestible Lysine Growth Performance of Pigs from 177 to 241 lb (Exp. 2)[a]

	True Ileal Digestible Lysine, %						Probability, P<			
Item	0.52	0.62	0.72	0.82	0.92	1.02	Trt	Linear	Quadratic	SE
d 0 to 14										
ADG, lb	1.95	2.25	2.45	2.33	2.52	2.42	0.01	0.01	0.01	0.098
ADFI, lb	5.50	5.45	5.48	5.28	5.34	5.23	0.13	0.01	0.89	0.122
F/G	2.82	2.44	2.25	2.27	2.12	2.16	0.01	0.01	0.01	0.073
TID lysine, g/d	13.0	15.3	17.9	19.6	22.3	24.2	0.01	0.01	0.21	0.213
TID lysine, g/kg gain	14.7	15.0	16.1	18.6	19.5	22.0	0.01	0.01	0.01	0.322
d 14 to 28										
ADG, lb	2.05	2.10	2.18	2.14	2.12	2.14	0.90	0.48	0.43	0.104
ADFI, lb	5.81	5.85	5.91	5.82	5.70	5.59	0.21	0.05	0.12	0.137
F/G	2.83	2.80	2.72	2.77	2.69	2.62	0.51	0.07	0.81	0.120
TID lysine, g/d	13.7	16.5	19.3	21.7	23.8	25.9	0.01	0.01	0.07	0.525
TID lysine, g/kg gain	14.7	17.3	19.5	22.3	24.7	26.6	0.01	0.01	0.51	0.965
d 0 to 28										
ADG, lb	2.01	2.17	2.30	2.23	2.31	2.27	0.01	0.01	0.02	0.075
ADFI, lb	5.66	5.66	5.71	5.57	5.53	5.42	0.07	0.01	0.23	0.103
F/G	2.82	2.62	2.48	2.51	2.40	2.39	0.01	0.01	0.02	0.064
TID lysine, g/d	13.4	15.9	18.6	20.7	23.1	25.1	0.01	0.01	0.10	0.383
TID lysine, g/kg gain	14.6	16.2	17.9	20.5	22.0	24.4	0.01	0.01	0.35	0.533
MOF/pig[b]	$15.77	$17.43	$18.71	$17.65	$18.34	$17.73	0.02	0.03	0.02	0.805
TID Lys:ME, g/Mcal	1.44	1.71	1.99	2.27	2.55	2.83				

[a]A total of 1,129 gilts (initially 177.5 lb, PIC).
[b]Margin over feed cost based on a market hog value of $45/cwt and current costs for corn, soybean meal, and choice white grease in southwestern Minnesota as of January 2006.