INFLUENCE OF DIETARY LYSINE ON GROWTH PERFORMANCE AND TISSUE ACCRETION RATES OF HIGH-LEAN GROWTH GILTS FED FROM 80 TO 160 LB[1]

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Summary

One-hundred eight high-lean growth gilts (75.5 lb initial weight) were used to determine the dietary lysine requirement to maximize growth performance and protein accretion from 80 to 160 lb. The experiment was designed as a randomized complete block, with initial weight serving as the blocking factor. Six dietary treatments were included, ranging from .54 to 1.04% digestible lysine (.69 to 1.25% total dietary lysine). Pigs were housed in pens of three, with six replicate pens/treatment. Pig weights and feed disappearance were collected weekly to calculate average daily gain (ADG), average daily feed intake ADFI, and feed efficiency (F/G). Initially, six pigs were slaughtered to determine baseline carcass composition. When the mean weight for pigs in a pen reached 120 and 160 lb, one pig per pen was randomly selected and slaughtered for carcass analyses. The right side of each carcass was ground twice and sampled to determine carcass composition and lean tissue (crude protein) accretion rate. Average daily gains were greater for gilts fed increased dietary lysine from 80 to 120 lb, from 120 to 160 lb, and from 80 to 160 lb. Average daily feed intakes from 80 to 120 and from 120 to 160 lb were not influenced by dietary lysine. However, ADFI for the entire experiment tended to decrease as digestible lysine increased. Increased dietary lysine resulted in improved F/G from 80 to 120 lb and from 120 to 160 and 80 to 160 lb. Gilts fed increased digestible lysine had greater CP accretion from 80 to 120 lb, 120 to 160 lb, and 80 to 160 lb . Based on the feed intake observed in this study, the high-lean growth gilt requires at least 18 to 19 and 22 g/d lysine intakes from 80 to 120 lb and from 120 to 160 lb, respectively, to maximize ADG, F/G, and lean accretion.

(Key Words: Pigs, Growth, Carcass Composition, Genotype, Gilts.)

Introduction

The National Research Council (1988) reported extensive research on dietary lysine estimates for growing-finishing swine. However, the extent of experiments pertaining to dietary lysine requirements based on protein accretion rate or carcass leanness potential is limited. Previous research conducted at Kansas State University indicated that high-lean growth gilts exhibit a greater response to dietary lysine than barrows. Therefore, gilts had a greater lean deposition rate and improved lean efficiency, even though barrows had a greater average daily gain. Similar research conducted by the NCR-42 committee on swine nutrition indicated that gilts had a greater response to increased crude protein and lysine compared to barrows in terms of rate and efficiency of lean deposition. Thus, nutritional programs based upon genetics and gender are a necessity to

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maximize both rate and efficiency of lean deposition. Therefore, the objective of this experiment was to determine the dietary lysine requirement to optimize growth performance and protein accretion rate for high-lean growth gilts fed from 80 to 160 lb.

Procedures

Animals. One hundred eight high-lean growth gilts (initially 75.5 lb) were used to determine the dietary lysine requirement to optimize growth performance and lean tissue deposition with six dietary treatments. The gilts were delivered to the Kansas State University Swine Research Center and were fed a corn-soybean meal diet containing .90% lysine during a 7 day acclimation period. Three pigs were housed per pen (4 ft × 15 ft pens with solid flooring) in an open-fronted building with six replicate pens per treatment. The trial was conducted from August 17 to November 9, 1992, and when temperatures exceeded 80°F, drip coolers were activated to wet the pigs for 3 out of every 15 min. Each pen contained a single-hole feeder and a nipple waterer to accommodate *ad libitum* access to feed and water. Pig weights and feed disappearance were collected weekly to determine ADG, ADFI, F/G, and lysine intake. When the mean weight of pigs in a pen reached 120 and 160 lb, one pig per pen was randomly removed and slaughtered.

Diet Formulation. Dietary treatments ranged from .54 to 1.04% digestible lysine, with total calculated dietary lysine ranging from .68 to 1.25% (Table 1). Corn-soybean meal diets were balanced to digestible lysine levels. Other amino acid levels were set using an ideal amino acid ratio to assure that lysine was the first limiting amino acid. Calculated amino acid digestibility coefficients were used for the feed ingredients. The corn-soybean meal ratio was altered to increase the dietary lysine content. L-lysine-HCl was maintained at .05% of the complete diet, so that lysine bioavailability was not influenced by high inclusion of synthetic lysine. All diets contained 3% soybean oil. The lysine:Mcal ratio of the diet ranged from 2.14 to 3.65. All other nutrients either met or exceeded NRC (1988) estimates for the 20 to 50 kg pig.

Carcass Composition. Six gilts were randomly selected for slaughter at 80 lb and the right side of the carcass was ground to determine initial empty body composition (percentage of moisture, crude protein, lipid, and ash). When the pen mean weight of pigs in a pen equalled 120 and 160 lb, one pig from each pen (six pigs/treatment) was slaughtered for carcass analysis. The head, leaf fat, and viscera were removed at slaughter and were not included in tissue accretion rate determination. At 24 h postmortem, the right side of each carcass was ground once through a .47 in plate and once through a .35 in plate and homogenized for 3 min in a ribbon-paddle mixer. From the chemical analysis, the lb of CP, lipid, ash, and DM were determined for each carcass based upon cold carcass weight. Moisture content was determined by subtracting the percentage DM from 100%. Chemical components (DM, CP, lipid, and ash) from the initial six gilts were averaged and expressed as a percentage of live weight prior to slaughter. Thus, initial composition, determined from percentage chemical composition of live weight, was subtracted from chemical composition determined at either 120 or 160 lb. Tissue accretion rates were calculated as the difference between final (120 or 160 lb) and initial (80 lb) composition, divided by the days on test. Intermediate accretion rates (120 to 160 lb) were determined by subtracting the chemical composition as a percentage of live weight at 120 lb from the final composition and dividing by the days on test. The mean of six gilts for each treatment was used as the initial composition for their respective treatment group at 120 lb.

Results

Growth Performance. Increasing digestible lysine improved ADG from 80 to 120 lb (linear, P<.01), from 120 to 160 lb (linear, P<.10), and from 80 to 160 lb (linear, P<.01; Table 2). Conversely, ADFI was not influenced (P>.35) by dietary treatment from 80 to 120 and from 120 to 160 lb. However, ADFI tended to decrease (quadratic, P<.10) as digestible lysine increased from 80 to 160 lb. Thus, greater ADG with similar ADFI improved F/G from 80 to 120 lb (linear, P<.01), and from 120 to 160 and 80 to 160 lb (quadratic, P<.01). Breakpoint analysis using a quadratic model from 120 to 160 lb indicated that G/F was maximum for gilts fed .83% digestible lysine. However, for the entire experiment (80 to 160 lb), breakpoint analysis indicated maximum F/G (quadratic model) for gilts fed .87% digestible lysine, respectively. Lysine intake (g/d) increased (linear, P<.01) from 80 to 120, from 120 to 160, and from 80 to 160 lb as a result of increased diet lysine fortification, rather than an increase in ADFI.

Tissue Accretion Rates. From 80 to 120 lb, moisture and CP accretion increased (linear, P<.01) for gilts fed increasing digestible lysine (Table 3). Moisture and CP accretion improved by 117 and 26 g/d, respectively, in gilts fed 1.04% compared with .54% digestible lysine. Conversely, lipid accretion decreased (linear, P<.01) by 47 g/d as digestible lysine was increased. Ash accretion was not influenced (P=.30) by dietary treatment. Lean gain and lean efficiency were both improved (linear, P<.01) for gilts fed increased digestible lysine. From 120 to 160 lb, greater dietary lysine tended to increase moisture accretion (quadratic, P<.10) and increased CP accretion (linear, P<.05; quadratic, P<.10). Moisture and CP accretion were maximized for gilts fed .94% digestible lysine; 150 and 53 g/d, respectively, greater than gilts fed .54% digestible lysine. However, CP accretion was maximum using a quadratic model for gilts fed .74% digestible lysine. Lipid (P=.60) and ash (P=.20) accretion were not influenced by dietary lysine from 120 to 160 lb. Numerically, lipid accretion appears to respond in a quadratic fashion, with minimal lipid accretion for gilts fed .84% digestible lysine. However, the coefficient of variation was large. Ash accretion was not influenced (P=.20) by dietary treatment. For the entire experiment (80 to 160 lb), moisture and CP accretion increased (linear, P<.01; quadratic, P<.05) for gilts fed greater digestible lysine. Moisture and CP accretion were again maximum for gilts fed .94% digestible lysine; 142 and 40 g/d greater than gilts fed .54% digestible lysine. Conversely, lipid accretion decreased (linear, P<.05; quadratic, P<.10) as digestible lysine increased. The lowest lipid accretion was observed for gilts fed a .84% digestible lysine diet, 34 g/d lower than that for gilts fed .54% digestible lysine. Dietary treatment did not influence (P=.15) ash accretion for the entire experiment. Crude protein accretion was maximized at .79%, whereas lipid accretion was minimized at .71% digestible lysine using a linear-linear model from 34 to 72.5 kg. Both lean gain (linear, P<.05) and lean efficiency (quadratic, P<.05) increased for gilts fed increased digestible lysine.

Discussion

The results of this experiment indicate that the dietary lysine requirement to optimize growth performance and protein accretion for the high-lean growth gilt is greater than current National Research Council estimations. Although ADG, F/G, and protein accretion rate improved linearly from 80 to 120 lb, they appeared to plateau for gilts fed .94% (1.15% total lysine or 19 g/d). These data represent a 4 to 5 g/d (26%) increase above current NRC estimates. Also, these data show the relationship between genetics and protein deposition (lean gain/d). When dietary lysine was under fed, protein accretion rates and lipid accretion rates were nearly identical. However, protein deposition increased while lipid deposition decreased for gilts fed greater dietary lysine. From 120 to 160 lb, gilts fed a .84% digestible lysine diet

(1.05% total lysine or 22 g/d) had the maximal ADG and the best F/G ratio. However, protein deposition was further improved by increasing the digestible lysine to .94%. These data represent a 15% greater lysine intake than current NRC estimates. On the other hand, ADFI was not influenced by dietary lysine from 80 to 120 and from 120 to 160 lb. However, the gilts in this experiment consumed 11% less than NRC estimates. Therefore, the increase in dietary lysine over NRC estimates is both a function of lower feed intake and a greater lysine need for protein deposition. Thus, genetic potential will dictate the lysine requirement to optimize growth performance and protein accretion rate.

When feed costs per lb of live weight gain are assessed, the cost from 80 to 120 lb is approximately $.12 to .14 per lb of live weight gain regardless of dietary lysine content. However, when the feed cost per lb of lean gain is analyzed, increasing dietary lysine results in decreased cost per lb of lean tissue deposited. Lean tissue deposition (protein accretion) was maximized for gilts fed .94% digestible lysine (1.15% total lysine), whereas cost of lean deposition was minimized at $.27/lb at the same dietary lysine. A similar pattern was noted for gilts fed from 120 to 160 lb. Feed cost per lb of live weight gain was similar for gilts fed .54 to .84% digestible lysine. However, feed cost increased by $.04 to .05/lb when digestible lysine was increased above .84%. The feed cost per lb of lean gain was minimized at $.27/lb for gilts fed a .84% digestible lysine (1.05% total lysine) diet. Again, this was the same level of dietary lysine that maximized lean tissue deposition (protein accretion).

In summary, the data from this experiment indicate the importance of developing nutrition programs based on feed intake and genetic potential for lean deposition. The results suggest that the high-lean growth gilt requires at least 18 to 19 g/d (1.15% total lysine) and 22 g/d (1.05% total lysine) of lysine intake from 80 to 120 and from 120 to 160 lb, respectively, for maximum ADG and lean tissue accretion. In conjunction, feed efficiency and cost/lb of lean tissue deposition are optimized when lean tissue deposition (protein accretion) is maximized.

Table 1. Diet Composition

	Digestible Lysine, %					
Item, %	.54	.64	.74	.84	.94	1.04
Corn	79.62	75.69	71.71	67.74	63.73	59.75
Soybean meal (48.5% CP)	14.08	18.09	22.11	26.12	30.14	34.15
Soybean oil	3.00	3.00	3.00	3.00	3.00	3.00
L-lysine HCl	.05	.05	.05	.05	.05	.05
L-threonine	—	.01	.03	.03	.07	.10
DL-methionine	—	.001	.03	.07	.11	.14
L-tryptophan	.001	—	—	—	—	—
Monocalcium phosphate (21% P)	1.60	1.53	1.46	1.38	1.31	1.24
Limestone	.95	.93	.92	.90	.89	.87
Salt	.35	.35	.35	.35	.35	.35
Trace mineral premix	.15	.15	.15	.15	.15	.15
Vitamin premix	.20	.20	.20	.20	.20	.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis, %						
Crude Protein (N x 6.25)	14.86	15.78	17.95	19.08	20.99	20.86
Total Dietary Lysine	.68	.79	.91	1.02	1.14	1.25
Ca	.75	.75	.75	.75	.75	.75
P	.65	.65	.65	.65	.65	.65
Mcal/lb	1550	1550	1550	1550	1550	1550

Table 2. The Effect of Increased Digestible Lysine on Growth Performance of High-Lean Growth Gilts Fed from 80 to 120 and 160 lb[a]

	Digestible Lysine, %						
Item	.54	.64	.74	.84	.94	1.04	CV
ADG, lb							
80 to 120 lb[b]	1.42	1.56	1.56	1.72	1.85	1.80	8.77
120 to 160 lb[c]	1.68	1.77	1.82	1.91	1.89	1.84	10.44
80 to 160 lb[b]	1.51	1.65	1.63	1.82	1.92	1.82	9.26
ADFI, lb							
80 to 120 lb	3.86	3.79	3.73	3.72	3.78	3.61	10.56
120 to 160 lb	5.22	5.14	4.80	4.63	5.08	4.82	10.82
80 to 160 lb[d]	5.20	5.18	4.71	5.00	5.18	5.20	7.81
F/G							
80 to 120 lb[b]	2.73	2.44	2.38	2.17	2.05	2.02	8.68
120 to 160 lb[be]	3.13	2.94	2.68	2.43	2.68	2.64	9.77
80 to 160 lb[be]	3.45	3.15	2.90	2.75	2.70	2.87	5.14
Lysine intake, g/d							
80 to 120 lb[b]	13.31	13.75	16.57	17.87	20.21	21.48	10.36
120 to 160 lb[b]	17.99	18.66	21.34	22.25	27.17	28.66	11.26
80 to 160 lb[b]	14.86	15.35	16.86	19.39	22.18	24.02	7.86

[a]A total of 108 pigs, three pigs/pen from 80 to 120 lb and two pigs/pen from 120 to 160 lb; six replicate pens/treatment.
[b]Linear effect of digestible lysine (P<.01).
[c]Linear effect of digestible lysine (P<.10).
[d]Quadratic effect of digestible lysine (P<.10).
[e]Quadratic effect of digestible lysine (P<.01).

Table 3. The Effect of Increased Digestible Lysine on Moisture, Protein, Lipid, and Ash Accretion in High-Lean Growth Gilts Fed from 80 to 120 and 160 lb[a]

	Digestible Lysine, %						
Item, g/d	.54	.64	.74	.84	.94	1.04	CV
80 to 120 lb							
Moisture[b]	258	282	292	344	366	375	10.72
CP[b]	77	84	89	103	104	103	15.69
Lipid[b]	96	74	60	72	70	49	37
Ash	14	11	15	16	13	17	32.64
Lean gain/d, lb[b]	.67	.62	.69	.81	.91	.90	13.27
Lean/ADFI[b]	5.76	6.09	5.42	4.69	4.17	4.09	11.30
120 to 160 lb							
Moisture[c]	305	319	352	379	455	314	23.11
CP[cd]	85	91	131	114	138	111	27.37
Lipid	123	127	103	73	94	127	53.58
Ash	17	31	24	21	16	25	35.64
80 to 160 lb							
Moisture[be]	286	313	329	372	428	365	9.15
CP[be]	83	90	111	113	123	110	13.78
Lipid[cd]	107	99	79	73	80	84	27.83
Ash	16	20	19	21	15	21	21.04
Lean gain/d, lb[d]	.73	.84	.94	1.02	1.01	.95	23.25
Lean/ADFI[de]	7.16	6.61	5.26	4.89	5.44	5.47	27.96

[a]Calculated from 36 pigs each at a pen mean weight of 120 and 160 lb, one pig/pen, six pens/treatment.
[b]Linear effect of digestible lysine (P<.01).
[c]Quadratic effect of digestible lysine (P<.10).
[d]Linear effect of digestible lysine (P<.05).
[e]Quadratic effect of digestible lysine (P<.05).