THE INTERRELATIONSHIP BETWEEN GENOTYPE, SEX, AND DIETARY LYSINE EFFECTS ON GROWTH PERFORMANCE AND PROTIN ACCRETION IN FINISHING PIGS FED TO 230 AND 280 LB[1]

K. G. Friesen, J. L. Nelssen, J. A. Unruh, R. D. Goodband, M. D. Tokach, L. J. Kats, J. A. Hansen, and J. L. Laurin

Summary

One hundred and twenty pigs (initially 96 lb BW) were used to determine the interrelationship between genotype, sex, and dietary lysine effects on growth performance and carcass composition in a 2 × 2 × 2 factorial arrangement. Genetic comparisons were made between pigs characterized by either high or medium potential for lean tissue gain. Within genotype, barrows and gilts were separately fed either a .90 or a .70% lysine diet until the mean weight of pigs in each pen of three reached 230 lb. One pig per pen was then slaughtered to determine carcass characteristics and chemical composition. From 230 to 280 lb, dietary lysine was lowered to .75 or .55% for pigs fed .90 or .70% dietary lysine, respectively. When the pig mean weight met or exceeded 280 lb, both pigs were slaughtered to determine carcass characteristics and chemical composition. The right side of the carcass was then ground and chemically analyzed to determine protein and lipid accretion rates. No interactions were detected; therefore, main effect means will be discussed. At 230 lb, high lean-gain pigs had increased ADG and gain to feed ratio compared to medium lean-gain pigs. Barrows had increased ADG and ADFI, but exhibited a poorer feed to gain ratio than gilts. Pigs fed .90% lysine had improved ADG compared to pigs fed .70% lysine. High lean-gain pigs had increased CP accretion and lipid accretion compared to medium lean-gain pigs. Similarly, gilts had increased CP accretion and decreased lipid accretion compared to barrows. Cumulative ADG (96 to 280 lb) was greater for high lean gain pigs, barrows, and pigs in the .90/.75% lysine regimen. Average daily feed intake was increased in barrows compared to gilts. Gilts had greater CP accretion than barrows. Crude protein accretion was greater in high lean gain pigs compared to medium lean-gain pigs, with high lean gain gilts having the greatest magnitude of response to increased dietary lysine. High lean-gain pigs exhibited greater growth performance and CP accretion compared to medium-lean pigs, with high lean-gain gilts offering the largest potential for maximized lean tissue accretion and improved lean efficiency.

(Key Words: Pigs, Lysine, Sex, Carcass Composition, Genotypes)

Introduction

The production of lean pork has become a major priority to the swine industry over the past 5 yrs. Increased market premiums for lean carcasses and decreased profit margins for fat, less efficient hogs have driven the industry towards leaner, more efficient hogs. Production is targeted at raising hogs with increased lean gain and improved lean efficiency. Lean gain is the rate at which muscle tissue is deposited as a function of time, and lean efficiency is the amount (lb) of feed required to deposit 1 lb of muscle tissue. Although these measurements are

[1]The authors wish to acknowledge Nutri-Quest and BioKyowa for partial financial and amino acid support for this project and Pig Improvement Co. Inc., Franklin, KY for partial financial support.

similar to ADG and the F/G ratio, they allow a producer to access the rate and efficiency of lean tissue produced instead of total (muscle, fat, and bone) weight gain. Muscle tissue is the marketable product and should be the emphasis of production analysis in the quest for improved production efficiency. Research has suggested that lean gain can be influenced by genotype, gender, and dietary lysine. Selection for decreased backfat and improved feed efficiency has resulted in pigs with increased lean gain potential. Within genotype, barrows typically exhibit a 5 to 6% increase in ADG and ADFI but poorer feed efficiency compared to gilts. By selecting for increased lean gain and by using split-sex feeding methods, the potential exists for increased dietary lysine to optimize lean growth. Thus, the objective of this experiment was to determine the interrelationship between genotype, sex, and dietary lysine effects on growth performance and protein accretion in finishing pigs fed to 230 and 280 lb.

Procedures

Animals. One hundred and twenty pigs (initially 96 lb) were used in a 2 × 2 × 2 factorial arrangement. Genetic comparisons were made between pigs previously characterized as having either high or medium lean gain potential by the procedures developed at Purdue University. Briefly, initial composition was determined by the following equation:

Initial muscle = -3.5 + (.44 × initial wt).

Hot carcass weight and 10th rib fat and loin depths were recorded to determine final composition by use of simple linear regression. Lean deposition per day was determined by the difference between final and initial composition divided by the number of days between the initial and final composition determinations. For a pig to be classified as high lean-gain, the lean growth rate must equal or exceed .75 lb/day of lean tissue per day. Medium lean-gain pigs have a lean deposition rate ranging from .50 to .75 lb/day. Within genotype, barrows and gilts were fed separately two dietary lysine regimens. Three pigs were housed per pen (15 ft × 4 ft pens with solid concrete flooring) in a open-fronted facility with five replicate pens per treatment. Drip coolers were activated when temperatures exceeded 80°F, cycling on for three out of every 15 min. Each pen contained a single hole self-feeder and a nipple waterer to accommodate ad libitum feed and water intake. Pig weights and feed disappearance were recorded at 14 d intervals to determine ADG, ADFI, and gain to feed ratio, until d 56 of the trial. From this point until the termination of the experiment, data were collected weekly. When the mean weight of pigs in a pen equalled or exceeded 230 lb, one pig from each pen was randomly selected and slaughtered for carcass analysis. The remaining two pigs were grown to a pen mean weight of 280 lb and then slaughtered for carcass analysis.

Diets. Two dietary regimes (Table 1) were used in this experiment based upon the dietary lysine estimates proposed by the University of Kentucky for high and medium lean-gain potential genotypes. Pigs were fed either a diet containing either.90 or .70% dietary lysine until a pen mean weight of 230 lb was achieved. At this point, dietary lysine was decreased to .75 and .55%, respectively. Dietary isoleucine, methionine + cystine, threonine, and tryptophan were maintained relative to lysine (Table 1) according to the ratio proposed by NRC (1988) for 110 to 240 lb finishing pigs. All other nutrient requirements met or exceeded NRC recommendations for 110 to 240 lb finishing pigs.

Results and Discussion

Growth Performance. Average daily gain was higher ($P<.01$) for pigs from the high lean gain genotype compared to pigs from the medium lean gain genotype when fed to 230 lb (Table 2). Within genotype, ADG was greater ($P<.05$) in barrows com-

pared to gilts, with increased dietary lysine (.90 vs .70%) improving (P<.01) ADG in both barrows and gilts. An interaction (P<.05) between genotype, sex, and dietary lysine existed during the period between 230 and 280 lb for ADG. Average daily gain was greatest in high lean-gain barrows fed a diet containing .75% dietary lysine with medium lean-gain gilts on the .55% dietary lysine diet having the poorest ADG (2.2 vs 1.6 lb, respectively). Cumulative ADG was higher (P<.01) for high lean-gain pigs compared to medium lean-gain pigs. Within genotype, ADG was increased (P<.05) in barrows compared to gilts and when dietary lysine was increased (P<.05). Genotype did not influence (P>.10) ADFI from 96 to 230 lb and from 230 to 280 lb, but ADFI was higher (P<.05) in high lean-gain pigs compared to medium lean-gain pigs for the entire growth period (96 to 230 lb). Average daily feed intake was greater (P<.05) for barrows from 96 to 230 lb and 230 to 280 lb compared to gilts. For the entire experiment, barrows consumed more (P<.01) feed than gilts regardless of genotype or dietary lysine. Gain to feed ratio (96 to 230 lb) was improved (P<.05) in the high lean-gain pigs compared to pigs from the medium lean-gain genotype. Lysine intake was higher (P<.01) for pigs fed increased dietary lysine and for barrows compared to gilts during all phases of the experiment.

Accretion Rates. A genotype by sex interaction (P<.05) was detected for moisture accretion in the 230 lb pigs. Moisture accretion increased at a greater magnitude in high lean-gain barrows compared to high lean gain gilts than in medium lean-gain barrows compared to gilts. Moisture, CP, and lipid accretion rates (Table 3) were increased (P<.01) in high lean gain pigs (334.15 vs 261.93 g/d, 118.17 vs 92.97 g/d and 272.26 vs 221.37 g/d, respectively) compared to medium lean gain pigs. Gilts had an increased (P<.01) CP accretion rate (114.26 vs 96.88 g/d, respectively) and a decreased (P<.01) lipid accretion rate (219.61 vs 274.02 g/d, respectively) compared to barrows. Feeding increased dietary lysine increased (P<.01) CP accretion rate regardless of genotype and gender (114.39 vs 96.75 g/d, respectively).

Moisture accretion was influenced (P<.01) by genotype, sex, and dietary lysine in the 280 lb pigs. Moisture accretion was maximized in high lean-gain barrows fed increased dietary lysine compared to medium lean-gain gilts fed low dietary lysine. Crude protein accretion (Table 3) was greater (P<.01) in high lean-gain pigs compared to medium lean-gain pigs (106.30 vs 89.65 g/d, respectively) and in gilts compared to barrows (106.53 vs 89.42 g/d, respectively). Conversely, lipid accretion was decreased (P<.05) in gilts compared to barrows (206.82 vs 264.20 g/d, respectively). Ash accretion rate was not influenced by treatment.

The results from this experiment indicate the differences between genotypes for growth performance and lean tissue accretion rate. The increased ADG in high lean-gain pigs corresponded to increased CP accretion compared to medium lean-gain pigs. Conversely, medium lean-gain pigs had a poorer ADG and CP accretion rate than the high lean-gain pigs even though feed intake was similar between the two genotypes. This can potentially be explained by poor feed efficiency from 96 to 230 lb and by an overconsumption of lysine/d (Table 3). Fat accretion was greater in high lean-gain pigs, which can potentially be explained by the increased ADG compared to medium lean gain pigs. Within genotype, barrows had increased ADG and ADFI with poorer feed efficiency compared to gilts. This response is typical of the differences detected between gilts and barrows. Both barrows and gilts in either genotype responded to increased dietary lysine. This response can be explained by the high ADFI recorded in all pigs, resulting in an increased lysine intake. High lean gain gilts had the greatest magnitude of response to increased dietary lysine, suggesting that the high lean-gain gilt may have a

greater dietary lysine requirement compared to high lean-gain barrows and medium lean gain barrows and gilts. Further research is required to determine lysine needs to optimize growth performance and protein accretion. However, this research emphasizes the need to select a genotype with a high rate and efficiency of lean gain in modern swine production.

Table 1. Diet Composition[a]

	Lysine, %			
Item, %	.90	.70	.75	
Corn	76.92	83.73	82.02	88.84
Soybean meal (48% CP)	20.79	13.83	15.57	8.62
Monocalcium phosphate	1.09	1.23	1.19	1.33
Limestone	.73	.74	.74	.74
Salt	.15	.15	.15	.15
Vitamin premix	.15	.15	.15	.15
Trace mineral premix	.10	.10	.10	.10
Lysine-HCl	.07	.07	.07	.07
Total	100.00	100.00	100.00	100.00
Chemical Analysis, %				
Isoleucine	.76	.60	.59	.49
Lysine	.97	.73	.73	.59
Methionine	.26	.25	.24	.22
Threonine	.63	.52	.50	.44
Tryptophan	.20	.15	.18	.14

[a]Pigs (3 pigs/pen) were fed diets containing either .90% or .70% dietary lysine until a pen mean weight equaled 230 lb. At this point one pig was slaughtered and the remaining two were fed either a .75% or .55% dietary lysine.

Table 2. The Effect of Genotype, Sex, and Dietary Lysine on Growth Performance in Pigs Fed to 230 and 280 lb[a]

	High-lean genotype				Medium-lean genotype				
	Barrows		Gilts		Barrows		Gilts		
Item	.90%[b]	.70%	.90%	.70%	.90%	.70%	.90%	.70%	CV
ADG, lb									
96-230 lb[cfg]	2.17	2.05	2.00	1.91	2.01	1.80	1.89	1.65	9.29
230-280 lb[i]	2.21	1.83	1.99	2.14	2.06	2.10	2.04	1.57	16.86
96-280 lb[cfh]	2.17	2.01	1.99	1.94	2.02	1.84	1.90	1.74	8.14
ADFI, lb									
96-230 lb[f]	6.85	6.62	6.12	6.33	6.68	6.11	6.36	5.60	8.65
230-280 lb[f]	9.83	8.58	8.30	8.40	9.33	9.30	8.59	8.09	12.04
96-280 lb[de]	7.50	6.97	6.58	6.68	7.19	6.53	6.40	6.20	6.88
F/G									
96-230 lb[d]	3.16	3.23	3.06	3.31	3.32	3.39	3.37	3.39	8.47
230-280 lb	4.45	4.69	4.17	3.93	4.53	4.43	4.21	5.15	15.22
96-280 lb	3.46	3.47	3.31	3.44	3.56	3.55	3.37	3.56	6.62
Lysine intake,									
96-230 lb[eg]	27.97	21.01	24.97	20.09	27.27	19.68	25.96	17.78	8.71
230-280 lb[eg]	33.43	21.41	28.24	20.95	31.74	23.19	29.23	20.19	11.47
96-280 lb[eg]	31.17	21.22	26.88	20.58	29.83	20.90	27.10	19.47	8.33

[a]A total of 120 pigs, 3 pigs/pen from 96-230 lb and 2 pigs/pen from 230-280 lb, 5 pens/treatment.
[b]A .90% or .70% dietary lysine was fed until a pen average of 230 lb was achieved. At this point one pig/pen was removed for slaughter with the remaining 2 pigs receiving .75% or .55% dietary lysine.
[c,d]Genotype effect ($P<.01$) and ($P<.05$), respectively.
[e,f]Sex effect ($P<.01$) and ($P<.05$), respectively.
[g,h]Dietary lysine effect ($P<.01$) and ($P<.05$), respectively.
[i]Genotype × sex × lysine interaction ($P<.05$).

Table 3. The Effect of Genotype, Sex, and Dietary Lysine on Moisture, CP, Lipid, and Ash Accretion Rates in Finishing Pigs Fed to Either 230 or 280 lb[a]

	High-lean genotype				Medium-lean genotype				
	Barrows		Gilts		Barrows		Gilts		
Item, g	.90[b]	.70	.90	.70	.90	.70	.90	.70	CV
96-230 lb									
Moisture[di]	363.7	356.7	325.3	290.9	289.3	190.9	301.4	266.1	23.4
CP[ceg]	115.9	105.3	131.9	119.5	102.2	64.1	107.5	98.1	16.0
Lipid[de]	334.1	278.3	238.8	237.9	249.6	324.1	213.7	188.1	23.9
Ash[d]	19.1	18.1	23.3	16.2	11.2	11.0	17.3	15.0	35.5
96-280 lb									
Moisture[ceg]	698.6	666.3	643.4	623.9	608.6	577.4	608.4	561.2	9.8
CP[ce]	99.7	91.7	115.8	118.1	81.1	85.4	100.4	91.8	13.2
Lipid[f]	319.0	258.2	218.0	178.6	245.0	234.5	234.9	195.8	28.9
Ash	19.4	17.7	20.8	15.4	18.9	18.9	18.5	16.6	27.7

[a]A total of 120 pigs, 3 pigs/pen from 96-230 lb and 2 pigs/pen from 230-280 lb, 5 pens/treatment.
[b]A .90% or .70% dietary lysine was fed until a pen average of 230 lb was achieved. At this point one pig/pen was removed for slaughter with the remaining 2 pigs receiving .75% or .55% dietary lysine.
[c,d]Genotype effect ($P<.01$) and ($P<.05$) respectively.
[e,f]Sex effect ($P<.01$) and ($P<.05$) respectively.
[g,h]Dietary lysine effect ($P<.01$) and ($P<.05$) respectively.
[i]Genotype by sex interaction ($P<.05$).