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Influence of dietary methionine on body weight gain and composition in high-lean growth gilts fed from 100 to 240 lb

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INFLUENCE OF DIETARY METHIONINE ON BODY WEIGHT GAIN AND COMPOSITION IN HIGH-LEAN GROWTH GILTS FED FROM 100 TO 240 Lb[1]

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Summary

One hundred-fourteen high-lean growth gilts (initial wt of 100 lb) were used to determine the level of digestible methionine required to optimize growth performance and carcass characteristics from 100 to 240 lb. The experiment was designed as a randomized complete block with blocks based on initial BW. Three pigs per pen and six pens per treatment were used. Gilts were fed a corn and soybean meal-based diet containing .21, .24, .27, .30, .33, or .36% digestible methionine (.25 to .425% total methionine) in both the grower and finisher periods. The grower diet (fed from 100 to 165 lb) was formulated to contain 1.17% total lysine (.94% digestible) and .52% cystine, whereas the finisher diet contained 1.01% total lysine (.83% digestible) and .49% cystine. Cornstarch was replaced by DL-methionine to provide the experimental methionine concentrations. Average daily gain, ADFI, and feed efficiency (F/G) were not influenced by increasing digestible methionine from 100 to 165 lb, 165 to 240 lb, or 100 to 240 lb. Neither average backfat thickness nor longissimus muscle area was influenced by increasing digestible methionine at 240 lb. From 100 to 240 lb, carcass protein and lipid accretion were not influenced by digestible methionine. The data from this experiment suggest that the methionine requirement for high-lean growth gilts is not greater than .25% total methionine (.21% digestible methionine; 6 g/d total methionine intake) from 100 to 240 lb. Thus, the required methionine:lysine ratios do not exceed 22 and 25% for high-lean growth gilts fed diets containing adequate cystine from 100 to 165 and 165 to 240 lb, respectively.

(Key Words: Pigs, Methionine, Sulfur Amino Acids, Genotype, Carcass Composition.)

Introduction

Efforts to develop ideal dietary amino acid patterns for swine have resulted in inconsistencies amongst the proposed patterns. One of the largest differences is in the estimate of methionine plus cystine:lysine ratio. Previous research at Kansas State University (Swine Day 1993) suggested that the ratio of methionine plus cystine:lysine increased as live weight increased. These results are consistent with research from the University of Illinois. However, feeding diets formulated on an ideal amino acid ratio did not indicate improved growth performance compared to pigs fed a corn-soybean meal-based diet. When the first four limiting amino acids (lysine, tryptophan, threonine, and methionine) were added to the diet, growth performance was similar to that of the corn-soybean meal-fed pigs, whereas backfat thickness was increased and longissimus muscle area was decreased. Considering the greater dietary lysine requirement for high-lean growth pigs, the objective of this experiment was to determine the dietary methionine requirement for maximum growth

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performance and carcass protein accretion rate in high-lean growth gilts.

Procedures

Animals. A growth assay was conducted using 114 high-lean growth gilts (Pig Improvement Co., L326, Franklin, KY; initial wt of 100 lb) fed one of six dietary methionine levels. The gilts (55 lb) were delivered to the Kansas State University Swine Teaching and Research Center and were fed a corn-soybean meal diet containing 1.15% total lysine (.97% digestible lysine) until they weighed 100 lb. Three pigs were housed per pen (4.6 m × 1.2 m pens) with solid flooring in an open-fronted building, with six replicate pens per treatment. The trial was conducted from August to November, 1993. When temperatures exceeded 80°F, drip coolers were activated to wet the pigs for 3 of every 15 min. Each pen contained a single-hole self-feeder and a nipple waterer to allow ad libitum access to feed and water. Pig weights and feed consumption were measured weekly to determine ADG, ADFI, and feed:gain ratio (F/G). Methionine, methionine + cystine, and lysine intakes were calculated based on analyzed dietary values.

Diet Formulation. Control diets fed from 100 to 165 lb (grower) and 165 to 240 lb (finisher) were formulated to contain 1.10 and 1.00% total lysine, respectively (.95 and .83% digestible lysine, respectively). These lysine levels were selected based on the results of Friesen et al. (Swine Day, 1993). DL-methionine replaced cornstarch to provide the five additional experimental treatments ranging from .21 to .36% digestible methionine (.25 to .425% total methionine; Table 1). Total cystine was .52 and .49% for the grower and finisher diets, respectively. Choline chloride was added at .05% (176 mg/lb added choline) to all diets. The essential amino acid concentrations were set using an ideal amino acid ratio in an attempt to make methionine the first limiting amino acid. The dietary ME was increased in all diets to 1,550 kcal/lb by the addition of soybean oil, so that the lysine:ME ratios equaled 3.4 and 2.9 g/Mcal for the grower and finisher diets, respectively. All other nutrients either met or exceeded NRC (1988) estimates for the 40- to 110-lb pig.

Carcass Characteristics. Carcasses were weighed immediately following slaughter and reweighed 24 h postmortem to record hot and chilled carcass weights, respectively. Dressing percentage was determined from live weight and hot carcass weight. The heart, liver, kidneys, and kidney fat were removed and weighed. Backfat thickness was measured at the first rib, last rib, and last lumbar vertebrae from both the right and left sides of the carcass. All six measurements were used to calculate the average backfat thickness. Tenth-rib fat depth was measured at 3/4 the length from the midline of the longissimus muscle. Longissimus muscle area at the 10th rib was traced, and the area calculated using a planimeter. Carcass color, firmness, and marbling were scored using a five-point scale developed by NPPC (1991). Muscling scores were based on a three-point NPPC (1991) scale.

Carcass Composition. Six gilts were selected randomly for slaughter at 100 lb, and the right side of each carcass was ground to determine initial empty body composition (percentage of moisture, CP, lipid, and ash). The ground carcass tissue was analyzed. When the mean weight of pigs in a pen reached approximately 240 lb, one pig from each pen (six pigs per treatment) was selected randomly and slaughtered for carcass analysis. The head, leaf fat, and viscera were removed at slaughter and were not included in determination of carcass tissue accretion rates. At 24 h postmortem, the right side of each carcass was ground once through a .40-mm plate and once through a .25-mm plate, then homogenized for 3 min in a ribbon-paddle mixer. From the chemical analysis, amounts of CP, lipid, ash, and DM were determined for each carcass based upon chilled carcass weight. Chemical components (DM, CP, lipid, and ash) from the initial six gilts were averaged and expressed as percentages of carcass weight. Tissue accretion rates were calculated as the difference between final (240 lb) and initial (100

lb) carcass content divided by the days on test.

Results

Growth Performance. Average daily gain, ADFI, and F/G were not influenced (P>.10) by dietary methionine throughout the entire experiment (Table 2). Increased digestible methionine resulted in greater (linear, P<.01) methionine and methionine + cysteine intakes from 100 to 165 lb, 165 to 240 lb, and 100 to 240 lb. From 100 to 240 lb, lysine intake tended to increase (quadratic, P<.08) as digestible methionine increased from .21 to .36%. However, dietary methionine did not influence (P>.10) lysine intake from 165 to 240 lb and from 100 to 240 lb.

Carcass Characteristics. High-lean growth gilts slaughtered at 240 lb had similar (P>.10) live weight at slaughter and hot and chilled carcass weights regardless of digestible methionine level (Table 3). However, dressing percentage tended to decrease and then increase (quadratic, P<.09) as digestible methionine increased. Average backfat thickness and 10th rib fat depth were not influenced (P>.10) by digestible methionine. Longissimus muscle area was not significantly influenced (P>.10) by dietary methionine. Carcass length and kidney fat content at different levels of digestible methionine were similar (P>.10). Carcass moisture, CP, and lipid contents were not influenced (P>.10) as digestible methionine increased. Carcass ash content decreased (quadratic, P<.10) as digestible methionine increased. Carcass muscle score and longissimus marbling and color scores were similar (P>.10) across digestible methionine levels. However, carcass firmness scores tended to decrease (linear, P<.09) as digestible methionine increased.

Tissue Accretion Rates. For the entire experiment from 100 to 240 lb, moisture accretion increased (quadratic, P<.08) as digestible methionine increased. Crude protein, lipid, and ash accretion rates were not influenced by digestible methionine (P>.10).

Discussion

The results of this experiment do not support the concept that high-lean growth gilts require greater dietary methionine to attain maximum carcass protein deposition. Research investigating the "ideal protein" concept has speculated that the requirement for methionine plus cystine relative to lysine increases with body weight. However, these two amino acids are used preferentially in higher proportions for body maintenance rather than lean tissue synthesis. Research evaluating amino acid requirements suggests that body maintenance does not account for a large portion of the total amino acid needed in growing-finishing pigs.

In this experiment, dietary cystine was fed in excess of the pigs' requirement. Thus, this excess may have masked the potential response to dietary methionine in high-lean growth gilts. Further research is necessary to determine the methionine requirement when cystine is neither deficient nor in excess.

These data demonstrate that the methionine requirement for high-lean growth gilts is not greater than .25% total methionine (.21% digestible methionine; 6.4 g/d total methionine) for maximum carcass protein gain from 100 to 240 lb. Thus, the methionine:lysine ratios do not exceed 22 and 25% for high-lean growth gilts fed diets containing adequate cystine from 100 to 165 lb and 165 to 240 lb, respectively. However, further research is necessary to establish the cystine and total sulfur amino acid requirements for maximum protein deposition in high-lean growth gilts.

Table 1. Basal Diet Composition (as Fed Basis)[a]

Item, %	100 to 165 lb	165 to 240 lb
Corn	76.03	76.57
Soybean meal (48% CP)	14.34	14.21
Porcine plasma, spray-dried	2.50	2.50
L-lysine-HCl	.40	.25
L-cystine	.15	.145
L-threonine	.20	.11
L-tryptophan	.05	.03
L-valine	.08	--
L-isoleucine	.06	--
Soybean oil	3.00	3.00
Monocalcium phosphate (21% P)	1.38	1.38
Limestone	.91	.91
Salt	.30	.30
Choline chloride (60%)	.05	.05
Cornstarch	.15	.15
Trace mineral premix[b]	.15	.15
Vitamin premix[c]	.25	.25
Total	100.00	100.00

[a]DL-methionine replaced cornstarch at .7 lb increments in the complete diet to give the following total methionine concentrations: .25, .285, .32, .355, .39, and .425%.

Table 2. The Effect of Dietary Methionine on Growth Performance of High-Lean Gilts[a]

	Digestible methionine, %						Probability (P<)		
Item	.21	.24	.27	.30	.33	.36	Linear	Quadratic	CV
ADG, lb									
100 to 165 lb	1.96	1.89	1.96	1.89	1.91	1.91	.80	.83	10.35
165 to 240 lb	1.87	1.94	2.05	1.80	1.85	1.87	.49	.55	9.08
100 to 240 lb	1.91	1.91	1.98	1.89	1.89	1.91	.80	.80	8.06
ADFI, lb									
100 to 165 lb	4.91	4.42	5.06	4.58	4.73	5.04	.45	.21	8.50
165 to 240 lb	6.56	6.49	6.58	6.47	6.73	6.51	.90	.94	10.53
100 to 240 lb	5.68	5.39	5.79	5.50	5.68	5.72	.58	.63	7.37
F/G									
100 to 165 lb	2.51	2.34	2.51	2.42	2.48	2.51	.43	.92	11.34
165 to 240 lb	3.51	3.35	3.35	3.59	3.52	3.41	.49	.90	12.84
100 to 240 lb	2.97	2.78	2.97	2.97	3.01	2.99	.45	.88	8.27
Methionine intake, g									
100 to 165 lb	5.6	5.7	7.4	7.4	8.4	9.7	.01	.12	7.96
165 to 240 lb	7.4	8.5	9.6	10.5	12.0	12.6	.01	.84	9.58
100 to 240 lb	6.4	7.0	8.4	8.9	10.1	11.1	.01	.58	6.76
Met + Cys intake, g									
100 to 165 lb	16.3	15.4	18.4	17.4	18.7	20.7	.01	.17	8.23
165 to 240 lb	19.9	20.0	21.7	21.5	23.1	23.9	.01	.64	7.54
100 to 240 lb	18.0	17.6	20.0	19.4	20.8	22.2	.01	.33	6.79
Lysine intake, g									
100 to 165 lb	25.0	23.2	26.4	23.9	24.7	26.4	.78	.08	8.72
165 to 240 lb	28.4	29.7	30.0	29.4	30.7	29.6	.79	.44	11.56
100 to 240 lb	26.4	26.2	28.1	26.5	27.6	27.8	.90	.92	8.28

[a]A total of 108 pigs, three pigs per pen from 100 to 165 lb and two pigs per pen from 165 to 240 lb; six replicate pens per treatment.

Table 3. The Effect of Dietary Methionine on Carcass Characteristics, Composition, and Quality in High-Lean Growth Gilts Slaughtered at 240 lb[a]

	Digestible methionine, %						Probabilities (P<)		
Item	.21	.24	.27	.30	.33	.36	Linear	Quadratic	CV
Live wt, lb	240.2	242.8	244.0	244.4	245.4	245.2	.39	.65	3.2
Hot carcass wt, lb	177.5	176.0	179.1	180.4	176.9	181.8	.29	.82	3.8
Cold carcass wt, lb	174.5	172.5	175.8	176.9	173.4	178.6	.30	.72	3.7
Dressing percentage	73.9	72.5	73.4	73.8	72.1	74.2	.65	.09	2.9
Average backfat thickness, in	1.0	1.0	1.0	.9	.9	1.0	.97	.28	11.0
Tenth rib fat depth, in	1.0	1.0	1.1	.9	1.0	1.0	.70	.81	17.2
Longissimus muscle area, in^2	5.6	5.7	5.9	6.3	5.8	5.9	.36	.19	9.7
Carcass length, in	31.9	31.7	31.3	31.9	31.8	31.7	.88	.49	2.3
Kidney fat, lb	2.3	1.9	3.0	2.5	2.2	2.4	.77	.26	29.4
Carcass Composition, %									
Moisture	60.2	63.1	60.4	65.8	65.1	61.7	.19	.11	5.3
CP (N × 6.25)	17.9	17.3	17.3	17.0	17.0	17.1	.11	.34	5.7
Lipid	18.0	15.9	19.1	14.1	14.5	17.8	.48	.30	23.9
Ash	3.6	3.5	3.2	3.2	3.2	3.7	.81	.10	14.0
Quality									
Muscle score[b]	2.6	2.6	2.4	2.5	2.4	2.5	.48	.63	15.2
Marbling[c]	2.0	2.2	2.1	2.5	1.9	2.3	.65	.77	33.0
Color[c]	2.3	2.7	2.6	2.5	2.3	2.4	.65	.43	22.1
Firmness[c]	2.8	3.0	2.6	2.7	2.4	2.5	.09	.92	20.9
Tissue accretion, g/d									
Moisture	376	414	393	422	441	391	.24	.08	9
CP	120	114	117	104	110	111	.20	.37	12
Lipid	157	138	145	105	118	157	.59	.16	39
Ash	24	23	21	19	19	24	.66	.12	25

[a]Calculated from 36 pigs at a pen mean weight of 240 lb, one pig/pen, six pigs/treatment.
[b]Carcasses were evaluated on a three-point scale ranging from thin muscling (1) to extremely thick muscling (3).
[c]Loins were evaluated on a five-point scale according to NPPC (1991) procedures.