DIETARY LYSINE REQUIREMENTS OF SEGREGATED EARLY-WEANED PIGS[1]

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Summary

A total of 320 (160 barrows and 160 gilts) 14- to 18-d-old pigs (initially 10.2 ± 2.2 lb) was used to determine the optimal level of dietary lysine needed for the segregated early-weaned pig. Two diet formulation methods were used with six dietary lysine levels within each formulation method, resulting in a 2 × 6 factorial arrangement of treatments. The first formulation method consisted of a basal diet that contained 1.95% lysine. Increasing levels of cornstarch replaced L-lysine to achieve the other five dietary treatments (1.2, 1.35, 1.50, 1.65, and 1.80% dietary lysine). All other amino acids in each diet were maintained at the same level as in the 1.95% lysine treatment. The second formulation method consisted of a basal diet (1.2% lysine) with the five additional treatments achieved by adding synthetic lysine and other essential amino acids to maintain an ideal amino acid ratio, relative to lysine. All diets contained 20% dried whey, 10% lactose, 7.5% spray-dried porcine plasma, 5.0% spray-dried wheat gluten, 5.0% select menhaden fish meal, 5.0% soybean oil, and 1.75% spray-dried blood meal. No lysine × formulation method interactions occurred for average daily gain (ADG) or average daily feed intake (ADFI) throughout the 28 d period. However, lysine × formulation method interactions were observed for feed efficiency (F/G) from d 0 to 7, d 0 to 14, and d 0 to 28. From d 0 to 7 postweaning, ADG was improved quadratically as dietary lysine increased and appeared to be maximized at 1.65% dietary lysine. Feed efficiency was lowest for pigs fed 1.80% lysine for the first diet formulation method and for pigs fed 1.95% lysine for the second diet formulation method. From d 0 to 14 postweaning, ADG and F/G were improved by increasing dietary lysine, with both response criteria maximized in pigs fed approximately 1.65% dietary lysine. However, ADFI was not affected during the 28-d experiment. These data suggest that segregated early-weaned pigs require approximately 5.2 and 6.2 g/d of lysine from d 0 to 7 and d 0 to 14 postweaning, respectively, to optimize growth performance. Based on these results, the diet for pigs < 11 lb needs to be formulated to contain at least 1.7% lysine. The transition diet (11 to 15 lb) should be formulated to contain approximately 1.5 to 1.6% lysine.

(Key Words: Pigs, Lysine, Requirements, Segregated Early Weaning.)

Introduction

Research from Iowa State University has demonstrated that segregated early-weaned pigs of high health status have higher lysine requirements than pigs with conventional health status. However, experimental lysine levels used ranged from .60% to 1.80% with increasing levels of .30%, and the level of soybean meal was altered within each diet. From this research, it is hard to determine the appropriate lysine requirement needed in a high nutrient dense diet.

[1]Appreciation is expressed to Global Ventures, Pipestone, MN, for providing the pigs used in this research.

As seen in that research, formulating experimental diets to evaluate the lysine requirement in this age of pig poses some unique problems. In older pigs, corn-soybean meal ratios generally are altered to increase the dietary lysine concentration, and other amino acids are set using an ideal amino acid ratio to assure that lysine is the first limiting amino acid. However, this method is not practical when dealing with early-weaned pigs because of the delayed-type hypersensitivity reaction seen with high levels of soybean meal. Therefore, to more appropriately define the lysine requirements of early-weaned pigs, two different formulation methods were used. The first formulation method was designed to evaluate different lysine levels with all other amino acids held constant. All other amino acids were set to be above their projected requirements based on the highest level of dietary lysine. The second formulation used a basal diet, to which lysine and other synthetic amino acids were added in a ratio relative to lysine to provide the additional treatments. This procedure was used to minimize excess amino acids and to prevent amino acid imbalances from occurring. In short, if the ratio of other amino acids relative to lysine is important for maximizing growth performance, the first method of formulation would tend to overestimate the lysine requirement. However, if utilization of high levels of synthetic amino acids limits pig performance, the second formulation method might underestimate lysine requirements.

Procedures

A total of 320 (160 barrows and 160 gilts) 14 to 18-d old pigs was blocked by weight and allotted to one of 12 dietary treatments. There were four pigs per pen, with a total of six pens per treatment. Two diet formulation methods were used for this experiment and six dietary lysine levels for each diet formulation method, resulting in a 2 × 6 factorial arrangement. The first method consisted of formulating a basal diet that contained 1.95% lysine. Increasing levels of cornstarch replaced L-lysine HCl to achieve the other five dietary treatments (1.2, 1.35, 1.50, 1.65, and 1.80% dietary lysine). All other amino acids in each diet were maintained at the same level as in the 1.95% lysine treatment. The second method consisted of formulating diets using the digestible ratios proposed to maintain ideal amino acid ratios in all diets. The appropriate ratios were met by increasing the levels of synthetic amino acids in each diet (Table 1). The first method of formulation might tend to overestimate the lysine requirement because the diets containing the higher level of lysine will be approaching the appropriate amino acid ratio. The second method of formulation might tend to underestimate the lysine requirement because of possible decreased utilization of high levels of synthetic amino acids used in the diets containing higher levels of lysine. All diets contained 20% dried whey, 10% lactose, 7.5% spray-dried porcine plasma, 5.0% spray-dried wheat gluten, 5.0% select menhaden fish meal, 5.0% soybean oil, and 1.75% spray-dried blood meal.

Pigs were housed in an environmentally controlled nursery in which the temperature was maintained at approximately 94°F for the first week of the trial and lowered approximately 3°F per week to maintain pig comfort. Pens were 4 ft × 4 ft, with slatted metal flooring and contained a four-hole self-feeder and one nipple waterer to allow ad libitum access to food and water. Pigs were weighed and feed disappearance was determined on d 7, 14, 21, and 28 to calculate ADG, ADFI, and F/G.

Data were analyzed as a randomized complete block design with pen as the experimental unit. Pigs were blocked on the basis of initial weight. Analysis of variance was performed using the GLM procedure of SAS, and linear and quadratic polynomials were evaluated.

Results

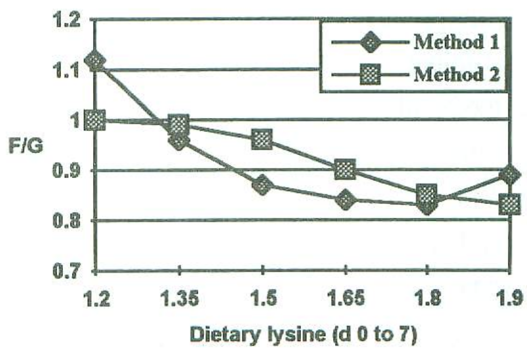
No lysine × formulation method interactions were observed for ADG or ADFI throughout the 28 d period (Table 2). However, lysine × formulation method interactions were observed for F/G during d 0 to 7, d 0 to 14, and d 0 to 28. Because of these interactions, data are presented for each diet formulation separately. From d 0 to 7 postweaning, ADG was improved (quadratic, P<.01) as dietary lysine increased, with ADG appearing to be maximized between 1.65 and 1.80% dietary lysine. Feed efficiency, from d 0 to 7 postweaning, was improved quadratically (P<.01) and linearly (P<.01) for the first and second diet formulations, with feed efficiency lowest for pigs fed 1.80% lysine for the first diet formulation method and for pigs fed 1.95% lysine for the second diet formulation method. From d 0 to 14 postweaning, ADG was improved (quadratic, P<.01) by increasing dietary lysine and was maximized at approximately 1.65% dietary lysine. A lysine × formulation method interaction was observed for F/G from d 0 to 14 with F/G being improved quadratically (P<.01) and linearly (P<.01) for the first and second diet formulations. For the overall experiment (d 0 to 28 postweaning), ADG and F/G were both improved (quadratic, P<.01) with increasing dietary lysine. However, ADFI was not affected during the 28-d experiment.

Discussion

Results from this experiment suggest that the dietary lysine requirement for the segregated early-weaned pig is greater than current National Research Council estimations. The NRC (1988) estimate for the 11 to 22 lb pig is 1.15% lysine. Also, the NRC (1988) suggests that a pig of this weight requires 5.3 g/d of lysine to support expected ADG, ADFI, and F/G of .55 lb, 1.01 lb, and 1.84, respectively. From d 0 to 14 postweaning (where pigs covered the weight range of 10.2 to 22.2 lb), approximately 6.2 g/d of lysine was required to support ADG, ADFI, and F/G of .88 lb, .84 lb, and .96, respectively. The performance of pigs in this research clearly shows the benefits of a segregated early-weaning program.

Average daily feed intake was not influenced by dietary lysine for the 28-d experiment. However, pigs in this research consumed 17% less feed than NRC estimates. Therefore, the increase in dietary lysine over NRC estimates may have been a function of lower feed intake and also a greater lysine need for protein deposition, because pigs of high health status generally have lower protein catabolism. Also, pigs used in this research were considerably younger at 10 lb when compared to pigs used to set the current NRC requirements. Thus, health and genetic potential will dictate the lysine requirement to optimize growth performance of segregated early-weaned pigs.

A lysine × formulation method interaction was observed for F/G for the 28-d experiment. This may have been the result of different utilization of the synthetic amino acids used in the two different diet formulation methods. In the first formulation method, amino acid imbalances may have occurred in pigs fed the lower lysine levels. As dietary lysine increased, the amino acid imbalances perhaps were minimized, resulting in improved efficiency. With the second formulation method, each diet had the same ratio of other amino acids relative to lysine. Use of this formulation method should have avoided amino acid imbalances. However, data suggest that a higher lysine content was needed to reach maximum feed efficiency with this formulation procedure. This response is depicted in the following graph.



These data suggest that segregated early-weaned pigs require approximately 5.2 to 6.2 g/d of lysine from d 0 to 7 and d 0 to 14 postweaning to optimize growth performance. Formulation method had little influence on the response to dietary lysine. However, changes in feed efficiency suggest changes in nitrogen utilization with high levels of excess amino acids (formulation method #1) or high levels of synthetic amino acids (formulation method #2). Based on these results, the diet for pigs < 11 lb needs to be formulated to contain at least 1.7% lysine. The transition diet (11 to 15 lb) should be formulated to contain approximately 1.5 to 1.6% lysine.

Table 1. Composition of Experimental Diets

	Formulation 1[a]	Formulation 2[b], Lysine, %					
Item,	1.20 Lysine, %	1.20	1.35	1.50	1.65	1.80	1.95
Corn	38.93	39.23	39.23	39.23	39.23	39.23	39.23
Dried whey	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Lactose	10.00	10.00	10.00	10.00	10.00	10.00	10.00
SD porcine plasma	7.50	7.50	7.50	7.50	7.50	7.50	7.50
SD wheat gluten	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Soybean oil	5.00	5.00	5.00	5.00	5.00	5.00	5.00
SD blood meal	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Monocalcium P	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Antibiotic[c]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Cornstarch	.95	2.50	2.17	1.67	1.18	.59	.003
SBM, 46.5%	.52	.20	.20	.20	.20	.20	.20
L-isoleucine	.45		.09	.18	.270	.360	.454
L-threonine	.39		.001	.098	.196	.293	.391
Zinc oxide	.38	.38	.38	.38	.38	.38	.38
Limestone	.30	.30	.30	.30	.30	.30	.30
Vitamin premix	.25	.25	.25	.25	.25	.25	.25
Trace mineral premix	.15	.15	.15	.15	.15	.15	.15
DL-methionine	.21		.032	.078	.124	.17	.215
L-cystine	.20		.019	.064	.109	.154	.199
L-valine	.20					.096	.201
L-trypthophan	.10			.025	.052	.079	.106
L-lysine HCl	.002	.014	.204	.394	.585	.775	.965
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[a]Diet formulation #1 consisted of L-lysine replacing cornstarch to provide 1.35, 1.50, 1.65, 1.80, and 1.95% dietary lysine levels.
[b]Diet formulation #2 consisted of L-lysine, L-isoleucine, L-threonine, DL-methionine, L-cystine, L-valine, and L-trypthophan replacing cornstarch to maintain the same amino acid ratios relative to lysine within each dietary lysine level.
[c]Provided 50 g/ton carbodox.

Table 2. Performance of Pigs (16 ± 2 D) Fed Increasing Levels of Dietary Lysine with Two Diet Formulation Techniques[a]

	Formulation #1 Dietary Lysine, %						Formulation #2 Dietary Lysine, %						
Item	1.20	1.35	1.50	1.65	1.80	1.95	1.20	1.35	1.50	1.65	1.80	1.95	CV
d 0 to 7													
ADG, lb[bc]	.56	.67	.73	.75	.77	.71	.61	.70	.74	.77	.76	.83	12.2
ADFI, lb	.63	.64	.63	.62	.63	.63	.61	.69	.71	.69	.64	.68	11.0
F/G[def]	1.12	.96	.87	.84	.83	.89	1.00	.99	.96	.90	.85	.83	7.9
d 0 to 14													
ADG, lb[bc]	.63	.76	.82	.86	.86	.87	.73	.80	.84	.90	.87	.89	9.1
ADFI, lb	.81	.84	.82	.81	.82	.84	.84	.89	.91	.87	.84	.86	9.2
F/G[def]	1.29	1.10	.99	.95	.96	.97	1.15	1.11	1.08	.97	.98	.97	5.8
d 0 to 28													
ADG, lb[bc]	.88	1.03	1.08	1.09	1.08	1.09	.98	1.04	1.09	1.07	1.10	1.11	5.6
ADFI, lb	1.28	1.27	1.24	1.24	1.23	1.28	1.27	1.29	1.29	1.24	1.27	1.29	6.6
F/G[defg]	1.46	1.24	1.15	1.13	1.13	1.17	1.30	1.23	1.18	1.16	1.15	1.16	3.9

[a]Means represent a total of 320 pigs (average weight = 10.2 lb) with 4 pigs per pen and 6 replications per treatment. Pigs were 14 to 18 d of age and were PIC (L26 × C15).
[b]Quadratic effect of increasing dietary lysine ($P<.01$).
[c]Linear effect of increasing dietary lysine ($P<.01$).
[d]Lysine × formulation method interaction ($P<.01$)
[e]Linear effect of increasing dietary lysine for formulations 1 and 2 ($P<.01$).
[f]Quadratic effect on increasing dietary lysine for formulation 1 ($P<.01$).
[g]Quadratic effect on increasing dietary lysine for formulation 2 ($P<.01$).