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M. B. Menegat
Department of Diagnostic Medicine/Pathobiology, Kansas State University, mbmenegat@ksu.edu

C. M. Vier
Kansas State University, Manhattan, carinevier@k-state.edu

S. S. Dritz
Kansas State University, Manhattan, dritz@k-state.edu

See next page for additional authors

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Authors

M. B. Menegat, C. M. Vier, S. S. Dritz, M. D. Tokach, J. C. Woodworth, J. M. DeRouchey, and R. D. Goodband

Evaluation of Phase Feeding Strategies and Lysine Specifications for Grow-Finish Pigs on Growth Performance and Carcass Characteristics[1]

M.B. Menegat,[2] C.M. Vier,[2] S.S. Dritz,[2] M.D. Tokach, J.C. Woodworth, J.M. DeRouchey, and R.D. Goodband

Summary

The objective of this study was to compare phase feeding strategies for grow-finish pigs using the estimated lysine requirements for optimal growth and feed efficiency compared to a standard strategy. A total of 1,188 pigs (PIC 359 × 1050; initially 61.5 lb BW) were used in a randomized complete block design with 27 pigs per pen and 11 pens per treatment. The treatments consisted of: MAX, a 4-phase feeding program with lysine levels for maximum growth (1.13, 0.96, 0.82, and 0.77% SID Lys in Phases 1 to 4, respectively); STD, a standard 4-phase feeding program for optimal income over feed cost (1.02, 0.87, 0.76, and 0.67% SID Lys in Phases 1 to 4, respectively); STD/MAX, a 4-phase feeding program based on standard lysine levels in early finishing and lysine levels for maximum growth in late finishing (1.02, 0.87, 0.82, and 0.77% SID Lys in Phases 1 to 4, respectively); and 2-PHASE, a 2-phase feeding program based on the average estimated lysine requirements for maximum growth with 0.96% SID lysine for Phases 1 to 3 and 0.77% SID lysine during Phase 4. The four phases were from approximately 60 to 110, 110 to 160, 160 to 220, and 220 to 280 lb, respectively. The experimental diets were based on corn, distillers dried grains with solubles, and soybean meal. Lysine levels were achieved by manipulating the ratio of corn to soybean meal. Overall, from d 0 to 117, pigs fed the 2-PHASE regimen had increased ADG ($P < 0.05$) compared to pigs fed the STD regimen, and feeding either the MAX or STD/MAX regimen resulted in intermediate ADG. There was no evidence for differences in ADFI, F/G, or final BW among dietary regimens. Also, no evidence for differences was observed across the dietary treatments for the carcass traits HCW, yield, backfat, loin depth, or lean percentage. For economics, the STD feeding program resulted in the lowest ($P < 0.001$) feed cost per pig and feed cost per lb of gain compared to the other 3 programs. Revenue and income over feed costs per pig were similar across the feeding programs. In conclusion, feeding lysine levels for maximum growth and efficiency in either a 2- or 4-phase feeding program results in the same growth performance and feed

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[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

cost. A broad range of lysine specifications within the levels tested herein can be utilized in grow-finish diets without compromising income over feed cost.

Introduction

The optimal concentration of nutrients required by growing pigs generally decreases over the growing-finishing period with a phase feeding program used as an attempt to meet the needs of the pigs over the changing requirements. Thus, in commercial production, phase feeding is thought to improve economics and reduce nitrogen excretion by more closely meeting the pig's nutrient requirements compared to feeding fewer phases.[3] However, in practice, it is challenging to accurately estimate feed intake and consequently deliver the optimal concentration of nutrients required for growth at each stage of the finishing period. Therefore, it is important to understand the biological and economic implications of feeding below, at, or above the nutritional requirements.

Establishing the dietary lysine requirement is the core component of developing feeding strategies for growing-finishing pigs. Lysine is the first limiting amino acid in typical swine diets and is therefore involved in optimal growth and lean deposition.[4] Approaches to estimate the lysine requirement with prediction equations have been focused on either maximizing growth rate and feed efficiency,[5] or optimizing income over feed cost.[6,7] The objective of this study was to compare phase feeding strategies for grow-finish pigs and determine their effects on growth performance, carcass characteristics, and economics.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at a commercial research facility in southwestern Minnesota. The barn was naturally ventilated and double-curtain-sided. Each pen was equipped with a 4-hole stainless steel dry self-feeder and a cup waterer for ad libitum access to feed and water. Feed additions to each individual pen were made and recorded by a robotic feeding system (FeedPro, Feedlogic Corp., Wilmar, MN).

A total of 1,188 pigs (PIC 359 × 1050; initially 61.5 lb BW) were used in a 117-d growth trial with 27 pigs per pen and 11 pens per treatment. Pigs were allotted to treatments based on initial BW in a randomized complete block design.

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[3] Han, I. K., Lee, J. H., Kim, J. H., Kim, Y. G., Kim, J. D., and Paik, I. K. 2000. Application of phase feeding in swine production. J Appl Anim Res. 17:27-56.
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[6] Main, R.G., Dritz, S. S., Tokach, M. D., Goodband, R. D., and Nelssen, J. L. 2008. Determining an optimum lysine:calorie ratio for barrows and gilts in a commercial finishing facility. J Anim Sci. 86: 2190–2207.
[7] Tokach, M. D., DeRouchey, J. M., Dritz, S. S., Goodband, R. D., and Nelssen, J. L. 2012. Amino acid requirements of growing pigs. Proceedings of Swine Profitability Conference, Manhattan, KS.

The treatments consisted of different phase feeding programs based on the estimated lysine requirements for maximal growth rate and feed efficiency[5] or for optimal income over feed cost (IOFC) adapted from Tokach et al.[7] The equations used to estimate SID lysine requirement of finishing gilts in g/Mcal NE were: $0.00006 \times BW^2$, lb - $0.0291 \times BW$, lb + 6.6894 for maximum growth[5] and $-0.00000015 \times BW^3$, lb + $0.00010 \times BW^2$, lb - $0.0304 \times BW$, lb + 6.0435 for optimal IOFC (adapted from Tokach et al., 2012[7]).

The treatments were arranged in a 1-way treatment structure: MAX, a 4-phase feeding program with lysine levels for maximum growth (1.13, 0.96, 0.82, and 0.77% SID Lys in Phases 1 to 4, respectively); STD, a standard 4-phase feeding program to optimize IOFC (1.02, 0.87, 0.76, and 0.67% SID Lys in Phases 1 to 4, respectively); STD/MAX, a 4-phase feeding program based on standard lysine levels in early finishing and lysine levels for maximum growth in late finishing (1.02, 0.87, 0.82, and 0.77% SID Lys in Phases 1 to 4, respectively); and 2-PHASE, a 2-phase feeding program based on the average estimated lysine requirements for maximum growth during the first three phases with 0.96% SID lysine fed during Phases 1, 2, and 3 (d 0 to 81) and 0.77% SID lysine fed during Phase 4 (d 81 to 117). Phases 1 to 4 were fed from d 0 to 25, 25 to 53, 53 to 81, and 81 to 117, respectively, which corresponded to body weights of approximately 60 to 110, 110 to 160, 160 to 220, and 220 to 280 lb, respectively (Table 1).

The diets were based on corn, distillers dried grains with solubles, and soybean meal (Table 2). Lysine levels in experimental diets were achieved by manipulating the ratio of corn to soybean meal while keeping the amount of L-Lys HCl constant within phases. Diet samples from each phase were taken from 6 feeders per dietary treatment 3 d after the beginning and 3 d before the end of each phase and stored at -4°F. Composite samples were homogenized, subsampled, and analyzed for DM, CP, ADF, NDF, ether extract, Ca, and P (Ward Laboratories Inc., Kearney, NE). Composite samples were additionally analyzed for CP, Ca, and P by Midwest Laboratories (Omaha, NE) and the average estimates between the laboratories were reported.

Pens of pigs were weighed and feed disappearance measured on d 0, 12, 25, 40, 53, 68, 81, 95, and 117 to determine ADG, ADFI, and F/G. On d 95, the 3 heaviest pigs in each pen were weighed and marketed according to the farm marketing strategy. On d 117, final pen weights were taken and pigs were tattooed with a pen identification number and transported to a USDA-inspected packing plant (JBS Swift and Co., Worthington, MN) for processing and carcass data collection. Carcass measurements included HCW, backfat, loin depth, and lean percentage. Percentage lean was calculated from plant proprietary equation. Carcass yield was calculated by dividing the pen average HCW by the pen average final live weight obtained at the farm.

For the economic analysis, feed cost per pig, feed cost per lb of gain, revenue per pig, and IOFC were calculated on a pen basis. Corn was valued at $3.30/bu ($118/ton), soybean meal at $290/ton, distillers dried grains with solubles at $94/ton, L-lysine at $0.75/lb, DL-methionine at $1.30/lb, L-threonine at $1.10/lb, and L-tryptophan at $4.75/lb. Feed cost per pig was calculated by multiplying the feed cost per lb by ADFI and by the number of days in each phase, then adding up the values of each phase. Feed cost per lb of gain was calculated by dividing the feed cost per pig by the overall weight gain.

Revenue was obtained by multiplying carcass gain by an assumed value of $70 per cwt of carcass. The IOFC was calculated by subtracting the feed cost per pig from revenue per pig.

Data were analyzed using a linear mixed model with treatment as fixed effect, block as random effect, and pen as the experimental unit. Hot carcass weight was used as a covariate for analyses of backfat, loin depth, and lean percentage. Statistical models were fitted using the GLIMMIX procedure of SAS version 9.4 (SAS Institute Inc., Cary, NC). Results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

The analyzed DM, CP, ADF, NDF, ether extract, Ca, and P content of experimental diets (Table 3) were consistent with formulated estimates.

In Phase 1 (d 0 to 25), ADG increased ($P = 0.001$) in pigs fed the MAX or STD feeding programs compared to the 2-PHASE diet. This response was associated with the higher lysine levels in MAX and STD diets compared to the 2-PHASE diet (1.13% and 1.02% vs. 0.96% SID Lys, respectively). Although the STD/MAX pigs received the same lysine level as STD in this phase (1.02% SID Lys), ADG was intermediate. Average daily feed intake was lower ($P = 0.001$) in the 2-PHASE feeding program compared to all other treatments. Feed efficiency was marginally improved ($P = 0.063$) in MAX-fed pigs compared to STD/MAX, with STD and 2-PHASE intermediate. At the end of Phase 1, BW was increased ($P = 0.002$) in pigs under MAX or STD regimens compared to the 2-PHASE diet, with pigs fed the STD/MAX regimen being intermediate.

In Phase 2 (d 25 to 53), ADG increased ($P = 0.005$) in pigs fed the 2-PHASE feeding program compared to STD and STD/MAX, with MAX intermediate. This response was due to the higher lysine levels in the 2-PHASE diet compared to STD and STD/MAX diets (0.96% vs. 0.87% SID Lys, respectively) during this Phase. Although there was no evidence for difference in ADFI, F/G was improved ($P < 0.001$) in the 2-PHASE-fed pigs compared to all other treatments. The improvement in F/G associated with 2-PHASE diet, even compared to MAX diet that was formulated with the same lysine level (0.96%), can possibly be explained by a compensatory growth improvement following the poor performance of 2-PHASE pigs in Phase 1. There was no evidence for differences in BW at the end of Phase 2.

In Phase 3 (d 53 to 81), ADG and F/G were improved ($P < 0.01$) in pigs under the 2-PHASE feeding program compared to MAX and STD regimens due to the higher lysine levels in the 2-PHASE diet (0.96% vs. 0.82% and 0.76% SID Lys, respectively). Compensatory growth benefits were observed in pigs fed the STD/MAX regimen, with similar ADG and F/G as 2-PHASE regimen even though the lysine level was lower in STD/MAX diet compared to the 2-PHASE diet (0.82% vs. 0.96% SID Lys, respectively). There was no evidence for differences in ADFI in this phase. Body weight was increased ($P = 0.029$) in pigs under 2-PHASE regimen compared to STD, with MAX and STD/MAX regimens intermediate.

In Phase 4 (d 81 to 117), there was no evidence for differences in ADG and F/G across the treatments. Average daily feed intake was marginally increased ($P = 0.051$) in pigs fed 2-PHASE feeding program compared to STD, while MAX and STD/MAX were intermediate.

Overall (d 0 to 117), pigs fed the 2-PHASE feeding program had increased ($P = 0.048$) ADG compared to pigs fed the STD regimen. Feeding either the MAX or STD/MAX regimen, i.e. a 4-phase feeding program for maximum growth or a combination of STD lysine levels in early finishing and lysine levels for maximum growth in late finishing, resulted in intermediate ADG. There was no evidence for differences in ADFI, F/G, or final BW across the treatments in the overall period. Also, no evidence for differences was observed across the dietary treatments for the carcass traits HCW, yield, backfat, loin depth, or lean percentage.

For economics, the STD feeding program resulted in the lowest ($P < 0.001$) feed cost per pig and feed cost per lb of gain. Revenue and IOFC per pig were similar across the feeding programs.

The results of this study demonstrate that feeding lysine levels for maximum growth of finishing pigs in either a 2- or 4-phase feeding program (2-PHASE or MAX, respectively) results in the same overall growth performance and feed cost. These results allow for the possibility of using fewer feeding phases in the grow-finish phase, which may have practical advantages for feed manufacture, storage, and delivery. From the economic standpoint, lower feed cost per lb of gain was achieved by feeding the STD program. Feeding STD lysine levels in early finishing and MAX levels in late finishing (STD/MAX) resulted in a similar feed cost as a full maximum-growth program (MAX). This result was not expected because, according to Main,[8] pigs fed lysine-deficient diets in early finishing, and at the estimated lysine requirement in late finishing, have lower feed cost per lb of gain compared to pigs fed at the estimated lysine requirement in both early and late finishing. However, it is noteworthy that in the present study none of the diets were considerably below the estimated lysine requirement in early finishing.

In conclusion, feeding lysine levels for maximum growth and efficiency in either a 2- or 4-phase feeding program results in the same growth performance and feed cost. A broad range of lysine specifications within the levels tested herein can be utilized in grow-finish diets without compromising income over feed cost.

[8] Main, R.G., Dritz, S. S., Tokach, M. D., Goodband, R. D., and Nelssen, J. L. 2008. Determining an optimum lysine:calorie ratio for barrows and gilts in a commercial finishing facility. J Anim Sci. 86:2190–2207.

Table 1. Description of feeding phases and lysine levels of experimental diets[1,2]

Phase:	1				2			
Duration, d:	0 to 25				25 to 53			
Weight range, lb:	60 to 110				110 to 160			
	MAX	STD	STD/MAX	2-Phase	MAX	STD	STD/MAX	2-Phase
SID Lys, %	1.13	1.02	1.02	0.96	0.96	0.87	0.87	0.96
SID Lys:ME, g/Mcal	3.42	3.08	3.08	2.89	2.89	2.62	2.62	2.89
SID Lys:NE, g/Mcal	4.61	4.12	4.12	3.84	3.84	3.46	3.46	3.84

Phase:	3				4			
Duration, d:	53 to 81				81 to 117			
Weight range, lb:	160 to 220				220 to 280			
	MAX	STD	STD/MAX	2-Phase	MAX	STD	STD/MAX	2-Phase
SID Lys, %	0.82	0.76	0.82	0.96	0.77	0.67	0.77	0.77
SID Lys:ME, g/Mcal	2.46	2.28	2.46	2.89	2.29	1.99	2.29	2.29
SID Lys:NE, g/Mcal	3.24	2.98	3.24	3.84	3.00	2.59	3.00	3.00

[1] Dietary treatments were: MAX, a 4-phase feeding program with lysine levels for maximum growth; STD, a standard 4-phase feeding program for optimal IOFC; STD/MAX, a 4-phase feeding program based on standard lysine levels in early finishing and for maximum growth in late finishing; and 2-PHASE, a 2-phase feeding program.

[2] The equations used for lysine requirement estimates for finishing gilts in g/Mcal NE were: $0.00006 \times BW^2$, lb - $0.0291 \times BW$, lb + 6.6894 for maximum growth (PIC, 2016); and $-0.00000015 \times BW^3$, lb + $0.00010 \times BW^2$, lb - $0.0304 \times BW$, lb + 6.0435 for optimal IOFC (adapted from Tokach et al., 2012).

Table 2. Composition of experimental diets (as-fed basis)[1,2]

	Phase 1				Phase 2			
Item	MAX	STD	STD/ MAX	2-Phase	MAX	STD	STD/ MAX	2-Phase
Ingredient, %								
Corn	47.54	51.98	51.98	54.73	54.74	58.34	58.34	54.73
DDGS[3]	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Soybean meal, 47% CP	19.09	14.60	14.60	12.13	12.13	8.46	8.46	12.13
Tallow	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Monocalcium phosphate	0.20	0.25	0.25	0.05	0.05	0.10	0.10	0.05
Limestone	1.28	1.30	1.30	1.20	1.20	1.23	1.23	1.20
Sodium chloride	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
L-Lys HCl	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DL-Met	0.02	---	---	---	---	---	---	---
L-Thr	0.09	0.08	0.08	0.09	0.08	0.08	0.08	0.09
L-Trp	0.03	0.03	0.03	0.05	0.04	0.04	0.04	0.05
VTM premix[4]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[5]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis								
SID amino acids, %								
Lys	1.13	1.02	1.02	0.96	0.96	0.87	0.87	0.96
Ile:Lys	63	62	62	62	62	61	61	62
Leu:Lys	161	168	168	173	173	180	180	173
Met:Lys	30	30	30	31	31	32	32	31
Met and Cys:Lys	57	57	57	59	59	61	61	59
Thr:Lys	62	62	62	64	63	63	63	64
Trp:Lys	18.9	18.5	18.5	19.8	18.7	18.9	18.9	19.8
Val:Lys	74	74	74	75	75	76	76	75
Total Lys, %	1.32	1.19	1.19	1.13	1.13	1.03	1.03	1.13
ME, kcal/lb	1,500	1,500	1,500	1,506	1,506	1,507	1,507	1,506
NE, kcal/lb	1,112	1,123	1,123	1,133	1,133	1,142	1,142	1,133
SID Lys:ME, g/Mcal	3.42	3.08	3.08	2.89	2.89	2.62	2.62	2.89
SID Lys:NE, g/Mcal	4.61	4.12	4.12	3.84	3.84	3.46	3.46	3.84
CP, %	21.4	19.6	19.6	18.6	18.6	17.1	17.1	18.6
Ca, %	0.60	0.60	0.60	0.53	0.53	0.53	0.53	0.53
P, %	0.52	0.51	0.51	0.46	0.46	0.45	0.45	0.46
Available P, %	0.36	0.37	0.37	0.32	0.32	0.33	0.33	0.32

continued

Table 2, *continued*. Composition of experimental diets (as-fed basis)[1,2]

	Phase 3				Phase 4			
Item	MAX	STD	STD/ MAX	2-Phase	MAX	STD	STD/ MAX	2-Phase
Ingredient, %								
Corn	60.50	62.93	60.50	54.73	81.14	85.18	81.14	81.14
DDGS[3]	30.00	30.00	30.00	30.00	---	---	---	---
Soybean meal, 47% CP	6.41	3.96	6.41	12.13	16.05	11.97	16.05	16.05
Tallow	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Monocalcium phosphate	---	---	---	0.05	0.25	0.30	0.25	0.25
Limestone	1.20	1.23	1.20	1.20	0.95	0.95	0.95	0.95
Sodium chloride	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
L-Lys HCl	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.25
DL-Met	---	---	---	---	0.02	0.01	0.02	0.02
L-Thr	0.08	0.07	0.08	0.09	0.07	0.06	0.07	0.07
L-Trp	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02
VTM premix[4]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[5]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis								
SID amino acids, %								
Lys	0.82	0.76	0.82	0.96	0.77	0.67	0.77	0.77
Ile:Lys	61	60	61	62	64	63	64	64
Leu:Lys	186	193	186	173	154	163	154	154
Met:Lys	33	34	33	31	30	30	30	30
Met and Cys:Lys	63	65	63	59	58	60	58	58
Thr:Lys	64	64	64	64	65	65	65	65
Trp:Lys	19.9	19.7	19.9	19.8	19.5	19.8	19.5	19.5
Val:Lys	76	77	76	75	73	74	73	73
Total Lys, %	0.97	0.91	0.97	1.13	0.88	0.76	0.88	0.88
ME, kcal/lb	1,510	1,510	1,510	1,506	1,524	1,525	1,524	1,524
NE, kcal/lb	1,149	1,155	1,149	1,133	1,164	1,174	1,164	1,164
SID Lys:ME, g/Mcal	2.46	2.28	2.46	2.89	2.29	1.99	2.29	2.29
SID Lys:NE, g/Mcal	3.24	2.98	3.24	3.84	3.00	2.59	3.00	3.00
CP, %	16.3	15.3	16.3	18.6	13.6	12.0	13.6	13.6
Ca, %	0.50	0.50	0.50	0.53	0.45	0.45	0.45	0.45
P, %	0.42	0.41	0.42	0.46	0.38	0.37	0.38	0.38
Available P, %	0.30	0.30	0.30	0.32	0.21	0.22	0.21	0.21

[1] Diets were fed ad libitum in meal form from 61.5 to 284.6 lb BW. Phases 1, 2, 3, and 4 were fed from 60 to 110 lb, 110 to 160 lb, 160 to 220 lb, and 220 lb to marketing, respectively.
[2] Lysine levels in experimental diets were achieved by manipulating the ratio of corn to soybean meal.
[3] DDGS = distillers dried grains with solubles.
[4] Vitamin and trace mineral premix provided per lb of diet: 111 ppm Zn, 111 ppm Fe, 33 ppm Mn, 17 ppm Cu, 0.33 ppm I, 0.30 ppm Se, 2,400 IU vitamin A, 600 IU vitamin D, 12 IU vitamin E, 1.2 mg vitamin K, 22.5 mg niacin, 7.5 mg pantothenic acid, 2.25 mg riboflavin, and 10.5 µg vitamin B_{12}.
[5] Optiphos 2000 (Huvepharma Inc, Peachtree City, GA) provided 91 FTU per lb of diet.

Table 3. Chemical analysis of experimental diets (as-fed basis)[1]

	Phase 1				Phase 2			
Item	MAX	STD	STD/ MAX	2-Phase	MAX	STD	STD/ MAX	2-Phase
Proximate analysis, %[2]								
DM	88.4	87.5	87.9	89.1	87.4	88.7	88.1	88.4
CP	19.0	17.3	17.9	17.7	18.2	17.6	16.1	16.5
ADF	6.3	6.1	5.1	5.6	6.0	5.9	5.5	5.4
NDF	13.7	11.8	11.4	11.8	12.9	12.5	11.2	11.2
Ether extract	5.4	5.0	4.7	5.2	4.8	4.9	5.0	4.5
Ca	0.67	0.80	0.76	0.64	0.87	0.73	0.70	0.91
P	0.50	0.49	0.47	0.46	0.47	0.51	0.45	0.41

	Phase 3				Phase 4			
Item	MAX	STD	STD/ MAX	2-Phase	MAX	STD	STD/ MAX	2-Phase
Proximate analysis, %[2]								
DM	88.7	88.8	89.0	89.6	87.8	88.4	87.5	87.8
CP	15.1	14.4	15.7	16.5	13.1	11.0	12.2	12.4
ADF	6.2	5.4	6.0	5.7	3.1	2.9	3.7	3.5
NDF	12.6	11.3	13	11.6	5.6	5.4	5.3	5.7
Ether extract	5.1	5.0	5.3	5.1	3.5	3.5	3.1	3.4
Ca	0.59	0.81	0.62	0.62	0.62	0.56	0.63	0.55
P	0.44	0.40	0.43	0.42	0.34	0.33	0.34	0.34

[1] Diet samples from each phase were taken from 6 feeders per dietary treatment throughout the study. Composite samples were homogenized, and subsampled for analysis.

[2] Composite samples were submitted to Ward Laboratories Inc. (Kearney, NE) for proximate analysis. Composite samples were additionally analyzed for CP, Ca, and P by Midwest Laboratories (Omaha, NE) and the average estimates between the laboratories were reported.

Table 4. Effect of phase feeding strategies using different lysine specifications on growth performance, carcass characteristics, and economics of grow-finish pigs[1,2,3]

Item	MAX	STD	STD/MAX	2-PHASE	SEM
BW, lb					
d 0	61.5	61.5	61.5	61.5	1.75
d 25	108.9[a]	108.0[ab]	106.7[bc]	105.8[c]	2.17
d 53	162.7	160.4	159.9	161.8	2.37
d 81	220.7[ab]	216.8[b]	219.4[ab]	222.6[a]	2.48
d 117	286.1	280.4	285.3	286.3	2.40
d 0 to 25					
ADG, lb	1.89[a]	1.86[a]	1.82[ab]	1.76[b]	0.025
ADFI, lb	3.64[a]	3.63[a]	3.59[a]	3.46[b]	0.061
F/G	1.93[b]	1.95[ab]	1.99[a]	1.96[ab]	0.018
d 25 to 53					
ADG, lb	1.92[ab]	1.87[b]	1.88[b]	1.99[a]	0.024
ADFI, lb	4.68	4.62	4.60	4.57	0.056
F/G	2.44[a]	2.47[a]	2.45[a]	2.29[b]	0.024
d 53 to 81					
ADG, lb	2.04[bc]	2.01[c]	2.10[ab]	2.15[a]	0.022
ADFI, lb	5.68	5.59	5.67	5.77	0.061
F/G	2.79[a]	2.78[ab]	2.70[bc]	2.68[c]	0.028
d 81 to 117					
ADG, lb	1.88	1.82	1.87	1.85	0.033
ADFI, lb	5.94[ab]	5.79[b]	5.99[ab]	6.06[a]	0.067
F/G	3.16	3.20	3.20	3.28	0.048
d 0 to 117					
ADG, lb	1.93[ab]	1.88[b]	1.92[ab]	1.94[a]	0.014
ADFI, lb	5.06	4.98	5.02	5.04	0.048
F/G	2.62	2.64	2.63	2.60	0.019

continued

Table 4, *continued*. Effect of phase feeding strategies using different lysine specifications on growth performance, carcass characteristics, and economics of grow-finish pigs[1,2,3]

Item	MAX	STD	STD/MAX	2-PHASE	SEM
Carcass characteristics					
HCW, lb	207.7	204.4	207.3	208.5	1.79
Carcass yield, %	72.6	72.9	72.6	72.8	0.15
Backfat, in.[4]	0.65	0.67	0.67	0.67	0.012
Loin depth, in.[4]	2.69	2.69	2.66	2.70	0.022
Lean, %[4]	57.0	56.6	56.6	56.7	0.22
Economics, $ per pig[5]					
Feed cost	47.99[a]	45.38[b]	47.05[a]	48.23[a]	0.44
Feed cost per lb gain[6]	0.212[a]	0.206[b]	0.210[a]	0.213[a]	0.001
Revenue[7]	113.07	110.80	112.77	113.65	0.98
IOFC[8]	65.08	65.42	65.72	65.43	0.83

[1] A total of 1,188 pigs (PIC 359 × 1050; initially 61.5 lb BW) were used with 27 pigs per pen and 11 pens per treatment.

[2] Dietary treatments were: MAX, a 4-phase feeding program with lysine levels for maximum growth; STD, a standard 4-phase feeding program for optimal IOFC; STD/MAX, a 4-phase feeding program based on standard lysine levels in early finishing and for maximum growth in late finishing; and 2-PHASE, a 2-phase feeding program.

[3] Means with different superscripts are significantly different ($P < 0.05$) in the row.

[4] Adjusted for HCW.

[5] Corn was valued at $3.30/bu ($118/ton), soybean meal at $290/ton, distillers dried grains with solubles at $94/ton, and L-lysine at $0.75/lb.

[6] Feed cost per lb gain = feed cost per pig ÷ overall gain per pig.

[7] Revenue = (HCW × $0.70) – (d 0 BW × 0.75 × $0.70).

[8] Income over feed cost = revenue – feed cost.