Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 525

1993

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Abstract

Two experiments were conducted to determine the effects of nutrient concentrations and complexity of ingredients used in nursery diets on growth performance to market weight. In Experiment 1, nursery regimens were: 1) simple ingredients/low lysine (corn-soybean meal-dried whey-based diet with 1.25% lysine for d 0 to 23 and a corn-soybean meal-based diet with 1.1% lysine for d 23 to 37) and 2) complex ingredients/ high-lysine (blood products, lactose, and other specialty ingredients with 1.5% lysine for d 0 to 9 and 1.25% lysine for d 9 to 23, and a corn-soybean meal-based diet with 1.1% lysine for d 23 to 37). In general, feed intake and rate of gain were increased for pigs fed the complex/high-lysine regimen. This improved performance resulted in an average advantage of 5 lb/pig at the end of the nursery phase. For the growing-finishing phase, pigs from the simple/low-lysine and complex/high-lysine nursery regimens were assigned to either a 2-step (.8 and .6% lysine to 150 and 250 lb, respectively) or 4-step (.95, .8, .75, and .6% lysine to 100, 150, 200, and 250 lb, respectively) regimen and fed to a market wt of 250 lb. Pigs fed the 4-step regimen had greater rate of gain, but there was no complementary effect of the complex high-lysine regimen in the nursery phase with the 4-step regimen in the growing- finishing phase. We should note, however, that there was also no compensatory response of the pigs fed the simple/lowlysine diet in the nursery phase when given either the 2-step or 4-step regimen during growing-finishing. The net result was that the 5 lb difference at the end of the nursery phase resulted in an additional 3.6 d required for pigs fed the simple/low-lysine regimen to reach a market wt of 250 lb. In Experiment 2, the same diet regimens were used except that a third diet, with 1.5% lysine (resulting from adding wheat gluten and crystalline lysine) was added to the simple nursery regimen. Pigs fed the complex nursery regimen generally had greater feed intake and rate of gain, resulting in a 3 lb/pig advantage at the end of the nursery phase. As in Experiment 1, there were no nursery regimen Ã— grow-finish regimen interactions that would indicate compensatory gain, with 1.8 additional days required to reach the 250 lb market weight for pigs fed the simple nursery regimen. In conclusion, the combined results of both experiments indicated that for each 1 lb advantage at the end of the nursery phase, days to a market wt of 250 lb were reduced by .6 to .7 d.; Swine Day, Manhattan, KS, November 18,1993

Keywords

Swine day, 1993; Kansas Agricultural Experiment Station contribution; no. 94-194-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 695; Swine; Compensatory gain; Diet complexity; Grow-finish; Lysine; Nursery

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EFFECTS OF NURSERY DIETS ON GROWTH OF PIGS TO MARKET WEIGHT

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Summary

Two experiments were conducted to determine the effects of nutrient concentrations and complexity of ingredients used in nursery diets on growth performance to market weight. In Experiment 1, nursery regimens were: 1) simple ingredients/low lysine (corn-soybean meal-dried whey-based diet with 1.25% lysine for d 0 to 23 and a corn-soybean meal-based diet with 1.1% lysine for d 23 to 37) and 2) complex ingredients/high-lysine (blood products, lactose, and other specialty ingredients with 1.5% lysine for d 0 to 9 and 1.25% lysine for d 9 to 23, and a corn-soybean meal-based diet with 1.1% lysine for d 23 to 37). In general, feed intake and rate of gain were increased for pigs fed the complex/high-lysine regimen. This improved performance resulted in an average advantage of 5 lb/pig at the end of the nursery phase. For the growing-finishing phase, pigs from the simple/low-lysine and complex/high-lysine nursery regimens were assigned to either a 2-step (.8 and .6% lysine to 150 and 250 lb, respectively) or 4-step (.95, .8, .75, and .6% lysine to 100, 150, 200, and 250 lb, respectively) regimen and fed to a market wt of 250 lb. Pigs fed the 4-step regimen had greater rate of gain, but there was no complementary effect of the complex/high-lysine regimen in the nursery phase with the 4-step regimen in the growing-finishing phase. We should note, however, that there was also no compensatory response of the pigs fed the simple/low-lysine diet in the nursery phase when given either the 2-step or 4-step regimen during growing-finishing. The net result was that the 5 lb difference at the end of the nursery phase resulted in an additional 3.6 d required for pigs fed the simple/low-lysine regimen to reach a market wt of 250 lb.

In Experiment 2, the same diet regimens were used except that a third diet, with 1.5% lysine (resulting from adding wheat gluten and crystalline lysine) was added to the simple nursery regimen. Pigs fed the complex nursery regimen generally had greater feed intake and rate of gain, resulting in a 3 lb/pig advantage at the end of the nursery phase. As in Experiment 1, there were no nursery regimen × grow-finish regimen interactions that would indicate compensatory gain, with 1.8 additional days required to reach the 250 lb market weight for pigs fed the simple nursery regimen. In conclusion, the combined results of both experiments indicated that for each 1 lb advantage at the end of the nursery phase, days to a market wt of 250 lb were reduced by .6 to .7 d.

(Key Words: Compensatory Gain, Diet Complexity, Grow-finish, Lysine, Nursery.)

Introduction

During the last decade, much research has been focused on phase-feeding programs for swine. The concept of phase feeding dictates use of multiple diets to better match the continuously changing nutrient needs of growing pigs. If done properly, such systems ensure adequate intake of essential nutrients, yet minimize nutrient excesses that are of no benefit to the pigs, add cost to diets, and end as excess nutrients excreted into the environment.

Current recommendations for phase-feeding programs commonly range from two

to four diets used in the nursery and from two to five diets used in the growing-finishing period. Obviously, use of many diets requires more storage facilities for ingredients and diets and careful management to ensure that pigs are given the appropriate diet for each phase of growth. Furthermore, multi-phase feeding programs typically are formulated to maximize growth performance with use of high quality (and expensive) ingredients, such as edible grade milk products and highly refined blood products. Thus, many producers question the return on investment of time and money unless these improvements result in fewer days to market, greater rate and efficiency of gain, and improved carcass merit.

The experiments reported herein were designed to determine the effects of a highly fortified, multiple-phase feeding program on growth performance from weaning through finishing and on carcass leanness in market hogs. Special attention was given to the effects of nutritional regimen during the nursery phase (i.e., high nutrient density diets vs simple diets) on subsequent growth performance during the grow-finish phase.

Procedures

In Experiment 1, 224 weanling pigs were used. There were seven pigs/pen and 16 pens/treatment in the 37-d nursery assay. Diet treatments were: 1) simple ingredients/low-lysine diet formulation (corn-soybean meal-dried whey-based diet with 1.25% lysine for d 0 to 23 and a corn-soybean meal-based diet with 1.1% lysine for d 23 to 37) and 2) complex ingredients/ high-lysine diet formulation (spray-dried blood products, lactose, and other specialty ingredients with 1.5% lysine for d 0 to 9 and 1.25% lysine for d 9 to 23, and a corn-soybean meal-based diet with 1.1% lysine for d 23 to 37). All nursery diets were fed in pelleted form. These diet regimens were fed to pigs that had been divided into four weight groups (light, heavy-light, light-heavy, and heavy), such that the overall treatment design was a 2 × 4 factorial with main effects of diet regimen and initial weight group.

The pigs were housed in 4 ft × 5 ft pens with woven-wire flooring. Room temperatures were 90, 87, 84, 80, and 75°F for weeks 1 to 5, respectively. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. The pigs were weighted on d 9, 23, and 37 of the experiment to allow calculation of average daily gain (ADG), average daily feed intake (ADFI), and feed/gain (F/G).

At the end of the nursery assay, the 16 pens from the middle two weight groups (i.e., heavy-light and light-heavy) were moved to a modified open-front finishing building (112 pigs total) and assigned to finishing treatments. The pigs were housed seven/pen with four pens per treatment. Each pen was 6 ft × 16 ft, with a two-hole self-feeder and nipple waterer to allow ad libitum consumption of feed and water. The finishing treatments were: 1) 2-step regimen (.8 and .6% lysine to 150 and 250 lb, respectively) and 2) 4-step regimen (.95, .8, .7, and .6% lysine to 100, 150, 200, and 250 lb, respectively). The diets for the growing-finishing period were fed in meal form. The combination of nursery treatment and finishing treatment yielded a 2 × 2 factorial arrangement, with main effects of simple vs complex nursery regimen and 2- vs 4-step finishing regimen.

As the average weight of pigs in each pen reached 250 lb, the pigs were scanned for fat depth at the last rib. Fat depth was adjusted to a common live weight by using the formula: fat depth ÷ live wt × overall avg live wt.

For Experiment 2, 160 pigs were used. There were five pigs/pen and 16 pens/treatment in the 35-d nursery assay. Diet treatments were: 1) simple diet formulation (corn-soybean meal-wheat gluten-dried whey-based diet with 1.5% lysine for d 0 to 7, corn-soybean meal-dried whey-based diet with 1.25% lysine for d 7 to 21, and a corn-soybean meal-based diet with 1.1% lysine for d 21 to 35) and 2) the same complex diet formulation used in Experiment 1. These two diet regimens were fed to pigs that

had been divided into four weight groups, such that the treatment design was a 2 × 4 factorial as in Experiment 1. Housing and management were the same as in Experiment 1, except that the pigs and feeders were weighed on d 7, 21, and 35 of the experiment.

At the end of the nursery assay, the two pens of each treatment with the greatest initial body weights were pooled, and this process was repeated with the next two pens for each treatment, and so on, so that 16 pens of 10 pigs were generated from the original 32 nursery pens. These 16 pens were moved to the finishing building and fed the same diet regimens used in Experiment 1, with the same housing and management procedures. Thus, the treatment design for the finishing phase was a 2 × 2 factorial, with main effects of simple vs complex nursery regimen and 2- vs 4-step finishing regimen. As in Experiment 1, the study was terminated for each pen when the pigs averaged 250 lb.

Results and Discussion

For Experiment 1, ADG, ADFI, and F/G were improved (P<.01) by feeding the complex diet vs the simple/low-lysine diet. Also, ADFI was less and efficiency of gain was greater for the smaller vs the larger pigs (i.e., linear effect of initial weight, P<.01). These responses were not completely independent, however, because ADG and ADFI showed a marked improvement as initial weight was increased for pigs fed the simple/low-lysine regimen vs much smaller increases in ADG and ADFI as initial weight was increased for pigs fed the complex regimen (diet complexity × quadratic effect of initial wt interactions, P<.10 and P<.05, respectively).

For d 9 to 23, d 23 to 37, and overall, pigs fed the complex regimen continued to eat more feed (P<.01) and have greater ADG (P<.05) than pigs fed the simple/ low-lysine regimen. Note, however, that the heaviest groups of pigs given the simple/low-lysine regimen had ADFI and ADG similar to those of the contemporary weight block fed the complex regimen. This indicates that, for the pigs with a weaning weight of 15 lb, the diet with a great variety of expensive ingredients was probably not necessary. However, this does not negate the marked improvement in growth performance of the smaller pigs when fed the complex regimen compared to the simple/low-lysine. Thus on average, pigs fed the complex diet regimen had a 5 lb/pig advantage in body wt at the end of the nursery phase compared to those fed the simple/low-lysine regimen.

For growing-finishing, there were few effects of nursery or growing-finishing diet regimen. Pigs given the complex regimen in the nursery phase had greater initial weights (P<.01), but this did not result in greater growth performance in the finishing phase. However, the 5 lb/pig advantage at the end of the nursery phase for these pigs was maintained, resulting in 3.6 fewer days required to reach the 250 lb slaughter weight.

Pigs fed the 4-step finishing regimen had 3% greater (P<.10) ADG than pigs fed the 2-step regimen. We should note, however, that this response was consistent for pigs given the complex and simple/low-lysine regimens (i.e., no nursery regimen × finishing regimen interaction). Thus, there was no compensatory growth for lost performance in the nursery phase.

For Experiment 2, the diets were again formulated with and without the complex mixture of dried blood products, fishmeal, yeast product, and flavor. However, for the simple diet regimen, wheat gluten, crystalline lysine, and additional soybean meal were used to bring the initial diet to the same lysine concentration (1.5%) as used in the complex ingredient regimen.

As in Experiment 1, pigs responded to the complex regimen with greater ADFI and ADG throughout most of the nursery phase. It is important to note that even from d 21 to 35, when the pigs were consuming the same phase III diet, ADFI and ADG were greater (P<.05) for pigs initially fed the more complex diet. Thus, the early response (d 0 to 7 and d 7 to 21) to improved nutritional status

was still having an effect in the last 14 d of the nursery period. The response to the complex regimen yielded a 3 lb/pig advantage at the end of the nursery phase, which was less than observed in Experiment 1. However, remember that in Experiment 1, the simple regimen initially had a low concentration of lysine (i.e., 1.25%).

For the growing-finishing phase of Experiment 2, ADG was actually decreased slightly (P<.10) by feeding the 4-step regimen vs the 2-step regimen. This occurred primarily from the unexpectedly poor performance of pigs given the complex nursery regimen and the 4-step growing-finishing regimen. This response is probably an artifact in the data. In contrast with ADG, efficiency of gain was increased by 8% for pigs fed the 4-step regimen. Nursery regimen did not affect growth performance in the finishing phase, but the 3 lb advantage at the end of the nursery phase resulted in 1.8 fewer d needed to reach market weight.

In conclusion, nursery pigs responded to improved nutritional status resulting from both nutrient concentrations and ingredients used in the diet. That improved performance in the nursery phase resulted in fewer days to market, such that for every 1 lb advantage at the end of the nursery phase, approximately .6 to .7 d less was needed to reach a market weight of 250 lb. This value is considerably less than the 1 lb of nursery body wt = 3 d less to market reported by some researchers. Nonetheless, our data do indicate that compensatory gain during growing-finishing did not negate the advantages achieved during the nursery-phase. The question then becomes whether the economic benefits of 2 to 3 fewer days to market compensate for the additional costs of a complex nursery diet regimen.

Table 1. Diet Composition for the Nursery Phases of Experiments 1 and 2[a]

	Simple			Complex		
Item	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III
Corn	27.05	42.31	64.30	34.79	45.62	64.30
Soybean meal	25.05	30.30	28.90	15.02	24.61	28.90
Fishmeal	–	–	–	2.00	–	–
Plasma protein	–	–	–	7.50	–	–
Blood meal	–	–	–	2.50	2.50	–
Wheat gluten	10.00	–	–	–	–	–
Whey	20.00	20.00	–	20.00	20.00	–
Lactose	10.00	–	–	10.00	–	–
Choice white grease	3.00	3.00	3.00	3.00	3.00	3.00
Dicalcium phosphate	2.20	1.88	1.98	2.07	1.98	1.98
Limestone	.45	.61	.60	.27	.56	.60
Salt	.20	.20	.30	–	.10	.30
KSU vitamin premix	.25	.25	.25	.25	.25	.25
KSU mineral premix	.15	.15	.15	.15	.15	.15
KSU selenium premix	.05	.05	.05	.05	.05	.05
Lysine-HCl	.50	.10	.12	–	–	.12
Methionine	–	–	–	.05	.03	–
Copper sulfate	.10	.10	.10	.10	.10	.10
Antibiotics[b]	1.00	1.00	.25	1.00	1.00	.25
Pellet binder	–	.05	–	.05	.05	–
Yeast culture	–	–	–	1.00	–	–
Probiotic flavor	–	–	–	.20	–	–
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analyses						
CP, %	23.4	19.6	18.5	21.05	19.6	18.5
Lysine, %	1.50	1.25	1.10	1.50	1.25	1.10
Ca, %	.9	.9	.8	.9	.9	.8
P, %	.8	.8	.7	.8	.8	.7

[a]For Experiment 1, pigs were given the phase II diet for d 0 to 23 and the phase III diet for d 23 to 35 to give the simple/low-lysine treatment. For Experiment 2, all three diets were used for both the simple and complex regimens.
[b]Apralan in phases I and II diets and Mecadox in phase III.

Table 2. Diet Composition for the Growing-Finishing Phases of Experiments 1 and 2

	Lysine, %[a]			
Item	.95	.80	.70	.60
Sorghum	71.40	76.45	80.70	83.70
Soybean meal	25.40	20.25	16.50	13.50
Monocalcium phosphate	1.35	1.45	1.05	1.05
Limestone	.95	.95	.95	.95
Salt	.30	.30	.30	.30
KSU vitamins premix	.25	.25	.25	.25
KSU minerals premix	.10	.10	.10	.10
KSU selenium premix	.05	.05	.05	.05
Antibiotic[b]	.20	.20	.10	.10
Total	100.00	100.00	100.00	100.00
Calculated analyses				
CP, %	18.80	16.40	14.80	13.60
Lysine, %	.95	.80	.70	.60
Ca, %	.75	.75	.65	.65
P, %	.65	.65	.55	.55

[a]For the 2-step regimen, pigs were fed the diets with .80 and .60% lysine for the growing (to 150 lb body wt) and finishing (150 to 250 lb body wt) phases, respectively. For the 4-step regimen, pigs were fed the diets with .95, .80, .70, and .60% lysine to 100, 150, 200, and 250 lb body wt, respectively.
[b]Supplied 200 and 100 g/ton chlortetracycline in the growing and finishing phases, respectively.

Table 3. Effects of Diet Complexity, Lysine Concentration, and Initial Body Weight on Growth of Nursery Pigs (Exp. 1)[a]

	Simple[b]				Complex[b]				
Item	Lgt	Lgt-Hvy	Hvy-lgt	Hvy	Lgt	Lgt-hvy	Hvy-lgt	Hvy	CV
Initial wt, lb[h]	10.3	12.2	13.4	15.8	10.4	12.2	13.3	15.8	4.2
Final wt, lb[e,h]	41.5	43.1	44.3	50.7	47.0	49.8	50.5	52.5	5.7
d 0 to 9									
ADG, lb[e,j]	.42	.42	.45	.48	.63	.69	.69	.59	13.3
ADFI, lb[e,h,i,k]	.44	.49	.50	.62	.59	.66	.68	.62	9.9
F/G[e,h]	1.05	1.17	1.11	1.29	.94	.96	.99	1.05	8.2
d 9 to 23									
ADG, lb[e]	.88	.78	.82	.85	.94	.95	1.00	.92	10.3
ADFI, lb[e,g]	1.16	1.15	1.21	1.35	1.26	1.33	1.35	1.35	8.4
F/G[c,h]	1.32	1.47	1.48	1.59	1.34	1.40	1.35	1.47	6.6
d 23 to 37									
ADG, lb[d,f]	1.07	1.15	1.07	1.34	1.28	1.29	1.22	1.33	10.6
ADFI, lb[e,h]	1.82	1.85	1.84	2.11	2.04	2.18	2.11	2.35	7.3
F/G[i]	1.70	1.61	1.72	1.57	1.59	1.69	1.73	1.77	6.9
Overall (d 0 to 37)									
ADG, lb[e]	.84	.83	.83	.94	.99	1.01	1.01	.99	7.9
ADFI, lb[e,h]	1.23	1.26	1.27	1.46	1.40	1.49	1.48	1.54	6.8
F/G[d,h]	1.46	1.52	1.53	1.55	1.41	1.48	1.46	1.56	4.6

[a]A total of 224 pigs (7 pigs/pen and 16 pens/treatment).
[b]Lysine regimens were 1.25, and 1.1% and 1.5, 1.25, and 1.1% and 1.25 for the simple and complex formulations, respectively, for d 0 to 9, 9 to 23, and 23 to 37.
[c,d,e]Effect of diet complexity (P<.10, P<.05, P<.01, respectively).
[f,g,h]Linear effect of initial wt (P<.10, P<.05, P<.01, respectively).
[i]Diet complexity × linear effect of initial wt (P<.05).

[j,k]Diet complexity × quadratic effect of initial wt (P<.10, P<.05, respectively).

Table 4. Effects of Diet Complexity and Lysine Concentrations in the Nursery Phase on Subsequent Growing-Finishing Performance of Pigs (Experiment 1)[a]

	Simple-Nursery		Complex-Nursery		
Item	.8/.6 Lysine (gro-fin)	.95/.8/.7/.6 Lysine (gro-fin)	.8/.6 Lysine (gro-fin)	.95/.8./.7/.6 Lysine (gro-fin)	CV
Initial wt, lb[c]	44.9	43.5	50.5	49.7	5.1
Final wt, lb	252.4	256.3	253.8	257.5	2.0
Days to 250 lb[b]	118.2	116.0	115.1	112.0	2.9
ADG, lb[d]	1.74	1.77	1.73	1.79	2.8
ADFI, lb	5.19	5.43	5.45	5.41	4.9
F/G	2.98	3.08	3.16	3.02	4.8
Last rib fat depth, in	.87	.87	.83	.90	9.0

[a]A total of 112 pigs was used (7 pigs/pen and 4 pens/treatment).
[bc]Effect of nursery diet regimen (P<.10, P<.01, respectively).
[d]Effect of finishing diet regimen (P<.10).

Table 5. Effects of Diet Complexity at Similar Lysine Concentrations and Initial Body Weight on Growth of Nursery Pigs (Experiment 2)[a]

	Simple-Nursery[b]				Complex-Nursery[b]				
Item	Lgt	Lgt-hvy	Hvy-lgt	Hvy	Lgt	Lgt-hvy	Hvy-lgt	Hvy	CV
Initial wt, lb[h,k]	9.8	11.2	12.5	14.9	9.8	11.1	12.4	14.8	3.0
Final wt, lb[d,h,j]	32.7	32.0	35.3	41.2	37.1	35.0	38.4	43.4	10.6
d 0 to 7									
ADG, lb[e,g]	.25	.28	.26	.35	.37	.37	.40	.53	29.3
ADFI, lb[e,h]	.29	.29	.34	.37	.41	.43	.40	.54	19.0
F/G	1.16	1.04	1.31	1.06	1.11	1.16	1.00	1.02	22.1
d 7 to 21									
ADG, lb[g]	.56	.56	.61	.67	.62	.62	.63	.75	15.8
ADFI, lb[h]	1.06	1.12	1.21	1.25	1.11	1.10	1.15	1.21	9.5
F/G[e,i]	1.86	2.00	1.98	1.87	1.79	1.77	1.83	1.61	11.0
d 21 to 35									
ADG, lb[d,k]	.96	.78	.87	1.05	1.12	.89	1.02	1.13	16.3
ADFI, lb[d,h,k]	1.89	1.63	1.99	2.22	2.12	1.87	1.96	2.40	10.5
F/G[f]	1.97	2.09	2.29	2.11	1.89	2.10	1.92	2.12	10.5
Overall (d 0 to 35)									
ADG, lb[e,j]	.65	.59	.64	.71	.79	.67	.74	.85	13.5
ADFI, lb[c,h,k]	1.24	1.16	1.34	1.46	1.37	1.26	1.33	1.55	9.0
F/G[c]	1.91	1.97	2.09	2.06	1.73	1.88	1.80	1.82	10.2

[a]A total of 160 pigs (5 pigs/pen and 16 pens/treatment).
[b]Lysine regimens were 1.5, 1.25, and 1.1% for d 0 to 7, 7 to 21, and 21 to 35, respectively, for simple and complex formulations.
[c,d,e]Effect of diet complexity (P<.10, P<.05, P<.01, respectively).
[f,g,h]Linear effect of initial wt (P<.10, P<.05, <.01, respectively).
[i,j,k]Quadratic effect of initial wt (P<.10, P<.05, P<.01, respectively).

Table 6. Effects of Diet Complexity in the Nursery Phase on Subsequent Growing-Finishing Performance of Pigs (Experiment 2)[a]

	Simple-Nursery		Complex-Nursery		
Item	.8/.6 Lysine (gro-fin)	.95/.8/.7/.6 Lysine (gro-fin)	.8/.6 Lysine (gro-fin)	.95/.8./.7/.6 Lysine (gro-fin)	CV
Initial wt, lb	35.6	36.0	38.9	39.6	12.8
Final wt, lb[d]	247.6	253.0	251.2	249.8	1.4
Days to 250 lb	121.1	119.8	115.7	121.6	4.4
ADG, lb[b,d]	1.78	1.79	1.83	1.72	3.2
ADFI, lb	5.73	6.05	5.75	5.90	5.3
F/G[c]	3.22	3.38	3.14	3.51	5.3

[a]A total of 160 pigs was used (10 pigs/pen and 4 pens per treatment).
[b,c]Effect of finishing diet regimen (P<.10, P<.05, respectively).
[d]Interaction of nursery and finishing regimens (P<.10).