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Effects of Feeding Increasing Amounts of Finishing Diet Blended with Nursery Diets on Growth Performance and Economics of Nursery Pigs¹

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Summary

A total of 1,260 pigs [PIC TR4 × (Fast LW × PIC L02); initial body weight (BW) 23.3 lb] were housed in two commercial research rooms and used in a 28-d study to determine the effects of blending increasing amounts of finishing feed into phase 3 nursery diets on pig growth performance. At weaning, pigs were placed into pens with 21 pigs per pen and 30 pens per room. Pigs were fed commercial nursery diets in a 5-phase feeding program with phases 1 and 2 fed before the start of the experiment. At the beginning of phase 3 (day 0), pens of pigs were blocked by pen weight and room. Within blocks, pens were allotted randomly to 1 of 4 treatments with 15 replications per treatment. Treatments consisted of a dose-titration of blending increasing amounts of late finishing feed (0, 2.75, 5.5, and 8.25 lb per pig, corresponding to 0, 3, 6, and 9 tons per 2,200-head barn, respectively) into a phase 3 nursery diet. Diet changes to the remaining phases were based on feed budgets. From day 0 to 14, average daily gain (ADG) was unaffected as finishing feed budget increased from 0 to 2.75 lb/pig but decreased thereafter (quadratic, $P = 0.090$). Average daily feed intake (ADFI) was unaffected, but feed-to-gain ratio (F/G) worsened (linear, $P < 0.001$) as more finishing feed was blended into phase 3 nursery diet. From day 14 to 28, pigs previously fed increasing levels of late finishing feed had improved (linear, $P < 0.05$) ADG and F/G, but unaffected ADFI. Overall (day 0 to 28), blending increasing amounts of finishing feed with phase 3 nursery diet decreased ADG (linear, $P = 0.050$) and tended to decrease (linear, $P < 0.07$) ADFI and final BW. However, there was no evidence of any linear or quadratic effects of increasing finishing feed budgets on overall F/G. Feed cost, gain value, and feed cost per lb of gain decreased (linear, $P < 0.05$) as finishing feed budget increased from 0 to 8.25 lb/pig. However, income over feed cost was not different among treatments. In conclusion, feeding increasing amounts of late finishing feed

¹Appreciation is expressed to New Fashion Pork (Jackson, MN) for use of research facilities and Zach Post for technical support.

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to phase 3 (28 lb) nursery pigs decreased overall ADG and ADFI, but did not affect income over feed cost.

Introduction

In a wean-to-finish pig production, one of the challenges in feed management is determining what to do with feed remaining in the bin at the end of the finishing phase. The precision of budgeting the finishing feed based on predicted feed intake and closeout dates is not perfect. Thus, there is often feed remaining in the bins that must be removed and transported to another site or fed to the next group of pigs. However, in a wean-to-finish barn, the next group will be newly weaned nursery pigs. A common strategy is to blend leftover finishing feed into the later stage nursery diets, which requires prolonged feed storage and may result in tandem blending of the early nursery phase diets. In a previous study,⁴ we investigated the timing of feeding late finishing feed to nursery pigs. Results from that study suggested that pig growth performance was influenced regardless of stage when blended finishing and nursery diets were fed. However, the younger the pigs were when fed the finishing feed, the greater negative impact was observed. For example, blending 5.5 lb/pig finishing feed into phase 3 (approximately 28 lb BW) nursery diet resulted in little impact on overall growth performance. The remaining question is to determine the maximum amount of finishing feed that can be blended with phase 3 nursery diets without affecting pig performance. Therefore, this study was designed to determine the dose effects of increasing leftover finishing feed from 0 to 8.25 lb per pig (corresponding to 0 to 9 tons per 2,200-head barn) on nursery pig growth performance and production economics.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in the experiment. The study was conducted at New Fashion Pork's nursery research facility located in southwest Minnesota. The barn was equipped with pens (8.5 × 18.25 ft²) that contained a 3-hole dry self-feeder and a cup waterer to allow for *ad libitum* access to feed and water. Diets were manufactured at the New Fashion Pork feed mill located in Worthington, MN.

A total of 1,260 pigs [PIC TR4 × (Fast LW × PIC L02); initial BW 23.3 lb] from two adjoining research rooms were used. Before the start of the experiment, newly weaned pigs were placed into pens with 21 pigs per pen and 30 pens per room. Barrows and gilts were mixed in a pen with a constant sex ratio across pens. Pigs were fed commercial nursery diets in a 5-phase feeding program with phases 1 and 2 fed during the pre-treatment period (Table 1). Phase changes were made by using feed budgets (Table 2). At the beginning of phase 3 (day 0 of the experiment), pens of pigs were blocked by pen weight and room. Each room contained seven complete blocks and a partial block (two partial blocks from the adjoining rooms formed a complete block). Within blocks, pens were allotted randomly to 1 of 4 treatments with 15 replications per treatment. Treatments consisted of a dose-titration of blending increasing amounts of late finishing feed (0, 2.75, 5.5, and 8.25 lb per pig, corresponding to 0, 3, 6, and 9 tons per 2,200-

⁴Wu, F., K. Coble; C. Hastad, M.D. Tokach, J.M. DeRouchey, S.S. Dritz, J.C. Woodworth, and R.D. Goodband. 2016 Effects of feeding a finishing diet blended with different phases of nursery diets on growth performance and economics of nursery pigs. Kansas Agricultural Experiment Station Research Reports. Vol. 2: Iss. 8.

head barn, respectively) into a phase 3 nursery diet. The finishing feed did not contain ractopamine. When the late finishing feed was blended with nursery diet, feed delivery followed the sequence of: half of the late finishing feed budget, a 50:50% blend of late finishing and phase 3 nursery diets, and ended with the remaining budget of the phase 3 nursery diet.

Feed additions to each individual pen were delivered and recorded by a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN). Pens were weighed and feed disappearance was measured every 7 d to determine ADG, ADFI, and F/G. Seven feed samples (five nursery diets, one finishing diet, and one blended diet) were collected directly from the feed robot delivery outlet. Feed samples were delivered to the Kansas State University Swine Laboratory and stored at -68°F until they were analyzed for dry matter (DM), crude protein (CP), and mineral contents (Ward Laboratories, Inc., Kearney, NE).

Data were analyzed using the GLIMMIX procedure of SAS (version 9.4; SAS Institute, Inc., Cary, NC) with pen as the experimental unit. The statistical model included the fixed effect of treatment (dose of finishing feed budgets) and random effects of block. Contrasts were used to determine the linear and quadratic effects of increasing the finishing feed doses. Calculation of economics were based on a gain value of \$0.60/lb and feed prices of \$521, \$449, \$389, \$297, \$265, and \$172/ton of nursery phase 1, 2, 3, 4, 5, and late finishing diets, respectively. Results were considered significant at $P < 0.05$ and marginally significant at $0.05 < P < 0.10$.

Results and Discussion

As expected, the finishing diet contained lower CP, calcium, and phosphorus concentrations than nursery diets (Table 3). Nutrient concentrations in blended diets approximated the average between the finishing diet and phase 3 nursery diet, indicating that diets were properly blended.

From day 0 to 14, feeding increasing amounts of late finishing feed tended to decrease (quadratic, $P < 0.09$) ADG and day 14 BW in a quadratic manner; ADG was unaffected as finishing feed budget increased from 0 to 2.75 lb/pig but decreased thereafter. There was no strong evidence that ADFI was affected by feeding the late finishing feed. However, F/G worsened (linear, $P < 0.001$) as more finishing feed was blended into the phase 3 nursery diet. Based on the rate of intake, pigs that were budgeted 2.75 lb/pig finishing feed had completed their finishing feed budgets by day 4. These pigs were able to fully compensate for the gain rate during the rest of this period, whereas their F/G was slightly poorer than those that did not receive finishing feed. However, pigs that received 5.5 and 8.25 lb/pig finishing feed completed their finishing feed budgets around day 8 and 11, respectively, and thus had less time for compensatory gain.

From day 14 to 28, pigs previously fed increasing amounts of late finishing feed had improved (linear, $P < 0.05$) ADG and F/G, which was likely a result of continued compensatory growth. Average daily feed intake was unaffected by the finishing feed budgets. Overall (day 0 to 28), blending increasing amounts of finishing feed with phase 3 nursery diet decreased ADG (linear, $P = 0.050$) and tended to decrease ADFI and final BW (linear, $P < 0.07$). However, there was no evidence of any linear or quadratic

effects of increasing finishing feed budgets on overall F/G. These observations were generally in agreement with the previous study (Wu et al., 2016)⁴ where slight, numerical decreases in overall ADG and ADFI, but not F/G, were observed when 5.5 lb/pig of finishing feed were blended with the phase 3 nursery diet.

Compensatory growth after a short period of nutrient deficiency has been widely documented in nursery pigs. Stein and Kil⁵ and Nemechek et al.⁶ both reported that pigs that received early nursery diets with deficient amino acids (or CP), but late nursery diets with adequate nutrients, were able to fully compensate for overall ADG with unaffected, or even improved, F/G. However, in the present study, pigs receiving 5.5 or 8.25 lb/pig finishing feed might have experienced prolonged and severe nutrient deficiency and, therefore, resulted in decreased overall ADG and ADFI compared with those receiving 0 or 2.75 lb/pig late finishing feed. In addition, it is worth noting that the late finishing feed used in the present study did not contain ractopamine; otherwise, more severe responses may be expected.

Economic analysis is presented in Table 5. Feed cost, gain value, and feed cost per lb of gain decreased (linear, $P < 0.05$) as finishing feed budget increased from 0 to 8.25 lb/pig. However, no evidence of differences in income over feed cost was observed among treatments.

In summary, feeding leftover finishing feed to phase 3 (initially 23-lb BW) nursery pigs negatively affected growth performance, but pigs were able to partially compensate for ADG after the finishing feed budget was concluded. Overall, blending increasing amounts of finishing feed with phase 3 (initially 23-lb BW) nursery diets decreased ADG and ADFI, but did not affect income over feed cost.

⁵Stein, H. H. and D. Y. Kil. 2006. Reduced use of antibiotic growth promoters in diets fed to weanling pigs: Dietary tools, part 2. *Anim. Biotechnol.* 17:217–231. doi:10.1080/10495390600957191

⁶Nemechek, J. E., F. Wu, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, and J. M. Woodworth. 2018. Effect of standardized ileal digestible lysine on growth and subsequent performance of weanling pigs. *Transl. Anim. Sci.* 2:156–161.

Table 1. Composition of experimental diets (as-fed basis)¹

Items	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Finishing
Ingredients, %						
Corn	41.50	44.49	40.17	44.78	45.55	80.79
Soybean meal (48% crude protein)	16.30	23.05	26.00	29.20	27.15	14.90
Corn DDGS ²	5.00	7.50	15.00	16.75	20.00	---
Nursery supplement	20.00	15.00	10.00	---	---	---
Spray dried whey	5.50	---	---	---	---	---
Limestone	0.48	0.70	---	---	1.30	0.88
Monocalcium phosphate (22% P)	0.45	0.68	---	0.15	1.03	0.40
Sodium chloride	0.38	0.38	---	0.03	0.34	0.43
Vitamin and mineral premix	0.30	0.30	0.30	0.15	0.15	0.10
Nursery mineral premix	---	---	2.50	2.50	---	---
L-lysine HCl	0.56	0.57	0.22	0.18	0.54	0.28
L-threonine	0.20	0.22	0.20	0.17	0.17	0.11
L-tryptophan	0.07	0.06	0.06	0.04	0.03	0.03
DL-methionine	0.14	0.14	0.16	0.22	0.21	0.05
L-valine	---	---	---	0.06	0.08	---
Choline chloride	0.04	0.01	---	---	---	---
Phytase ³	---	---	---	---	0.07	---
Protease	---	---	---	0.05	0.05	---
AV-E Digest ⁴	7.50	5.00	2.50	2.50	---	---
XFE Liquid Energy ⁵	0.75	---	-	0.75	0.75	0.75
Choice white grease	0.85	1.90	2.90	2.50	2.60	1.20
Tri-basic copper chloride	---	0.02	---	---	---	---
Ambitine ⁶	---	---	---	---	---	0.10
Total		100.00	100.00	100.00	100.00	100.00

continued

Table 1. Composition of experimental diets (as-fed basis)¹

Items	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Finishing
Calculated analysis						
Standardized ileal digestible (SID) AA, %						
Lysine	1.35	1.40	1.40	1.38	1.32	0.74
Isoleucine:lysine	0.58	0.57	0.58	0.57	0.56	0.57
Methionine and cysteine:lysine	0.62	0.58	0.58	0.58	0.58	0.56
Threonine:lysine	0.63	0.63	0.63	0.62	0.62	0.66
Tryptophan:lysine	0.20	0.19	0.19	0.19	0.18	0.20
Valine:lysine	0.69	0.67	0.66	0.67	0.68	0.65
Total lysine, %	1.51	1.56	1.56	1.55	1.47	0.82
Crude protein, %	21.30	22.27	22.94	22.99	21.73	12.74
Metabolizable energy, kcal/lb	1,522	1,515	1,515	1,519	1,512	1,496
Net energy, kcal/lb	1,094	1,108	1,123	1,150	1,150	1,180
Ca, %	0.70	0.71	0.73	0.79	0.77	0.46
P, %	0.64	0.65	0.66	0.68	0.67	0.40
Available P, %	0.45	0.43	0.43	0.45	0.45	0.24

¹Phases 1 and 2 diets were fed prior to the start of experiment.

²Distillers dried grains with solubles.

³Ronozyme HiPhos (DSM Nutritional Products, Inc., Parsippany, NJ).

⁴AV-E Digest (XFE Products, Des Moines, IA).

⁵Liquid Energy (XFE Products, Des Moines, IA).

⁶Ambitine (PMI Nutritional Additives, Shoreview, MN).

Table 2. Feed budgets per pig averaged within treatments

Phase	Finishing feed budget, ¹ lb/pig			
	0	2.75	5.5	8.25
Phase 1		5.50 (5.59) ²		
Phase 2		4.00 (3.92)		
Phase 3	8.25 (8.66)	1.38 (1.63) lb late finishing feed,	2.75 (3.03) lb late finishing feed,	4.13 (4.38) lb late finishing feed,
		2.75 (2.99) lb	5.5 (5.97) lb	8.25 (8.60) lb
		50:50% blend,	50:50% blend,	50:50% blend,
		6.87 (7.07) lb	5.5 (5.71) lb	4.12 (2.24) lb
		standard Phase 3	standard Phase 3	standard Phase 3
Phase 4	21.00 (22.28)	21.00 (21.28)	21.00 (21.47)	21.00 (21.66)
Phase 5	21.00 (16.90)	18.25 (16.15)	15.5 (10.08)	12.75 (8.83)

¹The budgeted amount of late finishing feed blended into phase 3 (initially 23-lb BW) nursery diet; blended diets were delivered in the sequence of finishing feed, 50% finishing and 50% standard blended diet, and standard diet.

²Values in the parenthesis indicate the actual amount (lb/pig) of diet consumed.

Table 3. Analyzed nutrient composition of experimental diets¹

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Finishing	50% Phase 3: 50% finishing blend
Dry matter, %	89.98	90.75	90.05	88.4	88.7	88.52	89.44
Crude protein, %	20.20	21.80	23.30	23.4	23.0	14.50	18.80
Calcium, %	0.97	1.12	1.03	0.73	1.01	1.18	1.06
Phosphorus, %	0.54	0.55	0.63	0.64	0.69	0.45	0.53
Zinc, ppm	2605	2169	2260	265	169	123	847
Copper, ppm	100	216	215	98	155	135	135

¹Multiple samples of each diet were collected, blended and subsampled, and analyzed (Ward Laboratories, Inc., Kearney, NE).

Table 4. Effects of blending increasing doses of finishing feed into nursery diets on growth performance¹

	Finishing feed budget, ² lb/pig					<i>P</i> value, <	
Item	0	2.75	5.5	8.25	SEM	Linear	Quadratic
Day 0 to 14							
ADG, lb	0.94	0.95	0.87	0.81	0.024	0.001	0.090
ADFI, lb	1.27	1.32	1.25	1.22	0.036	0.105	0.169
F/G	1.35	1.39	1.44	1.51	0.020	0.001	0.353
Day 14 to 28							
ADG, lb	1.35	1.37	1.39	1.41	0.027	0.029	0.993
ADFI, lb	2.16	2.19	2.09	2.12	0.052	0.175	0.948
F/G	1.60	1.60	1.50	1.50	0.020	0.001	0.940
Day 0 to 28							
ADG, lb	1.14	1.16	1.13	1.11	0.019	0.050	0.216
ADFI, lb	1.71	1.76	1.67	1.67	0.033	0.052	0.367
F/G	1.50	1.51	1.48	1.50	0.010	0.596	0.532
Body weight, lb							
Day 0	23.3	23.3	23.3	23.2	0.41	0.689	0.792
Day 14	36.5	36.6	35.5	34.7	0.54	0.001	0.086
Day 28	55.4	55.8	55.2	54.5	0.77	0.069	0.191

¹A total of 1,260 weaned pigs (PIC TR4 × (Fast LW × PIC L02)) with initial BW of 23.3 lb were used in a 28-d growth trial with 21 pigs per pen and 15 replications (pen) per treatment. Growth responses include average daily gain (ADG), average daily feed intake (ADFI), and feed:gain (F/G).

²The budgeted amounts of late finishing feed blended into phase 3 (initially 23-lb BW) nursery diet.

Table 5. Effects of blending increasing doses of finishing feed into nursery diets on production economics¹

Item	Finishing feed budget, ² lb/pig					<i>P</i> -value, <	
	0	2.75	5.5	8.25	SEM	Linear	Quadratic
Economics, \$/pig							
Feed cost ³	7.23	7.24	6.73	6.40	0.135	0.001	0.113
Gain value ⁴	19.19	19.49	18.95	18.59	0.313	0.050	0.215
Feed cost/lb gain ⁵	0.227	0.223	0.213	0.206	0.0019	0.001	0.557
IOFC ⁶	11.96	12.25	12.22	12.20	0.1983	0.384	0.380

¹A total of 1,260 weaned pigs (PIC TR4 × (Fast LW × PIC L02)) with initial body weight (BW) of 23.3 lb were used in a 28-d growth trial with 21 pigs per pen and 15 replications (pen) per treatment.

²The budgeted amounts of late finishing feed blended into phase 3 (initially 23-lb BW) nursery diet.

³Feed cost = diet cost × feed consumption.

⁴Gain value = total BW gain × \$0.60/lb.

⁵Feed cost per pound of gain = feed cost / (ADG × period length, d).

⁶Income over feed cost = gain value – feed cost.