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Evaluating Pellet and Meal Feeding Regimens on Finishing Pig Performance, Stomach Morphology, Carcass Characteristics, and Economics[1,2]

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Summary

A total of 2,100 pigs (PIC 327 × 1050, initially 68.8 lb) were used in a 118-d trial to determine the effects of pellet feeding regimens on finishing pig growth performance, stomach morphology, and carcass characteristics. Pens of pigs were balanced by initial BW and randomly allotted to 1 of 6 dietary treatments (14 pens/treatment with 25 pigs/pen). Pens were sorted by gender allowing for 7 barrow and 7 gilt pens/treatment. The same corn-soybean meal–based diets containing 15% dried distillers grains with solubles were used for all treatments and fed in 5 phases. The 6 treatments included a meal or pelleted diet fed from d 0 to 118, a meal diet fed from d 0 to 70 and then pellets from d 70 to 118, a pelleted diet fed from d 0 to 70 and then meal from d 70 to 118, or pellets and meal rotated every two weeks starting with meal or pellets. On d 110, 4 pigs from each pen were harvested with the stomachs collected and a combined ulcer and keratinization score determined for each pig.

Overall, there were no differences ($P > 0.956$) for ADG across feeding regimens. Pigs fed meal throughout had the greatest ($P < 0.05$) ADFI, while pigs fed pellets throughout had the lowest ($P < 0.05$), with all other treatments intermediate ($P < 0.05$). Pigs fed pelleted diets throughout had the most improved ($P < 0.05$) F/G, while pigs fed meal throughout had the worst F/G ($P < 0.05$), with all other treatments intermediate ($P < 0.05$). When pelleted diets were fed for the last 48 d, or for the entire trial, the incidence of ulceration and keratinization increased ($P < 0.05$), while pigs fed meal for the last 48 d had lower incidence ($P < 0.05$), with all other treatments intermediate ($P < 0.05$). Feeding pellets throughout increased ($P < 0.05$) the number of pigs removed per pen compared to all other treatments. Removals were determined by an onsite farm

[1] This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-68004-30336 from the USDA National Institute of Food and Agriculture.
[2] Appreciation is expressed to Holden Farms Inc. for the use of pigs and facilities.
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manager as animals unable to remain in the general population due to health or welfare problems. There were no differences ($P > 0.10$) for any carcass characteristics measured.

For economics, feeding a meal diet throughout the experiment increased ($P < 0.05$) feed cost/lb gain compared to all other treatments. There were no significant differences ($P > 0.10$) for IOFC; however, numerical differences showed that rotating between a pellet and a meal diet improved IOFC by $1 to $2 above feeding a meal diet throughout the finishing period.

In conclusion, feeding pelleted diets improved F/G but increased stomach ulceration and removals; however, rotating pellets and meal diets provided an intermediate F/G response without increasing in stomach ulceration and subsequent removals compared to only feeding pelleted diets.

Key words: finishing pig, meal, pellet, ulcer

Introduction

To help improve feed utilization and minimize feed wastage, many swine producers have changed to or are considering feeding finishing diets in pellet form. However, due to mill limitations and logistics many producers are unable to feed pelleted diets to all of their pigs continuously. Since many toll or producer-owned mills do not have enough capacity to pellet all diets, producers are left with the option to pellet only part or none of their feed. Little current data and no economic evaluation has been available to assist producers in determining the best regimen for maximizing the return on investment of feeding a limited amount of pelleted feed during the finishing period. In addition, the effects of feeding pelleted feed for varying lengths of time or pulse feeding (switching between pelleted and meal diets) on stomach morphology are also unknown.

The objective of this study was to determine the effects of pellet feeding regimens on finishing pig growth performance, stomach morphology, and carcass characteristics.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Holden Farms Inc. Research Facility (Northfield, MN) in a commercial research-finishing barn in Eastern, MN. The barn was double curtain-sided, and pens had completely slatted flooring and deep pits for manure storage. Each pen was equipped with a 3-hole stainless steel dry self-feeder and a cup waterer for ad libitum access to feed and water. Daily feed additions to each pen were accomplished through a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of providing and measuring feed amounts for individual pens.

A total of 2,100 pigs (PIC 327 × 1050; initially 68.8 lb) were used in a 118-d trial to determine the effects of pellet feeding regimens on finishing pig growth performance, stomach morphology, and carcass characteristics. Pens of pigs were balanced by initial BW and randomly allotted to 1 of 6 dietary treatments (14 pens/treatment with 25 pigs/pen). Pens were sorted by gender allowing for 7 barrow and 7 gilt pens/treatment.

The same corn-soybean meal-based diets containing 15% dried distillers grains with solubles (DDGS) were used for all treatments and fed in 5 phases. The 6 treatments included a meal diet fed from d 0 to 118, a pelleted diet fed from d 0 to 118, a meal diet fed from d 0 to 70 and then pellets to d 118, a pelleted diet fed from d 0 to 70 and then meal to d 118, or pellets and meal fed from d 0 to 118, rotated every two weeks and starting with either meal or pellets.

An on-site farm manager determined pig removals when pigs were at risk due to health or animal welfare and needed to be separated from the general population. Pigs were weighed at the time of removal, and the weight was accounted for in the growth performance from the period in which the pig was removed. This procedure was also used for pigs marketed prior to conclusion of the trial.

On d 110, pens of pigs were weighed and 4 randomly selected pigs were removed from each pen, weighed and transported to Natural Food Holdings in Sioux Center, IA. Pigs were not removed from feed except during the transportation process. Pigs were harvested and each stomach was collected. Stomachs were then assigned an ulcer and keratinization score, which was determined by visual inspection. Keratinization scores were assigned on a scale from 1 to 4 with 1 being normal or no keratinization of the esophageal region and 4 being keratin covering >75% of the esophageal region. Ulcer scores were also assigned on a scale from 1 to 4 with 1 being no ulcer present, and 4 being ulceration present on >75% of the esophageal region. Scores were then combined to produce a general stomach morphology score. On d 112 and d 118 of the trial, all remaining barrows and gilts, respectively, were transported to Tyson Foods in Waterloo, IA, for harvest. At the plant, HCW, backfat depth, loin depth, % yield, and percentage lean were determined.

Feed cost per pig, feed cost per lb gain, revenue per pig, and income over feed cost (IOFC) were used to evaluate economics and were also calculated on a pen basis. Diet costs used were $300/ton and $308/ton for the meal and pelleted diet, respectively, for all phases. Feed cost per pig was determined by total feed intake × feed cost, $/lb. Feed cost per lb gain was calculated using F/G × feed cost, $/lb. Revenue/pig was determined by total gain × $0.96/lb carcass gain, and IOFC was calculated using revenue per pig – feed cost per pig. For the analysis, pig removals during the trial were accounted for as mortalities.

Samples of corn, soybean meal, DDGS, and complete diets were collected and submitted to Ward Laboratories, Inc. (Kearney, NE) for analysis of DM, CP, ADF, NDF, crude fiber, fat, Ca, and P (Table 2). For all diets in pelleted form, pellet durability index (PDI) and percentage fines (Table 3) were determined.

Data were analyzed as a completely randomized design using the PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Pairwise comparisons were used to determine differences. Results were considered significant at $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

Results and Discussion

The chemical analysis of the DDGS, corn, and soybean meal indicated that most nutrients were similar to formulated values (Table 2). Chemical analysis of the diets was similar to expectations based on formulation (Table 3). Pellet Durability Index (PDI) and percentage fines values of the diets (>84% PDI and <35% percentage fines) represented high-quality pellets used during the experiment. The PDI and percentage fines values both improved during the final phase of the experiment when DDGS were removed from the diet. The particle size of the meal diet ranged from 641 to 714 µ during the experiment.

Overall, there were no differences ($P > 0.10$; Table 4) for ADG. Pigs fed meal throughout had the greatest ($P < 0.05$) ADFI, while pigs fed pellets throughout had the lowest ($P < 0.05$), with all other treatments intermediate ($P < 0.05$). Pigs fed pellets throughout had a tendency ($P < 0.10$) for decreased intake compared to pigs fed a meal diet from d 0 to 70 and then pellets to d 118. Pigs fed pelleted diets throughout had the most improved ($P < 0.05$) F/G, while pigs fed meal throughout had the worst ($P < 0.05$) F/G, with all other treatments intermediate ($P < 0.05$). Feeding pellets throughout increased ($P < 0.05$) the number of pigs removed per pen compared to all other treatments. When pelleted diets were fed for the last 48 d, or for the entire trial, the prevalence of ulceration and keratinization increased ($P < 0.05$), while pigs fed meal for the last 48 d had lower prevalence ($P < 0.05$), with all other treatments intermediate ($P < 0.05$). There were no differences ($P > 0.10$) for any carcass characteristics measured.

Feeding a meal diet throughout the experiment increased ($P < 0.05$) feed cost per lb gain compared to all other treatments. There were no significant differences ($P > 0.10$) for IOFC; however, numerical differences showed that rotating between a pellet and a meal diet improved IOFC by $1.00 to $2.00 above feeding a meal diet throughout the finishing period.

These data suggest that alternating between a pellet diet and a meal diet every 2 wk throughout the finishing period maximizes economic gains. Interestingly, the greatest IOFC occurred for the treatment diets rotated between pellet and meal diets every 2 wk, which can be explained by these treatments having an intermediate feed efficiency response to pelleting, while also having fewer removals when compared to treatments in which pigs were fed pellets continuously. It appears that feeding a pelleted diet continuously increases the prevalence of ulcers, which led to increased number of pigs being removed from the study. When pigs were fed a meal diet for even a short period of time after receiving a pelleted diet, it is theorized that previously formed ulcers began to heal. The improved ulcer and keratinization scores for pigs that were fed a meal diet at the point of slaughter, when formerly fed pellets, suggests feeding a meal diet rotated with pelleted diets at points throughout the finishing period will lessen ulceration of the stomach lining. In general, feeding a pelleted diet improved F/G but also increased removals and ulceration. It appears that a combination of both meal and pelleted diets is warranted in order to maximize F/G but also minimize ulceration and subsequent pig removals.

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

Item	Phase: 1	2	3	4	5
Ingredient, %					
Corn	61.12	67.79	72.36	73.82	84.34
Soybean meal (46.5% CP)	20.11	13.50	9.00	7.80	12.49
Choice white grease	1.00	1.00	1.00	1.00	1.00
Dried distillers grains with solubles	15.00	15.00	15.00	15.00	---
Monocalcium phosphate (21% P)	0.25	0.15	0.10	---	0.25
Limestone	1.15	1.20	1.20	1.20	1.00
Salt	0.50	0.50	0.50	0.50	0.50
L-lysine	0.43	0.44	0.44	0.38	0.21
DL-methionine	0.07	0.04	0.02	---	---
L-threonine	0.10	0.10	0.09	0.07	0.06
L-tryptophan	0.03	0.04	0.04	0.03	0.01
Vitamin trace mineral premix	0.25	0.25	0.25	0.20	0.15
Total	100	100	100	100	100
Standard ileal digestible (SID) amino acids, %					
Lys	1.05	0.90	0.79	0.71	0.65
Iso:lys	61	59	58	61	66
Met:lys	33	32	31	32	31
Met & cys:lys	58	58	58	61	62
Th:lys	62	62	62	64	67
Trp:lys	19.0	19.0	19.0	19.0	19.0
Val:lys	70	70	70	75	78
Total lys, %	1.20	1.03	0.91	0.83	0.75
ME, kcal/lb[2]	1,513	1,515	1,516	1,518	1,532
NE, kcal/lb[2]	1,134	1,152	1,165	1,169	1,177
SID lys:NE, g/Mcal	4.20	3.54	3.08	2.75	2.51
SID lys:ME, g/Mcal	3.15	2.70	2.36	2.12	1.92
CP, %	19.0	16.5	14.8	14.2	13.0
Crude fiber, %	3.3	3.2	3.1	3.1	2.2
Ca, %	0.58	0.56	0.53	0.51	0.49
P, %	0.44	0.39	0.36	0.34	0.36
Available P, %	0.29	0.26	0.24	0.22	0.21

[1] Phase 1 diets were fed from d 0 to 28, Phase 2 from 28 to 42, Phase 3 from 42 to 84, Phase 4 from d 84 to 98, and Phase 5 from d 98 to 118.
[2] NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington, D.C.

Table 2. Chemical analysis of ingredients (as-fed basis)[1]

Item	Corn	Soybean meal	Dried distillers grains with solubles
DM, %	88.87	91.05	90.68
CP, %	9.1(8.2)[2]	45.1(46.5)	29.8(27.7)
ADF, %	3.0	6.3	10.1
NDF, %	6.1	7.4	24.8
Ca, %	0.05(0.02)	0.41(0.34)	0.15(0.20)
P, %	0.29(0.26)	0.74(0.69)	0.81(0.77)
Ether extract, %	3.1(3.5)	1.8(3.9)	8.7(7.3)
Starch, %	60.7	4.0	3.7

[1]A composite sample of subsamples taken throughout the experiment at the feed mill was used for analysis.
[2] Values in parentheses represent values used in formulation.

Table 3. Chemical analysis of diets (as-fed basis)[1,2]

Item	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
DM, %	90.90	90.43	89.92	90.19	89.39
CP, %	19.1	16.5	15.3	14.8	12.6
ADF, %	4.3	3.5	4.7	3.8	1.9
NDF, %	10.1	10.6	11.6	11.0	8.6
Ca, %	0.64	0.56	0.53	0.50	0.57
P, %	0.45	0.42	0.40	0.36	0.35
Ether extract, %	4.8	4.9	5.2	4.9	4.2
Starch, %	39.6	42.7	43.6	45.9	51.2
Particle size, μ	683	692	705	714	641
Percentage fines, %	26.7	34.6	20.3	33.1	3.7
PDI, %[3]	84.5	85.8	86.9	90.2	94.5

[1] A composite sample consisting of 6 subsamples was used for analysis. Samples were taken at the farm.
[2] Meal and pelleted diet samples were both analyzed and results were averaged. Particle size represents the meal fed diets. Percentage fines and PDI represent the pelleted diets.
[3] PDI represents the pellet durability index.

Table 4. The effect of pellet feeding regimen on finishing pig growth performance, carcass characteristics, stomach morphology and economics[1]

	d 0 to 70:	Meal	Pellet	Meal	Pellet	Rotated[8]	Rotated[9]	
Item	d 70 to 118:	Meal	Pellet	Pellet	Meal	Rotated	Rotated	SEM
d 0 to 118								
ADG, lb		2.01	2.02	2.02	2.01	2.01	2.02	0.03
ADFI, lb		5.20^{a}	$4.98^{c,y}$	$5.06^{bc,x}$	5.02^{b}	5.08^{b}	5.05^{b}	0.05
F/G		2.59^{c}	2.46^{a}	2.51^{b}	2.50^{b}	2.51^{b}	2.49^{b}	0.01
BW, lb								
d 0		69.43	69.57	69.31	69.17	69.14	69.37	1.33
d 118		298.9	301.1	299.6	295.5	298.3	300.2	4.31
Pigs removed/pen		0.50^{b}	1.92^{a}	1.06^{b}	0.93^{b}	0.85^{b}	0.92^{b}	0.27
Stomach morphology score[2]		$5.25^{ab,z}$	$6.72^{a,x}$	$6.72^{a,x}$	$4.61^{b,y}$	$6.15^{ab,xz}$	$5.32^{ab,z}$	0.61
Carcass characteristics[3]								
HCW, lb		215.7	218.7	217.4	215.7	216.8	217.9	2.3
Yield, %		74.8	75.2	74.7	74.8	75.3	75.6	0.5
Backfat, in		0.66	0.67	0.66	0.65	0.66	0.66	0.01
Loin depth, in		2.87	2.90	2.91	2.89	2.90	2.91	0.02
Lean, %[4]		56.31	56.22	56.17	56.47	56.48	56.31	0.19
Economics								
Feed cost/pig, $		92.08	90.41	90.96	89.98	91.04	90.56	0.96
Feed cost/lb gain, $[5]		0.388^{a}	0.378^{b}	0.382^{b}	0.380^{b}	0.382^{b}	0.379^{b}	0.002
Total revenue/pig, $[6]		166.63	158.58	163.59	163.45	166.18	166.82	2.84
IOFC[7]		74.73	68.46	72.79	73.65	75.31	76.55	2.45

[a,b,c] Superscripts within a row are different ($P < 0.05$).
[x, y, z] Superscripts within a row tended to be different ($P < 0.10$).
[1] A total of 2,100 pigs (PIC 327×1050, initially 68.8 lb) were used in a 118-d trial with 25 pigs per pen and 14 pens per treatment (7 barrow and 7 gilt).
[2] Keratinization scores were assigned on a scale from 1 to 4 with 1 being normal or no keratinization of the esophageal region and 4 being keratin covering >75% of the esophageal region. Ulcer scores were also assigned on a scale from 1 to 4 with 1 being no ulcer present, and 4 being ulceration present on >75% of the esophageal region. Scores were then combined to produce a general stomach morphology score.
[3] On d 110, 4 pigs were removed from each pen and a combined keratinization and ulceration score was assigned to each stomach. On d 112 the pens remaining with barrows were marketed. On d 118 the pens remaining with gilts were marketed.
[4] Calculated using the equation: Lean % = 48.3575 (6.38916 in. backfat) + (4.424677 in. loin depth).
[5] Feed cost/lb gain = (feed cost/pig)/total gain. Diet costs used were $300/ton for meal diets and $308/ton for pelleted diets.
[6] Total revenue/pig = Total carcass gain/pig × $0.96.
[7] Income over feed cost = Total revenue/pig – feed cost/pig.
[8] Two pigs were fed pellets for the first two weeks and then rotated between pellets and meal every 2 wk for the remainder of the trial.
[9] Two pigs were fed meal for the first two weeks and then rotated between meal and pellets every 2 wk for the remainder of the trial.