Effects of Different Feed Mills and Conditioning Temperature of Pelleted Diets on Nursery Pig Performance and Feed Preference from 14 to 50 lb

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Summary

A total of 644 pigs (PIC 1050 or 327 × 1050, initial BW~14 lb) were used in 3 experiments to determine possible explanations for poorer pig performance in previous studies with pigs fed pelleted diets compared with those fed meal diets. Therefore, we examined feed pelleted from different mills as well as conditioning temperature as factors influencing our previous results.

In Experiment 1, pens of pigs were randomly allotted to 1 of 3 dietary treatments with 10 pens per treatment and 7 pigs per pen. The 3 dietary treatments used the identical corn-soybean meal–based formulation and were mixed from the same batch of ingredients. Experimental diets were: (1) feed mixed at mill B but pelleted in mill A; (2) feed mixed and pelleted at mill B; and (3) feed mixed at mill B and fed in meal form. Experiment 2 was a feed preference study where pens of pigs were randomly allotted to the same diets as Experiment 1 with 4 pens per treatment and 7 pigs per pen. Pens contained 2 feeders, each containing 1 of 3 treatment diets. Feeders were rotated once daily within each pen for the entire 33-d study with three diet comparisons tested: 1 vs. 2, 1 vs. 3, and 2 vs. 3.

In Experiment 3, pens of pigs were randomly allotted to 1 of 5 dietary treatments and fed for 16 d with 14 pens per treatment and 5 pigs per pen. Similar to Experiment 1, all diets used the identical corn-soybean meal–based formulation and were mixed from the same batch of ingredients. The experimental diets were: (1) feed mixed at mill A and fed in meal form; (2) feed mixed at mill A, but pelleted at mill B; (3), (4), and (5) feed mixed and pelleted at mill A at a conditioning temperature of 140, 160, or 180˚F, respectively.

In Experiment 1, pigs fed the mill-B pelleted diet had the greatest ($P < 0.05$) ADG, whereas pigs fed the mill-A pelleted diet had the lowest ($P < 0.05$) ADG, with the meal diet from mill B intermediate (Table 6). There were no differences in ADFI among the three experimental diets. The mill-A pelleted diet significantly worsened ($P < 0.05$) F/G and final BW compared with the mill-B pelleted diet, whereas the mill-B mash diet only tended ($P < 0.06$) to worsen F/G compared with the mill-B pelleted diet.

In Experiment 2 for comparison 1, pigs consumed more ($P < 0.05$) of the mill-B pelleted diet than the mill-A pelleted diet, which translated into pigs eating 70% of

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their daily intake from the mill B pellet (Table 7). For comparison 2 and 3, pigs fed either the mill-A or mill-B pellet consumed more feed ($P < 0.05$) than the mill B diet fed in mash form, with the pellets equated to 90% of their daily intake.

For Experiment 3, there were no differences among the three diets pelleted under increasing conditioning temperatures at mill A, so they were combined for analysis (Table 8). Pigs fed the meal diet had improved ($P < 0.05$) ADG compared with pigs fed the mill-A pellet with the mill-B pellet fed pigs intermediate. For ADFI, both mill-B and mill-A pellet-fed pigs had reduced ($P < 0.05$) intake compared with the meal diet but improved ($P < 0.05$) F/G. Final BW was reduced when pigs were fed the mill-A pelleted diet compared with the mash diet, with the pigs fed the mill-B pellet intermediate.

In our study, conditioning temperature did not seem to explain the differences between mill-related growth performance differences observed in Experiments 1 and 2. More research is needed to fully elucidate the reason why pig performance may differ when the same feed is processed in different mills.

Key words: feed preference, conditioning temperature, nursery pig, pelleting

Introduction

Pelleting swine diets typically improves pig growth performance and feed efficiency by approximately 4 to 6%. In recent Kansas State University studies, however, pigs fed pelleted diets had decreased ADG and poorer F/G than those fed meal-based diets. These differences in the response to pelleting were unexpected. The pellets used in these studies had no visible characteristics that might be responsible for the differences in performance. We questioned if something inherent in the pelleting process at one mill might be responsible for the differences; therefore, our objective was to compare pig performance and preference for the same diet pelleted at different feed mills, then to determine if conditioning temperatures might be the reason for the change in pig performance.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocols used in these experiments. The studies were conducted at the K-State Swine Teaching and Research Center and Segregated Early Weaning Facility in Manhattan, KS.

A total of 644 pigs (PIC 1050 or 327 × 1050, initially ~14 lb) were used in three experiments. In all experiments, pigs were randomly allotted to pens based on initial pig weight.

In Experiment 1, pens of pigs were randomly allotted to 1 of 3 dietary treatments with 10 pens per treatment and 7 pigs per pen. Experimental diets were fed for 42 d. The 3 dietary treatments used identical corn-soybean meal–based formulations and were batched from similar lots of ingredients (Table 1). Experimental treatments were: (1) feed mixed at mill B but pelleted in mill A; (2) feed mixed and pelleted at mill B; and (3) feed mixed at mill B and fed in meal form.

Experiment 2 was a feed preference study in which pens of pigs were randomly allotted to the same treatments as Experiment 1, with 4 pens per treatment and 7 pigs per pen. Pens contained two feeders, each feeder containing 1 of 3 treatment diets. Feeders were rotated once daily within each pen for the entire 33-d study, with three diet comparisons tested: 1 vs. 2, 1 vs. 3, and 2 vs. 3.

In Experiment 3, pens of pigs were randomly allotted to 1 of 5 dietary treatments and fed for 16 d with 14 pens per treatment and 5 pigs per pen. The 5 dietary treatments used the identical corn-soybean meal–based formulation. Batches of feed were made for the Phase 1 and 2 diets, respectively, then sacked, and bags were pulled randomly from each batch to create the base feed for each treatment. The experimental treatments were: (1) feed mixed at mill A and fed in meal form; (2) feed mixed at mill A, but pelleted at mill B (conditioning temperature of 143°F); and (3), (4), and (5) feed mixed and pelleted at mill A at a conditioning temperatures of 140, 160, or 180°F.

In Experiment 1, each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pens had wire-mesh floors and allowed approximately 3 ft^2/pig. Pig weight and feed disappearance were measured on d 0, 7, 14, 21, 26, 33, and 42 of the trial to determine ADG, ADFI, and F/G. In Experiment 2, each pen contained two, 2-hole, dry self-feeders and a nipple waterer to provide ad libitum access to feed and water. Pens were similar to Experiment 1, and pigs were weighed and feed disappearance was measured on d 0, 7, 14, 21, 26, and 33. In Experiment 3, pigs were provided unlimited access to feed and water by way of a 4-hole dry self-feeder and a cup waterer in each pen (5 ft × 5 ft). Pig weight and feed disappearance were measured on d 0, 6, 13, and 16 of the trial to determine ADG, ADFI, and F/G.

Complete diet samples were collected and submitted to Ward Laboratories, Inc. (Kearney, NE) for analysis of DM, CP, ADF, NDF, ADF, NDF, Ca, P, crude fat, and ash. In addition, diet samples from Experiment 1 were analyzed for total and available lysine. Percentage fines and pellet durability index (PDI) were also determined for pelleted diets in all three experiments. Bulk density was determined for all diets and angle of repose for all mash diets.

Data were analyzed using PROC MIXED in SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. The LSMEANS procedure was used to determine the mean differences of treatments. Statistics were considered significant at $P < 0.05$ and tendencies at $P \leq 0.10$.

Results and Discussion

As expected, chemical analysis of complete diets from all three trials revealed no notable differences between treatments within experiment (Tables 2 and 3). Diets analyzed from Experiment 1 showed no differences in total and available lysine. Pellet durability and percentage fines were also similar among pelleted diets within experiment (Tables 4 and 5).

Overall in Experiment 1, pigs fed the mill-B pelleted diet had the greatest ($P < 0.05$) ADG, whereas pigs fed the mill-A pelleted diet had the lowest ($P < 0.05$) ADG, with the meal diet from mill B intermediate (Table 6). There were no differences in ADFI among the three experimental diets. The mill-A pelleted diet significantly worsened ($P < 0.05$) F/G and final BW compared with the mill-B pelleted diet, whereas the mill-B mash diet only tended ($P < 0.06$) to worsen F/G compared with the mill-B pelleted diet.

In Experiment 2 for comparison 1, pigs consumed more ($P < 0.05$) of the mill-B pelleted diet than the mill-A pelleted diet, which translated into pigs eating 70% of their daily intake from the mill B pellet (Table 7). For comparison 2 and 3, pigs fed either the mill-A or mill-B pellet consumed more feed ($P < 0.05$) than the mill B diet fed in mash form, with the pellets equated to 90% of their daily intake.

For Experiment 3, there were no differences among the three diets pelleted under increasing conditioning temperatures at mill A, so they were combined for analysis (Table 8). Pigs fed the meal diet had improved ($P < 0.05$) ADG compared with pigs fed the mill-A pellet, with the mill-B pellet fed pigs intermediate. For ADFI, both mill-B and mill-A pellet-fed pigs had reduced ($P < 0.05$) intake compared with the meal diet but improved ($P < 0.05$) F/G. Final BW was reduced when pigs were fed the mill-A pelleted diet compared with the mash diet, with the pigs fed the mill-B pellet intermediate.

In conclusion, the same diet when produced at different feed mills may affect pig performance. In our study, Experiment 3 demonstrated that the conditioning temperature range of pelleted diets did not affect nursery pig growth performance; thus, differences in pelleting temperatures do not seem to explain the inter-mill growth performance and preference differences exhibited in the first two experiments. We speculate other factors that may explain the difference include mill operator experience level, post-pelleting handling techniques, pellet cooling systems, or humidity and room temperatures during the pelleting process. Additional research is needed to better understand how mill-to-mill variation affects growth performance of pigs.

Table 1. Diet composition for Experiments 1, 2, and 3 (as-fed basis)[1]

	Phase:		
Item	1	2	3
Ingredient, %			
Corn	36.05	52.76	61.31
Soybean meal (46.5% CP)	19.97	29.67	33.79
Spray-dried blood meal	1.25	1.25	---
Spray-dried blood plasma	4.00	---	---
DDGS[2]	5.00	---	---
Select menhaden fish meal	1.25	1.25	---
Spray-dried whey	25.00	10.00	---
Choice white grease	3.00	1.50	1.50
Monocalcium phosphate (21% P)	0.90	0.93	1.15
Limestone	1.00	1.05	0.95
Salt	0.30	0.30	0.35
L-lysine HCl	0.23	0.30	0.30
DL-methionine	0.15	0.18	0.12
L-threonine	0.09	0.15	0.12
Vitamin premix	0.25	0.25	0.15
Trace mineral premix	0.15	0.15	0.25
Choline chloride	0.04	---	---
Phytase[3]	---	0.02	0.02
Zinc oxide	0.39	0.25	---
Medication[4]	1.00	---	---
Total	100	100	100

continued

Table 1. Diet composition for Experiments 1, 2, and 3 (as-fed basis)[1]

	Phase:		
Item	1	2	3
Calculated analysis			
Standard ileal digestible (SID) amino acids, %			
Lysine	1.40	1.35	1.24
Isoleucine:lysine	56	58	63
Leucine:lysine	127	124	128
Methionine:lysine	32	35	33
Met & Cys:lysine	57	57	57
Threonine:lysine	63	64	63
Tryptophan:lysine	19	18.1	18.7
Valine:lysine	71	68	68
Total lysine, %	1.56	1.50	1.39
ME, kcal/lb[5]	1,552	1,520	1,515
NE, kcal/lb[6]	1,102	1,115	1,100
SID lysine:ME, g/Mcal	4.09	4.03	3.71
CP, %	22.10	22.10	21.60
Crude fiber, %	2.00	2.20	2.50
Ca, %	0.85	0.80	0.70
P, %	0.72	0.66	0.65
Available P, %	0.51	0.47	0.42

[1] Treatment diets were fed for 42, 33, and 16 d for Experiments 1, 2, and 3, respectively.
[2] Dried distillers grains with solubles.
[3] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 340.5 phytase units (FTU)/lb, with a release of 0.12% available P.
[4] Mecadox 2.5 was used during the first phase.
[5] NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington DC.
[6] INRA (Institut National de la Recherche Agronomique). 2004. Tables of composition and nutritional value of feed materials, Sauvant, D., J-M. Perez and G. Tran, Eds. Wageningen Academic Publishers, The Netherlands and INRA, Paris, France

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

	Phase: 1			2			3		
Mill:	A	B	B	A	B	B	A	B	B
Item Diet form:	Pellet	Pellet	Meal	Pellet	Pellet	Meal	Pellet	Pellet	Meal
DM, %	92.29	91.31	93.08	91.23	92.01	91.68	89	88.69	88.25
CP, %	20.6	21.4	19.3	22.2	22	20.2	22.5	22.9	22.5
ADF, %	3.2	3.3	3.4	2.8	3.3	4.3	2.8	2.6	3.3
NDF, %	6.8	5.9	7.2	6.6	6.3	6.6	6.9	7.1	7.1
NFE, %	55.6	54.4	58.3	53.1	54.5	54.2	54.4	54.4	53.2
Ca, %	0.91	1.03	0.84	1.03	1.10	1.04	1.01	1.04	0.91
P, %	0.71	0.82	0.68	0.66	0.81	0.59	0.64	0.64	0.59
Fat, %	5.8	5.7	5.5	5.4	5.3	5.2	4.1	3.6	4.3
Ash, %	7.78	7.12	7.34	8.28	7.51	8.78	5.78	5.82	5.58
Starch, %	25.3	26.5	26.2	28.8	25.8	31.3	34.7	34.7	34.4
Total lysine, %	1.21	1.29	1.13	1.16	1.31	1.07	1.40	1.35	1.35
Available lysine[2], %	1.18	1.26	1.10	1.13	1.28	1.05	1.37	1.33	1.33

[1] A composite sample consisting of 3 subsamples was used for analysis. Samples from Experiments 1 and 2 were combined for analysis because they were batched and pelleted together at the mill.
[2] Available lysine has not been bound and is still available to the pig.

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

	Phase: 1			2		
Mill:	A	A	B	A	A	B
Item Diet form:	Meal	Pellet	Pellet	Meal	Pellet	Pellet
DM, %	91.83	91.61	92.05	90.40	89.57	90.50
CP, %	22.2	23.0	22.2	23.5	22.7	23.3
ADF, %	2.7	2.9	2.8	2.9	2.7	2.8
NDF, %	6.0	6.3	6.4	6.3	5.9	6.3
NFE, %	55.7	54.40	55.2	55.0	55.70	55.6
Ca, %	1.13	1.07	1.07	0.97	0.82	0.94
P, %	0.74	0.74	0.71	0.70	0.61	0.66
Fat, %	4.9	5.0	4.8	3.7	3.6	3.5
Ash, %	6.89	6.85	7.52	5.94	5.37	5.88
Starch, %	22.8	22.37	23.4	29.9	32.77	30.9

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] Results from treatments 3, 4, and 5 were averaged.

Table 4. Physical analysis of diets, Experiments 1 and 2 (as-fed basis)[1,2]

Phase:	1			2			3		
Mill:	A	B	B	A	B	B	A	B	B
Item Diet form:	Pellet	Pellet	Meal	Pellet	Pellet	Meal	Pellet	Pellet	Meal
Percentage fines, %	8.4	1.0	---	1.8	1.4	---	16.2	1.6	---
PDI[3], %	78.4	67.9	---	86.6	64.2	---	30.8	33.2	---
Bulk density, lb/bu	61.4	60.5	57.9	63.4	60.7	57.1	61.54	59.3	54.8
Angle of repose, °	---	---	53.9	---	---	53.6	---	---	52.6

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] Samples from Experiments 1 and 2 were combined for analysis as they were batched and pelleted together at the mill.
[3] Pellet durability index.

Table 5. Physical analysis of diets, Experiments 3 (as-fed basis)[1]

Phase:	1			2		
Mill:	B	A	A	B	A	A
Item Diet form:	Pellet	Pellet[2]	Meal	Pellet	Pellet	Meal
Percentage fines, %	0.4	0.3	---	0.1	0.8	---
PDI, %	87.6	94.8	---	80.1	93.7	---
Bulk density, lb/bu	62.3	59.7	58.5	61.9	58.9	58.2
Angle of repose, °	---	---	50.2	---	---	42.3

[1] A composite sample consisting of 3 subsamples was used for analysis.
[2] Results from treatments 4, 5, and 6 were averaged.

Table 6. Effects of mill on nursery pig growth performance, Experiments 1[1]

Mill:	A	B			
Item Diet form:	Pellet	Pellet	Meal	SEM	Probability, P <
d 0 to 42					
ADG, lb	0.84[b]	0.95[a,x]	0.91[a,y]	0.02	0.001
ADFI, lb	1.43	1.51	1.51	0.03	0.208
F/G	1.71[b]	1.59[a,x]	1.67[a,y]	0.03	0.028
Wt, lb					
d 0	14.0	14.1	14.0	0.05	0.834
d 21	35.8[b]	40.3[a,x]	37.7[a,y]	0.63	0.001

[1] A total of 210 pigs (PIC 327 × 1050, initial BW 14 lb) were used in a 42-d growth trial with 7 pigs per pen and 10 pens per treatment.
[a,b] Superscripts within a row are different (P < 0.05).
[x,y] Superscripts within a row tend to be different (P < 0.10).

Table 7. Effects of mill on feed intake preference of pelleted and meal diets in nursery pigs, Experiments 2[1]

Item	ADFI, lb	ADFI, %[2]
Comparison 1		
Mill A pellet	0.34	30.22
Mill B pellet	0.80	69.78
SEM	0.04	2.54
Probability, *P* <	0.001	0.001
Comparison 2		
Mill B pellet	1.02	89.56
Mill B mash	0.12	10.44
SEM	2.41	0.03
Probability, *P* <	0.001	0.001
Comparison 3		
Mill A pellet	0.93	89.52
Mill B mash	0.11	10.48
SEM	0.04	13.98
Probability, *P* <	0.001	0.001

[1] A total of 84 pigs (PIC 327 × 1050, initial BW 14 lb) were used in a 33-d growth trial with 7 pigs per pen and 4 pens per treatment. Feeders were rotated once daily within each pen to eliminate any location effects of feeder.
[2] ADFI, % is a percentage of total feed intake for each treatment within a comparison.

Table 8. Effects of mill on nursery pig growth performance, Experiments 3[1,2]

Mill:	A				B		Probability, $P <$			
Diet form:	Meal	Pellet	Pellet	Pellet	Pellet			Mill A meal vs. mill B pellets	Mill A meal vs. mill A pellets	Mill A pellets vs. mill B pellets
Item Cond. temp., °F:	---	140	160	180	143	SEM	Treatment[3]			
d 0 to 42										
ADG, lb	0.64	0.59	0.57	0.59	0.59	0.02	0.055	0.075	0.018	0.840
ADFI, lb	0.86	0.69	0.68	0.70	0.69	0.01	0.001	0.001	0.001	0.738
F/G	1.35	1.20	1.20	1.19	1.19	0.03	0.001	0.001	0.001	0.993
Wt, lb										
d 0	13.5	13.5	13.5	13.5	13.5	0.07	0.999	0.975	0.945	0.975
d 21	23.9	23.0	22.6	23.2	23.1	0.35	0.071	0.125	0.023	0.666

[1] A total of 350 pigs (PIC 1050 barrows, initially 14 lb BW) were used in a 16-d growth trial with 5 pigs per pen and 14 pens per treatment.
[2] Pellets with different conditioning temperatures from mill A were not significantly different and were combined for statistical analysis.
[3] Shows the overall treatment effect.