Feed Processing Parameters and Their Effects on Nursery Pig Growth Performance

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Summary

A total of 180 nursery pigs (PIC 327 × 1050; initially 27.8 lb) were used in an 18-d study to determine the effects of conditioning parameters and feed form on pig performance. All diets were the same corn, dried distillers grains with solubles (DDGS), and soybean meal-based formulation with different processing parameters used to create the experimental treatments. Treatments included: (1) negative control mash diet, (2) positive control pelleted diet conditioned at 60 rpm, (3) pelleted diet conditioned at 30 rpm and reground, (4) pelleted diet conditioned at 60 rpm and reground, and (5) pelleted diet conditioned at 90 rpm and reground. The different rpm values among treatments represent the time in the conditioner during processing. The lower the rpm value, the longer time feed was in the conditioner. Pigs were weaned and fed a common acclimation diet for 21 d prior to the start of the experiment. Average daily gain and F/G did not differ ($P > 0.12$) between treatments overall, but ADFI decreased ($P = 0.03$) for pigs fed the pelleted, positive control diet compared with all other diets. Although no overall treatment effects were significant for ADG or F/G, the experiment was designed more specifically to evaluate treatment differences using preplanned comparisons. When considering preplanned contrasts, we observed that pigs fed mash diets tended to have greater ($P = 0.10$) ADG than those fed pelleted and reground diets, suggesting that processing may have had a negative influence on feed utilization, a hypothesis that is further supported because pigs fed mash diets tended to have greater ($P = 0.06$) ADG compared with those fed diets that were heat-processed, regardless of regrinding. Considering these results, it was not surprising that pigs fed mash diets had greater ($P = 0.05$) ADG and ADFI ($P = 0.01$) than those fed pelleted diets. When directly comparing diets conditioned at 60 rpm, fed either as whole pellets or reground to mash consistency, pigs fed pelleted diets had improved ($P = 0.01$) F/G due to lower ADFI ($P = 0.004$) but similar ADG ($P = 0.60$). This unexpected negative impact of pelleting on ADG may be due to a negative influence of heat treatment on palatability. The expected improvement in F/G from pelleting (6.8%) was observed but lost when diets were reground to near original mash particle size. This result may indicate that diet form (high-quality pellets vs. mash) affects F/G more than degree of starch gelatinization or other intrinsic factors associated with conditioning ingredients.

Key words: conditioning, feed processing, growth performance, pelleting, nursery pig

Introduction

Although pelleting diets is generally accepted as a method to improve feed efficiency, whether the improvement is due to enhancements in nutrient utilization or changes

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in diet form that minimize potential feed wastage is subject to disagreement. The role of starch gelatinization on efficiency of nutrient use and its impact on animal growth performance has not been consistently demonstrated in previous studies. Discrepancies among past experiments may be influenced by differences in diet formulation or processing conditions; furthermore, much of the previous research was conducted more than 10 years ago, when animals possessed less genetic potential for lean growth performance than those today. Thus, testing processing effects with current genetics may yield improvements in animal performance. Factors such as degree of starch gelatinization may now be both statistically and biologically significant with faster-growing and more efficient pigs; therefore, the objective of this experiment was to determine if conditioning retention time affects nursery pig performance regardless of diet form.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used for this experiment. The study was conducted at the Kansas State University Segregated Early Weaning Facility in Manhattan.

A total of 180 nursery pigs (PIC 327 × 1050; initially 27.8 lb) were utilized in an 18-d growth experiment. Pigs were weaned at 21 d of age and fed common diets for 21 d until the start of the experiment. There were 6 pigs per pen and 6 replicates per treatment. Each pen contained 1 nipple waterer and 1 self-feeder to allow for ad libitum access to water and feed. At 42 d of age, pigs were weighed and treatments were randomly assigned to pens in a completely randomized design.

All diets were corn, dried distillers grains with solubles (DDGS), and soybean meal–based (Table 1), but they were processed differently to form the experimental treatments. The 5 treatments consisted of a negative control diet that was fed in mash form, a positive control diet that was pelleted and conditioned at 60 rpm and fed in pellet form, and 3 diets that were pelleted but conditioned at 30, 60, or 90 rpm then reground and fed in mash form. The rpm difference represents the number of rotations of the central shaft and paddles inside the conditioner. Lowering the rpm slows the speed of the rotating paddles, and thus increases the retention time of the feed in the conditioner. The lower the rpm, the longer the feed remains in the conditioner. All pelleted diets were pelleted at 190°F. Samples of diets were collected after processing and analyzed for particle size and bulk density (Table 2). Pigs were weighed and feed disappearance was determined on d 0 and 18 to determine ADG, ADFI, and F/G.

Data were analyzed using the GLIMMIX procedure in SAS (SAS Institute, Inc., Cary, NC) with pen as experimental unit. Treatment was the fixed effect, and no random effects were observed. Preplanned orthogonal contrasts included the 3 reground diets vs. mash diet, the 4 heat-processed diets vs. mash diet, pellet diet vs. mash diet, and pelleted diet conditioned at 60 rpm vs. reground diet processed at 60 rpm. The results were considered significant if $P \leq 0.05$ and trends if $P \leq 0.10$.

Results and Discussion

As expected, ADFI was greater ($P = 0.03$) in pigs fed the mash diet, but this did not affect BW, ADG, or F/G ($P > 0.13$; Table 3). Because ADFI is determined by measur-

ing feed disappearance, we suspect that this response is a reflection of increased wastage rather than actual feed consumption.

Our intention was to regrind pelleted diets to a particle size similar to that of the negative control mash diet, but the reground diets had average particle sizes that were 66 to 100 μm smaller and average bulk densities that were 0.9 to 1.5 lb/bu heavier than mash diets (Table 2). Wondra et al. (1995[4]) reported that a 200-μm difference in particle size (400 vs. 600 μm) affected ($P < 0.05$) ADG. No research has evaluated if a difference of 100-μm particle size will affect pig growth performance, but using the Wondra et al. (1995) data, one can extrapolate that a 100-μm decrease in particle size yields a 1.3% improvement in feed efficiency. We observed no significant impact of mash vs. reground diets in BW, ADFI, or F/G in our study, but we saw a trend toward increased ADG ($P = 0.10$) for pigs fed mash diets compared with those fed pelleted and reground diets.

Based on the work of Lundblad et al. (2011[5]), one would expect pigs fed pelleted diets to have reduced ADFI and a 6 to 7% improvement in F/G compared with those fed mash diets; however, pigs fed pelleted diets in our study had reduced ADFI ($P = 0.01$), which was not correlated to an improvement in F/G ($P = 0.30$) because ADG was also negatively affected ($P = 0.05$). The cause of the reduction in ADFI is unknown but may be partially attributable to feed wastage; nevertheless, the overall ADG was greater, so feed intake and subsequent growth of nursery pigs eating mash diets was inexplicably greater than those fed pelleted diets. The expected improvement in feed efficiency was observed when comparing pelleted diets to those that were pelleted and processed at the same rpm but reground and fed in meal form. Pigs fed pelleted diets had the expected reduction ($P = 0.004$) in ADFI with similar ADG, which translated into improved F/G ($P = 0.01$; 1.49 vs. 1.70 for pelleted vs. reground, respectively).

In this experiment, we observed an unexpected negative impact of pelleting on ADG, which may be due to a negative impact of heat treatment on palatability. We observed the expected improvement in F/G from pelleting (6.8%), but this improvement was lost when diets were reground to near-original mash particle size. This result may indicate that diet form (high-quality pellets vs. mash) affects F/G more than degree of starch gelatinization or other intrinsic factors associated with conditioning ingredients.

[4] Wondra, K.J., J.D. Hancock, K.C. Behnke, R.H. Hines, and C.R. Stark.1995. Effects of particle size and pelleting on growth performance, nutrient digestibility, and stomach morphology in finishing pigs. J. Anim. Sci. 73:757–763.

[5] Lundblad, K.K., S. Issa, J.D. Hancock, K.C. Behnke, E. Prestløkken, L.J. McKinney, S. Alavi, J. Fledderus, and M. Sørensen. 2011. Effects of steam conditioning at low and high temperature, expander conditioning, and extruder processing prior to pelleting on growth performance and nutrient digestibility of nursery pigs and broiler chickens. Anim. Feed. Sci. Technol. 169:209–217.

Table 1. Diet composition (as-fed basis)[1]

Ingredient, %	
Corn	40.55
Soybean meal	25.25
Corn DDGS[2]	30.00
Poultry fat	0.50
Monocalcium phosphate	1.03
Limestone	1.30
Salt	0.35
L-lysine-HCL	0.45
DL-methionine	0.07
L-threonine	0.09
Vitamin premix	0.25
Trace mineral premix	0.15
Total	100.00
Calculated analysis	
Standardized ileal digestible (SID) amino acids, %	
Lysine	1.26
Isoleucine:lysine	65
Leucine:lysine	156
Methionine:lysine	33
Met & Cys:lysine	58
Threonine:lysine	62
Tryptophan:lysine	17.0
Valine:lysine	74
Total lysine, %	1.47
ME, kcal/lb	1,495
SID lysine:ME, g/Mcal	3.82
CP, %	24.1
Ca, %	0.76
P, %	0.69
Available P, %	0.41

[1] Diets were fed for 18 d beginning when the pigs were 42 d old.
[2] Dried distillers grains with solubles.

Table 2. Particle size and bulk density in treatment diets[1]

Form:	Mash	Pelleted	Pelleted then reground		
Conditioning rpm:[2]	n/a	60	30	60	90
Particle size					
Mean (dgw, µm)	592	-	526	492	508
SD, (sgw)	2.4	-	2.1	2.1	2.1
Bulk density, lb/bu	41.0	48.6	41.9	42.3	42.5

[1] All samples were collected at the feeders during the trial. Particle size was run on a Ro-Tap E Test Sieve Shaker (Tyler Industrial Group, Mentor, OH) with 13 sieves and a pan. Bulk density was calculated in g/qt then converted to lb/bu.
[2] Rpm was preset using the automation system during pelleting and verified manually.

Table 3. Effects of processing parameters on nursery pig performance[1]

Form:	Mash	Pelleted	Pelleted then reground				
Conditioning rpm:[2]	n/a	60	30	60	90	SEM	*P* =
BW, lb							
d 0	27.8	27.8	27.9	27.9	27.9	0.46	1.00
d 18	47.9	45.9	46.8	46.4	46.7	0.90	0.63
ADG, lb[3,4]	1.12	1.01	1.05	1.03	1.05	0.04	0.34
ADFI, lb	1.78[b]	1.50[a]	1.72[b]	1.82[b]	1.77[b]	0.07	0.03
F/G[5]	1.60	1.49	1.65	1.76	1.70	0.07	0.13

[ab] Means within a row that lack a common superscript differ $P < 0.05$.
[1] A total of 180 pigs (42 d of age; initially 27.8 lb) were used, with 6 pigs per pen and 6 pens per treatment.
[2] Rpm was preset using the automation system during pelleting and verified manually.
[3] Pigs fed mash diets had greater ADG than those fed the pelleted but not reground diet ($P = 0.05$).
[4] Pigs fed mash diets tended to have greater ADG than those fed pelleted then reground diets ($P = 0.10$).
[5] Pigs fed diets pelleted at 60 rpm and fed as pellets had improved F/G compared with those fed the diet as reground ($P = 0.01$).