

Kansas Agricultural Experiment Station Research Reports

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

Article 1207

2013

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Jeremiah E. Nemechek

Michael D. Tokach

Kyle F. Coble

See next page for additional authors

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Recommended Citation

Nemechek, Jeremiah E.; Tokach, Michael D.; Coble, Kyle F.; DeRouchey, Joel M.; Goodband, Robert D.; and Dritz, Steven S. (2013) "Effects of corn particle size and diet form on finishing pig growth performance and carcass characteristics," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. <https://doi.org/10.4148/2378-5977.7047>

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Effects of corn particle size and diet form on finishing pig growth performance and carcass characteristics

Authors

Jeremiah E. Nemecek, Michael D. Tokach, Kyle F. Coble, Joel M. DeRouchey, Robert D. Goodband, and Steven S. Dritz

Effects of Corn Particle Size and Diet Form on Finishing Pig Growth Performance and Carcass Characteristics^{1,2}

J.E. Nemechek, M.D. Tokach, K.F. Coble, J.M. DeRouchey, R.D. Goodband, and S.S. Dritz³

Summary

A total of 960 pigs (PIC TR4 × Fast Genetics York-AND × PIC Line 02, initially 75.7 lb BW) were used in a 101-d trial to determine the effect of corn particle size and diet form on finishing pig growth performance and carcass characteristics. Pens were randomly allotted to 1 of 6 experimental treatments by initial BW with 8 pens per treatment and 20 pigs per pen. All diets were fed in four phases with the same corn-soybean meal-based diet containing 30% dried distillers grains with solubles (DDGS; Phases 1 to 3) or 15% DDGS (Phase 4) used for all diets. The 6 experimental treatments were arranged in a 2 × 3 factorial with main effects of final feed form (meal vs. pellet) and corn particle size (650 μ , 350 μ , or an equal blend of the 650 μ and 350 μ ground corn). Overall (d 0 to 101), linear particle size × diet form interactions were observed ($P < 0.02$) for ADFI and F/G due to ADFI decreasing and F/G improving as particle size was reduced for pigs fed meal diets but not for pigs fed pelleted diets. Pigs fed pelleted diets had increased ($P < 0.001$) ADG and final BW and improved ($P < 0.001$) F/G. As corn particle size decreased, ADG and ADFI decreased ($P < 0.02$) linearly. Pigs fed pelleted diets had increased ($P < 0.001$) HCW compared with pigs fed meal diets. Yield, backfat, and loin depth were not influenced by particle size or diet form.

In summary, pigs fed pelleted diets had improved growth performance compared with those fed meal diets, with the greatest improvement in F/G observed from pigs fed coarse-ground (650 μ) corn. Feed efficiency improved as corn particle size decreased for pigs fed meal diets but not for those fed pelleted diets, suggesting that there was no benefit to grinding corn finer than 650 μ for pelleted diets.

Key words: finishing pig, particle size, pelleting

Introduction

Previous research at Kansas State University has shown that growth performance can be improved if corn particle size is reduced or if the diets are fed in pellet form, but grinding the complete diets was not beneficial (De Jong et al., 2012⁴). In this previous trial, the entire corn fraction of each experimental diet was ground to a specific particle size using either a roller mill (650 μ) or a hammer mill (320 μ). By feeding a blend of corn

¹ Appreciation is expressed to New Fashion Pork for the use of pigs and facilities and to Chad Hastad and Ryan Cain for technical assistance.

² This project was supported by National Research Initiative Competitive Grant no. 2011-68004-30336 from the USDA National Institute of Food and Agriculture.

³ Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

⁴ De Jong et al., Swine Day 2012, Report of Progress 1074, pp. 316–324

varying in particle size, the throughput of some feed mills could be increased, but little research has been conducted to determine the impact on finishing pig growth performance. Therefore, the objective of the current experiment was to determine the effect of corn particle size (650 μ , 350 μ , or an equal blend of the 650 μ and 350 μ ground corn) and diet form (meal vs. pellet) on finishing pig growth performance 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 New Fashion Pork Research Facility (Round Lake, MN) in a commercial research-finishing barn located in northwestern Iowa. The double-curtain-sided barn was tunnel-ventilated with completely slatted flooring and deep pits for manure storage. Each pen was equipped with a 5-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 deliveries for individual pens.

A total of 960 pigs (PIC TR4 $\times$ Fast Genetics York-AND $\times$ PIC Line 02, initially 75.7 lb BW) were used in a 101-d trial. Pens were randomly allotted by initial BW to 1 of 6 experimental treatments with 8 pens per treatment with 20 pigs per pen. Diets were fed in 4 phases, with Phases 1 through 4 fed from d 0 to 26, 26 to 46, 46 to 73, and 73 to 101, respectively (Table 1). Within each phase, the same corn-soybean meal-based diet containing 30% DDGS (Phases 1 through 3) or 15% DDGS (Phase 4) was used for all 6 experimental treatments. The 6 experimental treatments were arranged in a 2 $\times$ 3 factorial with main effects of final feed form (meal vs. pellet) and corn particle size (650 μ , 350 μ , or an equal blend of the 650 μ and 350 μ ground corn). All diets were prepared at New Fashion Pork's commercial feed mill in Estherville, IA.

Pigs were weighed and feed disappearance measured approximately every 2 weeks to calculate ADG, ADFI, and F/G. On d 87 of the trials, pens were weighed and the 6 heaviest pigs (selected by the marketing serviceman) were removed and transported 350 miles to Triumph Foods (St. Joseph, MO) for harvest. The remaining pigs were transported to Triumph Foods on d 101 for harvest. Pigs were weighed and feed disappearance was determined approximately every 21 d to calculate ADG, ADFI, and F/G. Yield was calculated using live weight at the farm and HCW at the plant. At the plant, backfat and loin depth were measured, and percentage lean was calculated using NPPC (1991) guidelines for lean containing 5% fat: $\text{Lean \%} = (2.83 + (0.469 \times (\text{HCW})) - (18.47 \times (\text{fat depth})) + (9.824 \times \text{loin depth})) / (\text{HCW})$.

Samples of corn and complete diets were collected during each phase. Particle size of corn samples and diets in meal form was determined using Tyler sieves (numbers 6, 8, 10, 14, 20, 28, 35, 48, 65, 100, 150, 200, 270, and a pan) and a Ro-Tap shaker (W.S. Tyler, Mentor, OH). One hundred-gram samples were sifted for 10 min without a flow agent, and the weight on each screen was used to calculate the mean particle size (Table 2). Pellet durability index (PDI) was determined using the standard tumbling-box technique, and modified PDI was done by adding 5 hexagonal nuts prior to tumbling.

Percentage fines were also determined, and fines were characterized as material that would pass through a #6 sieve (3,360 μ opening).

Data were analyzed as a completely randomized design using PROC MIXED in SAS (SAS Institute, Inc., Cary, NC), with pen as the experimental unit. Treatments were analyzed as a 2×3 factorial with main effects of corn particle size and diet form. Linear and quadratic effects of decreasing particle size were determined as well as interactive effects of corn particle size and diet form. Results were considered significant at $P < 0.05$ and considered a trend at $P < 0.10$.

Results and Discussion

Particle size and pellet quality measurements

Particle size of corn was similar to expectations with corn targeted at 650 μ ranging from 616 to 681 μ and corn targeted at 350 μ ranging from 336 to 359 μ (Table 2). Because corn particle size of the diets containing a 50:50 mixture of 650 and 350 μ ground corns could not be determined, whole diet particle size was measured. These data found that whole diets of the 50:50 mixture were intermediate between high- and low-particle size corn diets, which was expected. High-quality pellets were produced as reflected by the PDI being greater than 90% and the percentage fines being 20% or less for all diets and phases.

Growth performance and carcass measurements

Overall (d 0 to 101), linear particle size $\times$ diet form interactions were observed ($P < 0.02$) for ADFI and F/G because ADFI decreased and F/G improved as particle size was reduced for pigs fed meal diets, but not for pigs fed pelleted diets (Table 3). Pigs fed pelleted diets had increased ($P < 0.001$) ADG and improved ($P < 0.001$) F/G. As corn particle size decreased, ADG and ADFI decreased ($P < 0.02$) linearly. Pigs fed pelleted diets had increased ($P < 0.001$) HCW compared with pigs fed meal diets, but no other effects ($P > 0.12$) on carcass characteristics were observed.

In summary, pigs fed pelleted diets had improved growth performance compared with those fed meal diets, with the greatest magnitude of F/G improvement to pellets occurring when pigs were fed 650- μ corn. Feed efficiency improved as corn particle size decreased for pigs fed meal diets but not for those fed pelleted diets, suggesting that grinding corn finer than 650 μ for pelleted diets conferred no benefit. Further research is needed to understand why F/G did not improve in pelleted diets as particle size was reduced from 650 to 350 μ .

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

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredient, %				
Corn	48.45	53.13	56.33	63.28
Soybean meal (46.5% CP)	17.88	13.36	10.39	18.42
Dried distillers grains with solubles	30.00	30.00	30.00	15.00
Beef tallow	1.50	1.50	1.50	1.50
Limestone	1.36	1.22	1.06	1.05
Salt	0.35	0.35	0.35	0.35
Vitamin-trace mineral premix	0.100	0.100	0.075	0.050
L-lysine HCl	0.365	0.340	0.305	0.275
L-threonine	---	---	---	0.050
Ractopamine HCl ² , 9 g/lb	---	---	---	0.025
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible (SID) amino acids, %				
Lysine	1.01	0.88	0.78	0.90
Isoleucine:lysine	68	70	72	68
Leucine:lysine	172	185	200	166
Methionine:lysine	30	33	35	30
Met & Cys:lysine	58	62	67	58
Threonine:lysine	60	62	65	65
Tryptophan:lysine	17	17	17	18
Valine:lysine	80	83	87	79
Total lysine, %	1.20	1.06	0.95	1.05
ME, kcal/lb	1,559	1,563	1,567	1,551
CP, %	21.3	19.5	18.3	18.5
Ca, %	0.58	0.52	0.45	0.46
P, %	0.43	0.41	0.40	0.39
Available P, %	0.32	0.31	0.30	0.32

¹ Phase 1 diets were fed from d 0 to 26, Phase 2 from d 26 to 46, Phase 3 from d 46 to 73, and Phase 4 from d 73 to 101.

² Paylean; Elanco Animal Health (Greenfield, IN).

Table 2. Analysis of pellet quality and particle size¹

Item	Corn particle size:		50:50 blend		350 μ	
	Meal	Pellet	Meal	Pellet	Meal	Pellet
Corn particle size, μ						
Phase 1	675	675	---	---	350	350
Phase 2	616	616	---	---	336	336
Phase 3	681	681	---	---	359	359
Phase 4	656	656	---	---	355	355
Diet particle size, μ						
Phase 1	610	---	541	---	425	---
Phase 2	595	---	480	---	483	---
Phase 3	611	---	483	---	455	---
Phase 4	622	---	500	---	496	---
Standard pellet durability index, % ²						
Phase 1	---	92.8	---	94.1	---	96.0
Phase 2	---	97.6	---	93.2	---	94.5
Phase 3	---	94.1	---	91.7	---	95.8
Phase 4	---	96.8	---	92.4	---	97.8
Modified pellet durability index, % ³						
Phase 1	---	89.5	---	87.4	---	86.5
Phase 2	---	91.4	---	91.6	---	89.0
Phase 3	---	90.2	---	92.0	---	89.3
Phase 4	---	90.1	---	90.2	---	91.4
Fines, %						
Phase 1	---	9.2	---	11.7	---	11.3
Phase 2	---	9.7	---	10.5	---	8.8
Phase 3	---	18.2	---	11.9	---	10.7
Phase 4	---	20.0	---	8.6	---	11.2

¹ A composite sample of 3 subsamples was used for analysis.

² Pellet durability index was determined using the standard tumbling-box technique.

³ Procedure was altered by adding 5 hexagonal nuts prior to tumbling.

Table 3. The effect of corn particle size and diet form (meal vs. pellet) on finishing pig performance¹

Corn particle size:	Probability, P <											
	650 μ		50:50 blend ²		350 μ		SEM	Diet form $\times$ particle size		Diet form	Particle size	
	Meal	Pellet	Meal	Pellet	Meal	Pellet		Linear	Quadratic		Linear	Quadratic
Diet form:												
d 0 to 101												
ADG, lb	1.97	2.07	1.96	2.05	1.91	2.03	0.021	0.58	0.72	< 0.001	0.01	0.58
ADFI, lb	5.31	5.19	5.22	5.23	4.99	5.18	0.065	0.02	0.82	0.60	0.02	0.28
F/G	2.69	2.51	2.67	2.55	2.62	2.56	0.020	0.005	0.94	< 0.001	0.65	0.34
Weight, lb												
d 0	75.7	75.7	75.7	75.7	75.8	75.7	0.989	0.99	0.99	0.99	0.99	0.99
d 101	263.9	275.5	264.8	274.1	260.5	268.1	2.860	0.50	0.96	0.002	0.07	0.33
Carcass characteristics ³												
HCW, lb	195.4	205.3	193.4	199.4	197.4	203.6	2.017	0.34	0.63	< 0.001	0.12	0.23
Yield, %	74.1	74.5	74.3	74.4	74.6	74.3	0.402	0.68	0.41	0.80	0.94	0.77
Backfat, in.	0.72	0.74	0.72	0.72	0.72	0.75	0.026	0.32	0.62	0.33	0.42	0.56
Loin depth, in.	2.62	2.61	2.58	2.65	2.60	2.57	0.029	0.32	0.35	0.82	0.92	0.42
Lean, % ⁴	55.6	55.2	55.2	55.9	55.3	55.1	0.326	0.26	0.39	0.95	0.87	0.49

¹ A total of 960 pigs (PIC TR4 $\times$ Fast Genetics York-AND $\times$ PIC Line 02, initially 75.7 lb BW) were used in a 101-d trial with 8 pens per treatment and 20 pigs per pen.

² Equal blend of the 650- μ and 350- μ ground corn.

³ The 6 largest pigs were marketed from each pen on d 87. All remaining pigs were marketed from each pen on d 101. Carcass characteristics other than yield were adjusted by using HCW as a covariate.

⁴ Calculated using NPPC (1991) guidelines for lean containing 5% fat. Lean % = $(2.83) + (0.469 \times (\text{HCW})) - (18.47 \times (\text{fat depth})) + (9.824 \times (\text{loin depth})) / (\text{HCW})$.