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Does diet form (pelleted vs meal) affect optimum particle size of corn for finishing pigs? (1992)

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DOES DIET FORM (PELLETED VS MEAL) AFFECT OPTIMUM PARTICLE SIZE OF CORN FOR FINISHING PIGS?

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Summary

One hundred and sixty pigs, with an average initial wt of 121 lb, were used in an experiment to determine the effects of diet form and particle size on growth performance and nutrient digestibility. The pigs were fed corn-soybean meal-based diets with the corn milled to particle sizes of 1,000, 800, 600, or 400 μm. The diets were fed in meal and pellet forms. In general, reducing particle size increased electrical energy required for milling and decreased production rate. Milling to 400 μm, as opposed to 600 μm, required twice as much electrical energy and reduced production rate by 50%. Reducing particle size of the corn from 1,000 to 400 μm resulted in a 4% increase in DE of the diets and 6% decrease in ADFI. The net result was similar DE intakes, with 22% less daily fecal excretion of DM, 25% less daily fecal excretion of N, and 7% greater efficiency of gain when particle size was reduced from 1,000 to 400 μm. Pelleting the diets resulted in 3% greater ADG and 6% greater efficiency of gain. Also, pelleting increased digestibilities of DM, N, and GE by 5 to 7%. Stomach keratinization and lesions increased with reduced particle size and pelleting, but performance was not affected. In conclusion, particle size reduction and pelleting improved efficiency of gain and decreased daily excretion of DM and N in the feces, with some increase in ADG because of pelleting.

(Key Words: Process, Particle Size, Pellet, Performance, Stomach Ulcer, G-F.)

Introduction

Particle size reduction is a process fundamental to preparation of ingredients for swine and is usually accomplished by grinding in a hammermill or roller mill. Grinding improves mixing and handling characteristics of ingredients (e.g., increased uniformity of blended diets and decreased segregation of ingredients) and efficiency of growth via increased nutrient digestibility. However, bridging can be a problem for diets with cereal grain particle size < 800 μm, thus requiring more attention to management, repairs, and design (especially agitators) of feeders.

Pelleting is a process used to prevent segregation and improve handling characteristics of mixed diets and would eliminate bridging problems in diets with small particle sizes. Pelleting improves efficiency of gain, but the response is thought to result from decreased feed wastage rather than improved nutrient digestibility. Thus, grinding and pelleting improve growth performance by different mechanisms, with the possibility that their benefits may be additive. The experiment reported herein was designed to determine the effects of pelleting diets with mean particle sizes ranging from 1,000 to 400 μm. Attention was given not only to potential positive effects on growth performance, but also to any negative effects from

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increased processing inputs or stomach lesions caused by fine grinding and(or) pelleting.

Procedures

A total of 160 finishing pigs (two groups of 80 pigs), with an avg initial wt of 121 lb, were blocked by weight and allotted to eight dietary treatments based on sex and ancestry. There were two pigs per pen and 10 pens per treatment. In the first group, 80 barrows were used (two per pen) and in the second group, 40 barrows and 40 gilts were used (one barrow and one gilt per pen). The pigs were housed in a totally enclosed, environmentally regulated building with a slatted floor. Each pen (5 ft × 5 ft) had a one-hole self-feeder and nipple waterer. The basal diet (Table 1) had corn ground to four particle sizes (1,000, 800, 600, or 400 μm) and was fed as meal and pellets. This resulted in a 4 × 2 factorial arrangement of treatments. The corn for the two groups of pigs had 12.5 and 13.0% moisture, respectively. To achieve desired particle sizes of 1,000, 800, 600, and 400μm, hammermill screens with openings of 3/8, 3/16, 1/8, and 1/16 in. were used in Rep. 1, and 1/2, 3/8, 3/16, and 1/16 in. were used in Rep. 2, respectively. A constant motor load during milling was maintained so production rate and electrical energy consumption could be measured. Pellet durability was recorded for the pelleted diets.

Five weeks after initiation of the experiment, chromic oxide was added to the diets (.20%) as an indigestible marker. After a 5-d adjustment period, fecal samples were collected from each pig and pooled within pen. The fecal and diet samples were dried; ground; and analyzed for Cr, DM, gross energy, and N concentrations so that apparent digestibilities of DM, energy, and N could be calculated. The pigs were slaughtered when each weight block reached an average of 250 lb. Hot carcass weight and last rib fat thickness were recorded, and stomachs were collected for evaluation of changes in morphology. Hot carcass wt was used as a covariate in analyses of last rib fat thickness.

Table 1. Composition of Basal Diet[a]

Ingredient	%
Corn	82.53
Soybean meal (48% CP)	14.37
Monocalcium phosphate	1.08
Limestone	1.02
Salt	.30
Vitamins and minerals[b]	.60
Antibiotic[c]	.10
Total	100.00

[a]The basal diet was formulated to .65% lysine, .65% Ca, .55% P, and 1.56 Mcal DE/lb.
[b]KSU vitamin mix (.25%), KSU mineral mix (.10%), and KSU selenium mix (.05%), with .20% chromic oxide added as an indigestible marker.
[c]Antibiotic supplied 100 g/ton chlortetracycline.

Results and Discussion

Measurements of milling characteristics are given in Table 2. Energy required for milling to 1,000, 800, and 600 μm increases slightly as particle size was reduced. However, milling to 400 μm required more than twice as much energy as milling to 600 μm (7.35 and 3.46 kWh/t, respectively). Likewise, production rate decreased sharply (2.85 vs 1.43 t/h) as particle size was reduced from 600 to 400 μm. Energy required for pelleting was similar for diets with the different particle sizes, but pellet durability increases from 78.8 to 86.4% as particle size of the corn was decreased from 1,000 to 400 μm.

Average daily gain was not affected by particle size of the diets ($P > .30$). However, feed intake was reduced with fine grinding ($P < .01$), so that efficiency of gain was increased by 7% (linear, $P < .001$) as particle size was reduced from 1,000 to 400 μm. The improvements in efficiency of gain associated with particle size reduction correlated well with the improvements of 3, 5, and 4% for digestibilities of DM, N, and GE as corn particle size was reduced from 1,000 to 400 μm. Thus, total feed intake was decreased by fine grinding, but the nutritional value of that feed was increased, and improved efficiency of gain resulted.

A somewhat surprising response was that apparent feed intake was not reduced with pelleting. Historically, improved F/G with pelleted diets has been attributed to decreased feed wastage, giving decreased apparent feed intakes. In the present experiment, much attention was given to proper feeder adjustments to minimize wastage of meal and(or) pelleted diets. Given the similar feed intakes and greater nutrient digestibilities for pelleted diets (i.e., 5, 7, and 7% increases for digestibilities of DM, N, and GE), improvements in rate and efficiency of gain must be attributed to improved nutritional value of the pelleted diets and not to reduced feed wastage.

Another important issue facing swine producers is manure disposal. Thus, the effects of reducing particle size and pelleting on fecal excretion of DM and N was calculated. Reducing particle size of corn from 1,000 to 400 μm reduced daily excretions of DM and N by 22 and 25%, respectively. Pelleting reduced daily excretions of DM and N by 24 and 22%, respectively. These reductions in daily excretion of DM and N represent advantages to fine grinding and pelleting that should not be overlooked.

In contrast to the positive effects of fine grinding and pelleting on performance, negative effects of increased keratinization (an indication of irritation) and lesions (actual erosion of tissue) in the esophageal region of the stomach were detected. Both criteria increased linearly as particle size was reduced from 1,000 to 400 μm ($P < .001$). However, the significance of these increases is questionable, because there were no changes in growth performance or health of the animals. This does not exclude the possibility that finely ground corn may aggravate a genetic predisposition to stomach lesions, but it certainly does question the validity of assuming that finely ground diets (e.g., 600 to 400 μm) will cause severe stomach lesions in all populations of pigs.

In conclusion, particle size reduction and pelleting are processing methods that can improve growth performance and reduce manure disposal problems. Considering milling costs, growth performance, nutrient digestibility, and stomach morphology, a particle size of 600 to 500 μm is recommended for both meal and pelleted diets.

Table 2. Characteristics of Corn and Diets

	Particle size treatment, μm			
Item	1,000	800	600	400
Grain mean particle size, μm	1,020	778	650	450
Variation in particle size of grain (Sgw)	2.50	2.23	1.97	1.72
Diet mean particle size, μm	1,017	886	705	517
Variation in particle size of diet (Sgw)	2.55	2.22	2.05	1.78
Milling energy, kWh/t	2.42	2.78	3.46	7.35
Milling production rate, t/h[a]	3.00	3.00	2.85	1.43
Pellet durability, %	78.8	79.4	82.4	86.4

[a]Milling production rate of the 1,000 μm treatment was limited by capacity of the exit augers (i.e., 3 t/h).

Table 3. **Effects of Particle Size and Diet Form on Performance of Finishing Pigs[a]**

	Meal				Pellet				
Item	1,000	800	600	400	1,000	800	600	400	CV
ADG, lb/d[b]	2.11	2.07	2.09	2.17	2.18	2.21	2.24	2.16	6.8
ADFI, lb/d[e]	7.16	7.07	7.19	6.97	7.25	7.01	7.06	6.58	5.4
F/G[cf]	3.39	3.42	3.44	3.21	3.33	3.17	3.15	3.05	5.9
Last rib BF, in.	1.2	1.2	1.3	1.2	1.2	1.2	1.2	1.2	10.8
Dressing percentage	73.09	73.59	73.08	73.97	73.58	73.26	74.05	73.96	1.0
Apparent digestibility, %									
DM[cd]	80.77	81.78	79.57	83.87	84.85	84.77	85.57	87.04	2.6
N[cd]	73.27	74.31	73.10	77.18	78.39	78.28	79.21	82.69	4.5
GE[ceg]	80.00	80.28	78.55	83.95	85.07	85.36	86.13	87.96	2.7
Intake of digestible nutrients, lb/d									
DM[h]	5.68	5.69	5.86	5.68	6.13	5.80	5.68	5.59	4.9
N	.121	.122	.128	.123	.133	.126	.124	.125	6.0
DE[h]	11.21	11.14	11.55	11.32	12.26	11.63	11.41	11.25	4.9
Fecal excretion, lb/d									
DM[ce]	1.36	1.27	1.41	1.09	1.09	1.04	.96	.83	15.4
N[ce]	.044	.042	.043	.036	.037	.035	.032	.025	16.8
Stomach keratinization[f]	.95	1.68	1.25	2.13	.95	1.88	1.95	1.96	18.6
Stomach lesions[f]	.10	.15	.45	.80	.20	.68	.40	.85	25.3

[a]160 pigs (2 pigs/pen and 10 pens/trt) with an avg initial wt of 125 lb and an avg final wt of 253 lb.
[bc]Pellet vs meal ($P < .01$ and $P < .001$, respectively).
[def]Linear effect of particle size reduction ($P < .05$, $P < .01$, and $P < .001$, respectively).
[g]Quadratic effect of particle size reduction ($P < .05$).
[h]Pellet vs meal × particle size linear ($P < .05$).