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Swine Feed Efficiency: Influence of Particle Size

Terry L. Steinhart
Iowa State University, tsteinha@iastate.edu

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Abstract
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Author
Terry L. Steinhart, Iowa State University

Reviewers
Mike D. Tokach, Kansas State University
Joel M. DeRouchey, Kansas State University

Introduction

The primary energy sources in swine diets are cereal grains. Feed accounts for 70% of the cost of production in a swine operation; thus any improvement in feed efficiency will have a huge impact on cost of production.

When you reduce the particle size of feed ingredients, the surface area of the grain is increased. This will allow greater interaction with digestive enzymes. Handling and mixing of ingredients will improve as particle size is reduced up to the point where continued reduction in particle size may cause bridging of the feed in feeding systems. Too fine of a grind may increase dust problems, feed processing cost, and incidence of gastric ulcers in swine. Thus, improved feed conversion from reduced particle size must be offset by these disadvantages.

In the past, dietary particle size was often classified as fine, medium and coarse. These terms were not very precise. A better classification is now based on the average geometric diameter of particles measured in microns and the geometric standard deviation of the particle distribution. This definition of particle size now allows specific recommendations to optimize swine performance.

The optimal particle size is influenced by the age of pig and diet form (pellet or meal). Pigs of all ages benefit from smaller micron feed. However, studies have shown that young pigs have less benefit to the smallest particle sizes than finishing pigs. Smaller particle sizes can be used with pellets because the dustiness and flow problems associated with small particle size in meal diets are not an issue and smaller particle sizes help to improve pellet quality.

Growing Pigs

Research has shown that reducing particle size from 900 microns or greater to 500 microns improves feed efficiency by approximately 1 to 1.2% for every 100 micron reduction in particle size. The reduction in particle size does not appear to influence daily gain. As an example, Healy et al. (1994) fed starter diets to 21 day old weaned pigs with grain ground to 900, 700, 500, or 300 microns. The grain was corn and hard or soft endosperm milo. Reducing grain particle size to 500 microns had little effect on daily gain, but reduced average daily feed intake resulting in improved feed efficiency. Grinding finer than 500 microns did not further improve performance. The production rate (tons of grain manufactured per hour) also was reduced as particle size decreased. The energy cost for the particle size reduction can be offset by the improvement in feed efficiency as long as the available equipment can meet the grain processing needs.

Table 1: Effect of Diet Particle Size on Growth Performance of Nursery Pigs.

	Particle size, microns			
Item	900	700	500	300
Average daily gain, lb	0.84	0.80	0.85	0.78
Average daily feed intake, lb[a]	1.29	1.21	1.23	1.19
Feed efficiency[b]	1.55	1.52	1.46	1.53
Production rate, tons/hour	4.06	2.84	1.63	0.85

Adapted from Healy et al., 1994.
[a]Linear effect ($P < 0.08$); [b]Quadratic ($P < 0.01$).

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For finishing pigs, several studies have demonstrated that grinding to less than 500 microns continues to improve feed efficiency to the lowest particle size tested. The advantage in F/G from research with less efficient genetics in the 1990's demonstrated a 1.2% improvement in F/G for each 100 micron reduction in particle size (Figure 1). More recent research (Figure 2) found a 1% improvement in F/G for each 100 micron reduction in particle size. Health challenges can make some genetics more susceptible to gastric ulcers than others. These factors must be considered in determining the optimal particle size to be used on a given farm.

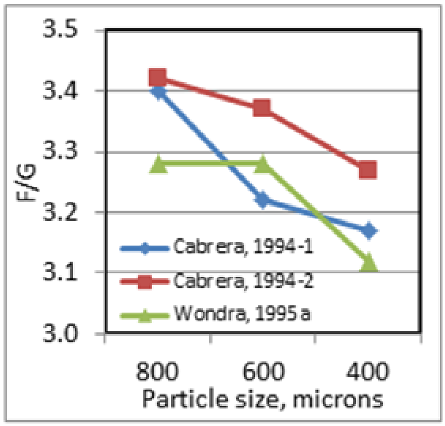

Figure 1: Influence of Particle Size on F/G. Data from 1990's.

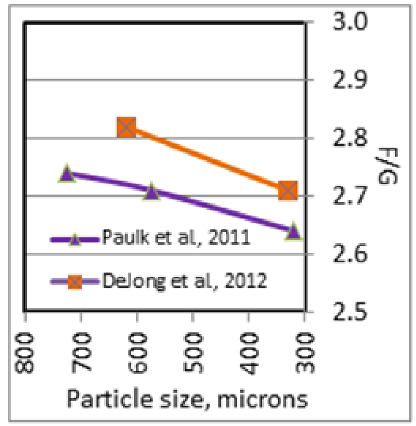

Figure 2: Influence of Particle Size on F/G. Data from 2011 and 2012.

Sows

Wondra et al. (1995) fed lactating sows diets with 1,200, 900, 600, or 400 microns. Reducing particle size from 1200 to 400 microns improved litter weight gain by 1.3% for every 100 micron reduction in particle size. Most producers worry that feed intake will be decreased for lactating sows when particle size is reduced in meal diets. Their research found that intake was actually increased by decreasing the particle size. Subsequent research has confirmed this response. Reduction in particle size does not come without a cost. Stomach ulcerations increase as particle size is reduced. Although no research is available with gestating sows, the benefit to particle size reduction would be expected to be less than with lactating sows because of the differences in feed intake. Thus, grain for lactating sow diets should have a similar particle size as that for nursery or finishing pigs, but producers may want particle size to be larger for gestating sows.

Conclusion

Because reducing particle size of grain improves digestibility and feed efficiency, there is a considerable economic incentive to feeding grain with small particle size. However, fine grinding can also increase electricity usage, decrease feed production rate, increase ulcers, and increase dustiness and decrease flow ability of the diet. Because the optimal particle size is influenced by so many factors, nutritionists, veterinarians, and feed mill managers must work together to determine the optimal particle size for a production system.

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