Assessing Particle Size and the Cost of Grinding

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Particle size reduction improves feed efficiency in all stages of the production cycle in pigs. Based on studies by researchers at Kansas State University (KSU), an average particle size of 700 to 800 microns (um) is recommended. However, this recommendation is based on studies conducted using corn-soybean meal based diets. To our knowledge, there is no information on the effect of particle size in wheat and barley-based diets from on-farm mills in Western Canada. This presents an opportunity to improve animal performance and income for producers by improving our understanding of particle size under regional conditions. Feed and ground grain samples from 1 toll mill facility and 4 on-farm mills (2 Alberta and 2 Saskatchewan) were collected and analyzed for average particle size to establish the variability among mills. Hammer mill was the most common type of mill, with all but one of the participants using this grinding system.

Particle Size Variability

Particle size in samples of wheat ranged from 697 to 889 um and averaged 795 um. On average, wheat was ground within standards set by the Kansas State University (700 to 800 um using corn-soybean meal-based diets) while barley particle size was slightly coarser, but within acceptable variation limits (+ 10%). Particle size of complete feeds, from two of the farms sampled, were higher than KSU recommendations indicating possible losses in terms of feed efficiency. Variability in diet particle size was possibly due to the type of primary grain used, other ingredients, and their proportion in the overall formulation. All farms were aware of the benefits of particle size reduction in improving feed efficiency; however none of the participants had a quality control program in place to monitor particle size.

Flow-ability

A majority of the participants cited reduced flowability when grinding grains (or diets) to a smaller particle size, with finely ground diets creating greater issues within the mill and feeding systems. However, results suggest that bulk density, fat content and their interaction with particle size may also have an impact on flowability within the feeding system. Regardless of particle size, wheat and wheat-based diets flowed better than barley and barley-based diets.

Table 1. Average particle size of swine diets from on-farm mills in Saskatchewan and Alberta.

Location	Grinder	No. of feed types sampled	Annual feed production, tonnes	Average particle size (dgw), um		
Saskatchewan	Hammer mill	7	9,600	904	(851-945)	a
Saskatchewan	Hammer mill	6	4,000	906	(831-968)	a
Saskatchewan	Hammer mill	2	35,000	732	(728-737)	b
Alberta	Hammer mill	2	3,780	697	(676-717)	b
Alberta	Disk mill	6	5,600	749	(657-795)	b
			57,980			
P-value				<.0001		

Grinding Efficiency

The second phase of the project utilized five individual sources of wheat and barley, each ground to an average particle size of 550, 700 and 850 um using either a hammer or a roller mill to determine the effect of grain type (wheat vs. barley), grinder type particle size and their interactions on grinding cost, and particle and handling characteristics of ground grains.

Results show that production rate (tonnes per hour ,TPH) was 45% higher when grinding wheat compared to barley. Grinding grains using the roller mill resulted in 14% higher production rate compared to hammer mill. Regardless of grain and type of grinder, there was a significant linear decrease in production rate (5.02 to 4.01 TPH) when grinding grains from 850 to 550 um. With current power costs (2016), grinding barley using the hammer mill resulted in a higher power consumption (3.39kWh/t) compared to wheat, consequently increasing the grinding cost of barley by $0.36/tonne (Fig. 1). Regardless of particle size, grinding cost between wheat and barley was similar when a roller mill was used.

Grinding barley using a hammer mill had the highest grinding cost

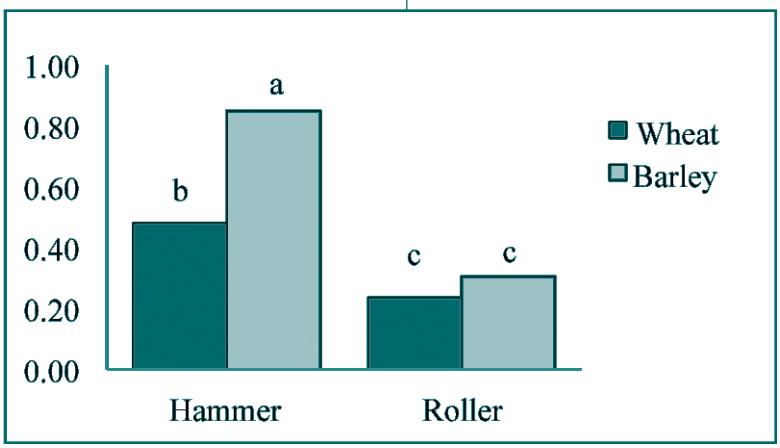

Fig. 1. Effect of grain and grinder on grinding cost, $/tonne.

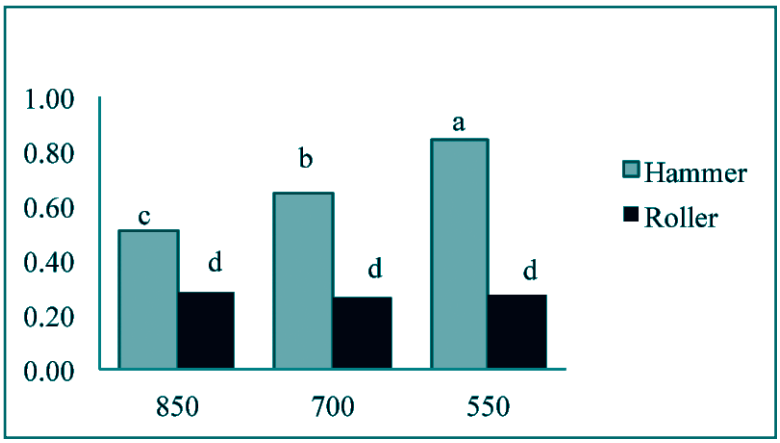

Fig. 2. Particle size and grinder on grinding cost, $/tonne

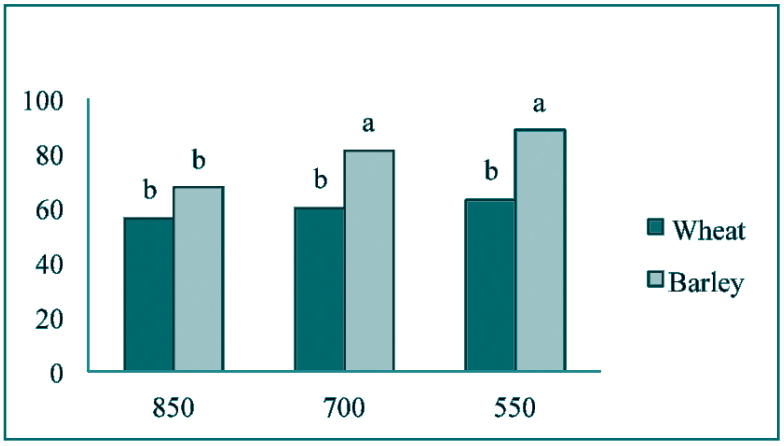

Fig. 3. Effect of grain and particle size on emptying angle of repose.

Grinding grains from 850 to 550 um using the hammer mill increased power consumption by 3.17 kWh/t resulting in $0.34/tonne increase in grinding cost. However, there were no differences in power consumption and grinding cost when reducing the particle size of grains using the roller mill (Fig. 2). Reducing the particle size of barley from 850 to 550 um significantly reduced its flowability (Fig. 3).

Implications

Grinding barley from 850 to 550 um using the hammer mill had the highest grinding cost, ranging from $0.64 - $1.05/mt. Using this information and assuming a feed efficiency improvement of 1.3% for every 100 um reduction in particle size for barley based diets, a net savings of $7.80/pig in total feed cost may be achieved just by reducing the particle size of barley by 300 um . To address flowability issues associated with grinding finely, finding the optimum ratio between wheat and barley may address this issue because wheat is more flowable than barley even at lower particle size.