Project Number & Title 4B-112: Optimising particle size distribution for grains and protein sources

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Aims and Objectives. Previous Pork CRC projects had shown that reducing the amounts of milled grain particles > 1 mm in size (for sorghum, or 1.7 mm for barley) improves feed conversion ratios in both weaner and grower pigs. This project built on these findings by:

1. Evaluating the particle size distributions of milled grains currently used in feeds by both large and small producers, using a custom built hand-held sieving device.
2. Testing in the laboratory whether the same underlying particle size mechanism applies to field peas for both starch and protein digestion.
3. Testing in weaner pig trials whether variations in particle size below 1 mm have any effects on FCR or growth rate for field peas or sorghum.
4. Investigating the composition and particle sizes of residual feed at the ileum as a function of passage time using a cannulation model.

Key Findings For the four target areas described above:

a. There is a wide range of particle size (distributions) for milled grains in current production, including many with a high percentage of > 1 mm particles. Measurement of particle size distribution can be simple but is rarely carried out.
b. The same diffusion-controlled digestion process found for starch in milled cereal grains also applies for both starch and protein in field peas as a model legume.
c. For mean particle sizes between 0.4 and 0.8 mm, there were no significant performance differences for weaner pigs on sorghum- or pea-rich diets.
d. The cannulation time course study showed very low levels of starch and no large particles (> 0.5 mm) at the ileum. Feeds with larger particles had a slower rate of passage, suggesting that the negative effect of large particle sizes on feed efficiency observed previously may be related to passage rate as well as digestibility effects.

Application to Industry

I. Particle size management is an important and potentially overlooked aspect of feed quality, particularly by smaller producers. A hand-held on-site sieving device prototype gave essentially the same results as conventional laboratory sieving analysis, and offers the potential for on-site adjustment of milling parameters (particularly to reduce the levels of particles greater than 1 mm in size) with predicted impact on animal performance.
II. Starch and protein digestion in field peas follows the same 'outside-in' diffusion process as in cereal grains, offering a potential new approach to nutrient synchrony by combining protein and starch sources with similar enzyme digestion rates.
III. For diets containing 49% sorghum or 30% pea with milled grain or legume particle size distributions in the 0.4 – 0.8 mm range, there is unlikely to be significant differences in animal performance efficiency even though up to 40% of sorghum/pea particles are 1 mm or larger. In contrast, reducing the percentage of sorghum or barley particles larger than 1 mm has previously been shown to improve efficiency in diets containing 72% of the grain. This suggests that larger particles may be more tolerated in diets containing diverse grains than in single grain formulations.
IV. The current focus on digestion rates as the reason why larger particles reduce animal performance needs to be broadened to include gastric emptying rates.