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Aims and Objectives

Grain particles not digested in the small intestine (SI) and fermented in the lower gut reduce efficiency of feed use (15% energy lost as heat, methane and microbes) and intake (activation of ileal brake). Rate of grain digestion depends on enzyme diffusion rate (EDR), which varies widely with structure and composition of grains and processing (milling, heat, exogenous enzymes). Threshold particle size, where all grain is digested in the SI, is determined primarily by EDR. This project aimed to measure EDR for a range of grains/processing and develop a threshold particle size calculator.

Key Findings

1. Enzyme diffusion rates can be determined for a wide range of grains (wheat, barley and sorghum) through laboratory analysis of first-order kinetic rate constants as a function of milled grain particle size.
2. Wheat and barley have faster enzyme diffusion rates than sorghum, consistent with relative in vivo digestibility.
3. Particle size cut-offs for efficient small intestinal digestion can be predicted from EDR.
4. Fibre can affect the relationship between EDR and ileal digestible energy, probably through effects on passage rate. Fibre-adjusted ileal DE correlates reasonably with EDR
5. NIR shows promise as a tool to determine EDR non-invasively, but more calibration samples are needed to validate.

Application to Industry

Recommendations include:

- The particle size distribution of milled grains should be routinely assessed
- For efficient use in feeds, it is predicted that milled wheat/barley should not contain particles greater than 0.8-1.0 mm to ensure digestion in the small intestine.
- For sorghum, the particle size cut-off is predicted to be lower at about 0.6-0.8 mm
- Multi-pass milling should be considered as a route to assuring the absence of over-size particles without generating fines.
- Further work should be carried out to generate a NIR calibration for amylase diffusion coefficient and link this to particle size specifications for maximal feed efficiency from grains.