

## Characteristics of starch granules influence energy digestion in wheat and barley for pigs and poultry

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Starch granule characteristics vary significantly within and between grains (1). Granule composition and structure is thought to influence the digestive process in pigs (2) and poultry (3). This experiment was conducted to investigate the characteristics of starch granules in wheat and barley and the relationship to energy digestion in pigs and poultry.

Three samples of barley and wheat with differing pig digestible energy (DE) and poultry apparent metabolisable energy (AME) content were selected using *in vivo* data. Total starch and amylose content of the samples were determined and then total amylopectin was calculated. Two replicates per sample were prepared for assessment of starch granules by light microscopy using a modification (0.5 mg sample instead of 0.1 mg) of the method developed by (4). The diameter and area of starch granules (around 2000 per sample) were measured using an image analyser. Starch granules were categorised as small if less than 10µm or large if greater than 10µm. The relationship between these data, amylopectin : amylose ratios and their energy values in pigs and poultry were compared.

	Barley 1	Barley 2	Barley 3	Wheat 1	Wheat 2	Wheat 3
Mean area (µm <sup>2</sup> )	25.46	35.94	35.97	27.62	37.98	30.59
Mean diameter (µm)	3.20	4.07	3.94	4.33	4.73	4.05
Large starch granule (%)	8.6	17.3	23.2	56.3	46.9	37.8
DE (MJ/Kg)	10.70	12.09	12.99	13.78	13.94	14.79
AME (MJ/Kg)	11.51	10.20	11.79	14.10	13.40	14.28
Amylopectin/amylose ratio	0.35	0.39	0.52	0.74	0.57	0.78

The diameter and area of starch granules were greater in high DE barley than in lower DE barley. Also, the proportion of large starch granules and amylopectin in the high DE barley was high. Amylopectin has an amorphous structure which allows rapid access of moisture and enzymes to substrates (1). Therefore, the enzymatic breakdown of barley with higher amylopectin content may occur faster. In contrast, wheat with a greater proportion of small granules had a higher DE value. The amylopectin content in all the wheat samples were higher than the barleys and there was no relationship between amylose and DE. The larger surface area associated with smaller starch granules in wheat may increase enzyme accessibility to substrates. The lack of a relationship in poultry suggests that starch granules are effectively broken into smaller particles by the grinding action of the gizzard, but not so by the stomach of pigs. However, high amylose content in wheat but not in barley was associated with reduction of AME in poultry. In conclusion, starch granule characteristics may provide a basis for predicting DE for pigs and AME for poultry.

1. Evers AD, Blakeney AB, O'Brien L. Aust J Agric Res 1999;50(5):629-650.
2. van Barneveld RJ. Aust J Agric Res 1999;50(5):667-87.
3. Moran ET, Jr. Poultry Sci 1982;61(7):1257-1267.
4. Fulcher RG, Churchill K, Peterson D, Medin T. Cereal Chem Conf. Perth, Australia, 1997:129-32.