Comparative starch, energy and amino acid digestibility and characterization of undigested starch using confocal laser scanning of pulse and cereal grains in growing-finishing pigs

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Starch is one of the major chemical components to predict net energy (NE) value of feedstuffs, but NE value may vary depending on apparent ileal digestibility (AID) vs. apparent total tract digestibility (ATTD) of starch. Starch structure and digestibility may differ depending on the botanical origin of the starches. The objectives were to determine digestibility of starch, energy, and amino acids, and to characterize undigested starch of grains in growing-finishing pigs. Seven ileal-cannulated barrows (initial body weight (BW) 30 kg) were fed 6 diets containing 96% of 1 of 6 feedstuffs (pulse: faba bean, field pea, chick pea; cereal: barley, wheat, or corn) or a N-free diet in a 7 × 7 Latin square at 2.8 × maintenance digestible energy (DE) to collect fecal and digesta samples. Apparent hindgut fermentation (AHF) was calculated as ATTD − AID. Starch structure of feedstuffs and digesta was analyzed using confocal laser scanning microscopy (CLSM) and scanning electron microscopy (SCEM). The AID of starch was lowest in faba bean (85.3%), followed by field pea, chick pea, and was greatest for cereals (93-96%). The AHF of starch was greatest for pigs fed faba bean (14.6%) and field pea (12.7%). The AHF of energy was greater in pigs fed pulses than pigs fed cereals (17-20% vs. 8-11%). The ATTD of crude protein (CP), however, was greatest for faba bean (90.8%). Wheat had the greatest standardized ileal digestibility (SID) of CP (90.8%) and majority of the amino acids (AA) (except Lys and Asp). The CLSM revealed that pulses had more prominent starch granules that were embedded in protein matrixes, hence more starch granules remained in the digesta. In SCEM images, starch granules of corn are smallest which may have contributed to greater AID of starch (97%). In conclusion, AID of starch in cereals is greater than pulses; however, the ATTD of starch was 99% across feedstuffs, indicating starch is almost completely degraded. The greater fermentation of pulse grain will contribute to its energy value. The variation in AID of AA and ATTD of energy indicated possible interactions between starch and other macronutrients such as protein and fiber.

Implications: The accuracy of formulating pig diets containing pulse and cereal grains based on NE values can be enhanced if starch is defined by its enzymatically-digestible and fermentable fractions.