

# Effects of extrusion on nutrient and energy digestibility in cereal grains fed to growing pigs

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## Abstract

Two experiments were conducted to determine effects of extrusion on energy and nutrient digestibility in cereal grains fed to growing pigs. One source of yellow dent corn, wheat, and sorghum, were ground and divided into 2 batches. One batch of each grain was extruded, whereas the other batch was used without further processing. Ileal digestibility of starch and AA in each grain was determined using 7 ileal cannulated barrows that were allotted to a 7×7 Latin square. Results indicated that extruded grains had greater ( $P<0.001$ ) apparent ileal digestibility (AID) of starch than non-extruded grains. Extrusion increased standardized ileal digestibility (SID) of CP and all AA except Pro in corn, but that was not the case for wheat and sorghum. Exp. 2, 48 barrows were allotted to a randomized complete block design. Apparent total tract digestibility (ATTD) of GE was increased by extrusion of corn or sorghum, but not of wheat (interaction,  $P<0.001$ ). The ATTD of NDF in wheat was reduced by extrusion, but not for corn and sorghum (interaction,  $P<0.001$ ), but extrusion reduced ( $P<0.05$ ) the ATTD of ADF in all grains. Extrusion increased the digestible energy (DE) and metabolizable energy (ME) in corn and sorghum, but there was no increase for wheat (interaction,  $P<0.001$ ). In conclusion, extrusion increased the AID of starch and the ATTD of energy in all grains increased by extrusion. SID of AA in corn and ME of corn and sorghum also increased after extrusion.

**Keywords:** extrusion, gelatinization, grains, starch, swine

## Introduction

Extrusion as a feed technology commonly used in cereal grains can improve, growth performance of weanling pigs (Hancock and Behnke, 2001) because of the effects of heat, moisture, and pressure that is applied during extrusion. This process may increase starch digestibility in field peas and mixed diets due to starch gelatinization and improves digestibility of starch and amino acids (AA) (Rojas *et al.*, 2016; Stein and Bohlke, 2007). Extrusion of mixed diets may also increase the concentration of digestible energy (DE) and of metabolizable energy (ME) and the response seems to be more pronounced in high fiber diets than in low fiber diets indicating that extrusion may increase the solubility of dietary fiber (Rojas *et al.*, 2016). Although cereal grains generally have low concentrations of dietary fiber, it is possible that if extrusion results in increased digestibility of starch or AA, the digestibility of energy may also increase, but data to verify this hypothesis have not been published. Therefore, the objective of these experiments was to test the hypothesis that the ileal digestibility of AA and starch, and the apparent total tract digestibility (ATTD) of ADF, NDF, and GE as well as the DE and ME in corn, wheat, and sorghum may be increased by extrusion.

## Materials and methods

Yellow dent corn, wheat, and sorghum were ground to approximately 500 microns and divided into 2 batches. One batch of each grain was used without further processing, whereas the other batch was extruded. Two experiments were conducted. In Exp. 1, 7 diets were formulated to contain one of each non-extruded or extruded cereal grain and a N-free diet was also formulated to determine endogenous losses of AA in pigs. Seven cannulated barrows (initial BW=14.2±0.9 kg) were allotted to a 7×7 Latin square design; therefore, there were 7 observations per treatment. Diets were fed for 7 d. The initial 5 d of each period was the adaptation period to the diet, and ileal digesta were collected

on d 6<sup>th</sup> and 7<sup>th</sup> using standard procedures. In Exp. 2, 6 diets were formulated to contain one of each non-extruded or extruded cereal grain. Forty eight growing barrows (initial BW=15.1±3.7 kg) were allotted to a completely randomized block design. Pigs were fed experimental diets for 12 d. The initial 5 d were considered an adaptation to the diet. Subsequently, urine and fecal materials were collected using the marker to marker approach (Adeola, 2001).

## Results and discussions

There was no interaction between source of grain and processing for the AID of starch. However, the extruded grains had greater ( $P<0.001$ ) AID of starch than non-extruded grains. This increase is most likely as a result of the observed increase in starch gelatinization because gelatinized starch is more available for intestinal enzymes (Rojas *et al.*, 2016). The AID and SID of CP and AA in wheat and sorghum were not affected by extrusion, but extruded corn had greater AID of CP and all AA except Pro than non-extruded corn (interaction,  $P<0.05$ ). The SID of CP in corn was increased by extrusion, but that was not the case for wheat and sorghum (interaction,  $P<0.01$ ). This observation is in agreement with previous data when field peas and mixed diets were extruded. The reason for this increase may be that heat from extrusion changes the 3-dimensional structure of protein, and thus, increases access of digestive enzymes to the peptide bonds (Rojas *et al.*, 2016; Stein and Bohlke, 2007). The ATTD of NDF in diets containing wheat was reduced by extrusion, but the ATTD of NDF in corn and sorghum was not affected by extrusion (interaction,  $P<0.001$ ). Extrusion reduced ( $P<0.05$ ) the ATTD of ADF in all grains. This is most likely a result of the most fermentable parts of the fiber in the grains being solubilized during extrusion because it was observed that the concentrations of ADF and NDF were reduced in the extruded grains. This solubilization likely led to a high concentration of insoluble fiber remaining in the extruded grains, resulting in reduced fermentation by the pigs. The ATTD of GE was increased by extrusion of corn or sorghum, but that was not the case for wheat (interaction,  $P<0.001$ ). Extrusion also increased the DE and ME in corn and sorghum compared with non-extruded grains, but there was no increase in DE or ME by extruding wheat (interaction,  $P<0.001$ ). This increase is likely a result of the increased AID of starch and AA observed in Exp. 1. In conclusion, extrusion increased AID of starch and the SID of AA in cereal grains fed to growing pigs, and as a result, the ATTD of energy was also increased. The ME of corn and sorghum was also increased by extrusion, but that was not the case for wheat.

## References

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