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Short communication

The effect of feeding barley on diet nutrient digestibility and growth performance of starter pigs

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ABSTRACT

Wheat and barley are feed grains used as dietary sources of energy for swine in western Canada, Australia and northern Europe. Inclusion of high quality (HQ) barley grain in starter pig diets is limited due to its greater fibre content and lower net energy (NE) value than wheat. Low quality (LQ) barley due to adverse agronomic conditions is also available, but its feed value for young pigs is unknown. To explore, 280 starter pigs (initial body weight: 8.65 ± 0.87 kg) were fed pelleted diets including HQ or LQ barley (with or without balancing for NE value) to replace 650 g wheat/kg for 3 weeks starting 1 week post-weaning. Five diets were formulated as [MJ NE/kg; g standardised ileal digestible (SID) lysine/MJ NE]: 1) wheat (10.0, 1.07); 2) HQ barley (10.0, 1.06); 3) LQ barley without NE correction (9.76, 1.09); 4) LQ barley with NE correction (10.0, 1.06); and 5) LQ barley with low NE value (9.42, 1.12). The apparent total tract digestibility coefficient (CATTD) of gross energy (GE) was greater ($P < 0.05$) for the wheat diet than for barley diets. The CATTD of GE was lower ($P < 0.05$) for the HQ barley diet than for LQ barley diets and greater ($P < 0.05$) for the LQ low NE barley diet than the LQ barley diet without NE correction. The digestible energy (DE) and predicted diet NE value were greater ($P < 0.05$) for the wheat diet than barley diets except for the LQ barley diet with NE correction. These energy values were lower ($P < 0.05$) for the HQ barley diet than for LQ barley diets and greater ($P < 0.05$) for the LQ barley diet with NE correction than LQ barley diets without NE correction or low NE. For day 1–21, average daily feed intake (ADFI), average daily gain (ADG) and feed efficiency (G:F) of the wheat diet did not differ from that of the HQ barley diet but was lower ($P < 0.05$) than those of LQ barley diets. The ADG of the HQ barley diet did not differ from LQ barley diets. The NE correction did not affect ADFI, ADG and G:F of LQ barley diets. In conclusion, despite lower nutrient digestibility and energy value, LQ or HQ barley can fully replace wheat grain in diets for starter pigs and achieve equivalent or better growth performance.

Abbreviations: AA, amino acids; ADF, acid detergent fibre; ADFI, average daily feed intake; ADG, average daily gain; BW, body weight; CATTD, apparent total tract digestibility coefficient; CP, crude protein; DE, digestible energy; DM, dry matter; GE, gross energy; G:F, feed efficiency (ADG/ADFI); HQ, high quality; LQ, low quality; Lys, lysine; NDF, neutral detergent fibre; NE, net energy; NIRS, near infrared reflectance spectroscopy; NSP, non-starch polysaccharide; SID, standardised ileal digestible.

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1. Introduction

Increased prices of traditional feedstuffs reduce profit margins in pork production (Woyengo et al., 2014). In western Canada, Australia and northern Europe, wheat and barley are the main feed grains. Wheat grain has a greater net energy (NE) value than barley (NRC, 2012); however, the greater digestible energy (DE) value of wheat than barley did not increase growth of pigs (Lawrence, 1972; Bowland, 1974). Inclusion of barley grain in starter pig diets is limited due to its high fibre content that is associated with lower nutrient digestibility and NE value (Noblet et al., 1993; Lynch et al., 2007). Whether young pigs fed barley grain instead of wheat in diets formulated to equal NE value can maintain growth performance requires investigation.

The DE value of barley grain samples varies by 20% (Fairbairn et al., 1999). This variation in DE and thus NE value is mostly caused by changes in apparent total tract digestibility coefficient (CATTD) of energy (Noblet, 2006). Adverse agronomic conditions might turn an expected high quality (HQ) barley grain into low quality (LQ) barley with greater fibre content, lower density and thus lower DE and predicted NE value (Fairbairn et al., 1999; Van Barneveld, 1999). However, LQ barley may still be acceptable for swine feeding because even young pigs can compensate for low energy, barley-based diets by increasing feed intake (Beaulieu et al., 2006). The NE values of ingredients can be predicted using their DE value and chemical composition (Noblet et al., 1994; De Jong et al., 2014) and used to formulate diets to target dietary NE value. However, whether young pigs fed with LQ barley grain with or without correction for NE value can maintain growth performance requires investigation.

The null hypothesis for the present study was that wheat, HQ barley or LQ barley diets with or without NE correction would have similar nutrient digestibility and growth performance for starter pigs. The objectives were to determine nutrient digestibility, DE and calculated NE values of wheat, HQ and LQ barley diets, the growth performance of weaned pigs fed these diets and effects of NE correction of LQ barley diet on these variables.

2. Materials and methods

2.1. Experiment design and diets

Animal procedures for the study were approved by the University of Alberta Animal Care and Use Committee for Livestock and followed principles established by the Canadian Council on Animal Care (CCAC, 2009). The study was conducted at the Swine Research and Technology Centre, University of Alberta (Edmonton, AB, Canada).

In total, 280 pigs (Duroc × Large White/Landrace F_1; Hypor, Regina, SK, Canada) were weaned at 24 ± 1 days of age. Pigs were selected based on average daily gain (ADG) during the first 5 days post weaning and body weight (BW) on day 5 after weaning (8.65 ± 0.87 kg); lighter or heavier pigs were not used. Pigs were divided within gender into heavy and light BW, randomly placing one heavy and one light barrow and gilt into one of 70 pens with four pigs each, for 14 pens for each of the five experimental diets. Pigs were fed sequentially a commercial pre-starter [228 g CP/kg, 10.3 MJ NE/kg, 13.7 g standardised ileal digestible (SID) lysine (Lys)/kg] and starter (203 g CP/kg, 11.0 MJ NE/kg, 12.4 SID Lys/kg) diets (Hi-Pro Feeds, Sherwood Park, AB, Canada) for 2 and 5 days, respectively, before feeding the experimental diets.

Three cereal grain samples were sourced (Table 1): two batches of hulled barley from Sunhaven Farms Milling (Irma, AB, Canada) and one batch of wheat from a University of Alberta Research Station (St. Albert, AB, Canada). Feed quality of the barley samples was assessed prior to formulation of experimental diets using density and predicted NE values. The NE content of barley grain was estimated using Eq. 5 from Noblet et al. (1994) that was adopted by NRC (2012), using DE value, predicted CP, crude fat, and starch content from near-infrared reflectance spectroscopy (NIRS) and acid detergent fibre (ADF) from wet chemistry.

Experimental diets contained 200 g soybean meal/kg and one of the three cereal grain samples: wheat, HQ barley or LQ barley. Five experimental diets (Table 2) were formulated to a specific NE value (MJ/kg) adjusted by including canola oil and for SID Lys content (g/MJ NE) using synthetic amino acids (AA). The five diets were: 1) wheat-based (10.0, 1.07); 2) HQ barley-based (10.0, 1.06); 3) LQ barley-based without NE correction (9.76, 1.09); 4) LQ barley-based corrected for NE (10.0, 1.06); and 5) LQ barley-based, low NE (9.42, 1.12). Diets did not include antimicrobials or growth promoters. Amino acids other than Lys were formulated to an ideal ratio to Lys (NRC, 2012). Premixes were added to meet or exceed mineral and vitamin requirements (NRC, 2012). Titanium dioxide (TiO_2, Sigma Aldrich, Oakville, ON, Canada) was added as indigestible marker. Diets were steam pelleted at 70 °C (70 hp; California Pellet Mill, Crawfordsville, IN, USA). Pellets were 4.5 mm in diameter and 6–10 mm in length.

The study was conducted as a randomised complete block design with 70 pens in 4 nursery rooms. Rooms were ventilated using negative pressure and were maintained within the thermo-neutral zone for the pigs, with a 12-h light (0600 to 1800 h), 12-h dark cycle. Pens within block (representing areas within room) were randomly allocated to one of the five diets during the 3-week study, starting 7 day post weaning. Pens (1.1 × 1.5 m) were equipped with a multiple-space self-feeder (model N4-424; Crystal Springs Hog Equipment, Ste Agathe, MB, Canada), a nipple drinker and plastic slatted flooring. Pigs had free access to feed and water during the entire study.

Individual pigs, feed added to each pen and feed remaining were weighed weekly. The ADG, average daily feed intake (ADFI) and feed efficiency (G:F) for each pen were calculated using BW changes and feed disappearance. Freshly-voided