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Short communication

Effect of feeding wheat millrun on diet nutrient digestibility and growth performance in starter pigs

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ABSTRACT

Wheat by-products could be an alternative feedstuff for sustainable pork production. The effects of substitution of soybean meal (SBM) and wheat with increasing inclusion of wheat millrun on diet nutrient digestibility and growth performance of young pigs were evaluated. In total, 160 weaned pigs were fed five pelleted wheat-based diets containing 0, 50, 100, 150 or 200 g wheat millrun/kg in substitution for up to 150 g SBM/kg and 50 g wheat/kg for 3 weeks (day 1–21) starting 2 weeks after weaning at 21 days of age. Diets were balanced for net energy (NE) using canola oil and for amino acids using crystalline amino acids to provide 10.1 MJ NE/kg and 1.05 g standardised ileal digestible (SID) lysine (Lys)/MJ NE. Increasing inclusion of wheat millrun to 200 g/kg linearly reduced ($P < 0.001$) diet apparent total tract digestibility coefficient (CATTD) of dry matter by 0.04 and CATTD of gross energy by 0.03, but did not affect CATTD of crude protein. Increasing dietary inclusion of wheat millrun linearly increased ($P < 0.05$) the calculated diet NE value by 0.07 MJ/kg indicating that the NE value of wheat millrun was underestimated. Increasing dietary inclusion of wheat millrun did not affect average daily feed intake (ADFI) and average daily gain (ADG) for each week or for the entire trial (day 1–21). Increasing dietary inclusion of wheat millrun linearly increased ($P < 0.05$) feed efficiency (G:F) by 0.12 for day 8–14 or by 0.04 for the entire trial. In conclusion, up to 200 g wheat millrun/kg can replace 150 g SBM/kg and 50 g wheat/kg in diets formulated to equal dietary NE value and SID Lys content and fed to nursery pigs starting 2 weeks after weaning without detrimental effects on growth performance.

1. Introduction

Alternative ingredients such as wheat by-products from dry milling of wheat are increasingly included in swine diets to reduce feed cost (Zijlstra and Beltranena, 2012; Rosenfelder et al., 2013; Woyengo et al., 2014). Wheat milling by-products used in the feed industry are marketed as wheat millrun or wheat middlings (Slominski et al., 2004). The nutritional value

Abbreviations: 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); Lys, lysine; NDF, neutral detergent fibre; NE, net energy; SBM, soybean meal; SID, standardised ileal digestible; VFA, volatile fatty acids.

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of wheat shorts and wheat middlings has been explored (Huang et al., 1999; Cromwell et al., 2000; Shaw et al., 2002; De Jong et al., 2014). The nutritional value of wheat millrun has been characterised and was increased for growing pigs using processing and enzyme supplementation (Fahrenholz, 1989; Nortey et al., 2008; Jha et al., 2012; Shrestha, 2012), but such information is scarce for young pigs.

Feeding alternative feedstuffs provides challenges to achieve predictable growth performance (Zijlstra and Beltranena, 2013). Compared with wheat grain, wheat millrun contains more crude protein (CP), lipids and fibre, and consequently has a lower net energy (NE) value (Sauvant et al., 2004; Rosenfelder et al., 2013). As an omnivorous species, swine has the potential to convert high fibre diets into pork products (Zijlstra and Beltranena, 2013). However, whether growth performance of young pigs fed wheat millrun can be sustained remains unknown.

The hypothesis for the present study was that weaned pigs offered diets containing up to 200 g wheat millrun/kg in substitution for soybean meal (SBM) and wheat and formulated to an equal NE and standardised ileal digestible (SID) amino acid content would have growth performance and dietary nutrient digestibility similar to pigs fed a diet without wheat millrun. The objective was to determine whether a dose response exists for growth performance and apparent total tract digestibility coefficients (CATTD) of dietary energy and CP in weaned pigs fed diets with up to 200 g wheat millrun/kg.

2. Materials and methods

The animal procedures were approved by the University of Alberta Animal Care and Use Committee for Livestock and followed guidelines 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).

2.1. *Experimental design and diets*

In total, 160 pigs (Duroc × Large White/Landrace F_1; Hypor, Regina, SK, Canada) were weaned at 21 ± 1 days of age. After weaning, pigs were fed sequentially commercial phase 1 [241 g CP/kg, 11.1 MJ NE/kg, 16.4 g SID lysine (Lys)/kg] and phase 2 (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 12 days, respectively.

Pigs were selected based on average daily gain (ADG) during the first 12 days post weaning and body weight (BW) on day 12 after weaning (9.8 ± 1.25 kg). Two gilts and two barrows, both with one heavy and one light BW, were randomly arranged within each pen, for four pigs per pen. Pens were blocked by location in the barn. The five diets were randomly assigned to pens within each block, for a total of 8 pen replicates per diet. Pigs were fed the test diets starting from 35 ± 1 days of age.

Experimental diets were formulated to contain 0, 50, 100, 150 or 200 g wheat millrun/kg in substitution of SBM and wheat grain (Table 1). Wheat millrun was sourced from Masterfeeds (Edmonton, AB, Canada). Wheat grain was ground in a hammer mill using a 2.3-mm screen. Diets were formulated to provide 10.1 MJ NE/kg, 1.05 g SID Lys/MJ NE and other amino acids as ideal ratios to Lys (NRC, 2012) according to established NE (Sauvant et al., 2004) and SID amino acid (NRC, 2012) values. Diets did not contain antimicrobials or growth promoters. For wheat millrun, a calculated 7.91 MJ NE/kg and 0.50 g SID Lys as fed were used for diet formulation based on measurements in our laboratory (data not shown). Premixes were added to meet or exceed mineral and vitamin requirements (NRC, 2012). Acid-insoluble ash (Celite 281; World Minerals, Santa Barbara, CA, USA) was included at 8 g/kg as an indigestible marker. Diets were mixed and steam pelleted at 70 °C (70 hp; California Pellet Mill, Crawfordsville, IN, USA). Pellets were 4.0–4.5 mm in diameter and 6–10 mm in length.

Pigs were housed in 40 pens divided in two nursery rooms. Rooms were ventilated using negative pressure and were maintained within the thermo-neutral zone for the pigs, with a 12 h light (06.00–18.00 h), 12 h dark cycle. Pens (1.1 m × 1.5 m) were equipped with a multiple-space self-feeder, a nipple drinker and plastic slatted flooring.

Pigs had free access to feed and water throughout the study. Individual pigs and amount of feed added to each pen feeder and remaining were weighed weekly during the 3-week study. Body weight changes and feed disappearance were used to calculate ADG, average daily feed intake (ADFI) and feed efficiency (G:F) for each pen. Freshly voided faeces were collected from 08.00 to 16.00 h by grab sampling from pen floors on day 19 and 20. Faeces were pooled by pen and frozen at −20 °C. Upon completion of the trial, faeces were thawed, homogenised, sub-sampled and freeze-dried.

2.2. *Chemical analyses and calculations*

Wheat millrun, diets and lyophilised faeces were ground through a 1-mm screen in a centrifugal mill (Retsch GmbH, Haan, Germany). The wheat millrun sample was analysed for moisture (method 930.15; AOAC, 2006), CP (method 984.13 (A–D)), ether extract (method 920.39), crude fibre (method 978.10), acid detergent fibre (ADF) inclusive of residual ash (method 973.18), neutral detergent fibre (NDF) assayed without a heat stable amylase and expressed inclusive of residual ash (Holst, 1973), total dietary fibre (method 985.29), starch (assay kit STA-20; Sigma, St. Louis, MO, USA), ash (method 942.05), calcium (method 968.08), phosphorus (method 946.06), amino acids [method 982.30E (a–c)] and chemically available Lys (method 975.44) as described by AOAC (2006). Diets and faeces were analysed for moisture by drying at 135 °C for 2 h (method 930.15; AOAC, 2006), CP [N × 6.25; method 988.05 (AOAC, 2006)], acid-insoluble ash (Vogtmann et al., 1975; modified by Newkirk et al., 2003) and gross energy (GE) using an adiabatic bomb calorimeter (model 5003; Ika-Werke GmbH & Co. KG, Staufen, Germany). Based on results of chemical analyses, the CATTD of CP, GE and dry matter (DM) was calculated using the