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The effect of feeding increasing inclusion of extruded *Brassica juncea* canola expeller on growth performance and nutrient digestibility in weaned pigs

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ABSTRACT

Expellers contain more dietary energy than meals to support growth performance of young pigs. The feeding value of extruded *Brassica (B.) juncea* canola expeller was evaluated feeding 240 weaned pigs (initial body weight 7.6 kg), starting 1 week after weaning at 19 days of age. The extruded *B. juncea* expeller contained (as is) 344 g crude protein, 15.7 g chemically available lysine (Lys), 169 g ether extract, 127 g acid detergent fibre, 195 g neutral detergent fibre/kg and 11 μmol/g total glucosinolates. Pigs were fed five pelleted wheat-based diets for two growth phases: Phase 1, days 0–14; and Phase 2, days 15–35. Diets including 0, 60, 120, 180 and 240 g extruded *B. juncea* expeller/kg were formulated to provide 10.0 and 9.7 MJ net energy (NE)/kg and 1.17 and 1.06 standardised ileal digestible (SID) Lys/MJ NE for Phase 1 and 2 diets, respectively. The extruded *B. juncea* expeller substituted soybean meal. Diets were balanced for NE by decreasing canola oil inclusion from 55 to 29 and 26 to 0 g/kg for Phase 1 and 2, respectively; and for amino acids by increasing crystalline amino acids. Increasing dietary inclusion of extruded *B. juncea* expeller linearly reduced ($P < 0.001$) apparent total tract digestibility of dry matter, gross energy and crude protein and decreased diet digestible energy values in both phases. For days 0–35, increasing inclusion of extruded *B. juncea* expeller did not affect feed efficiency, but quadratically increased average daily feed intake (ADFI; $P < 0.001$) and average daily gain (ADG, $P < 0.01$), which corresponded with a quadratic increase ($P < 0.01$) in intake of NE and SID Lys. On day 35, pigs fed 60, 120, 180 and 240 g extruded *B. juncea* expeller/kg were 1.1, 1.5, 1.5 and 1.1 kg heavier ($P < 0.05$), respectively, than control pigs. Feed energy values may explain the achieved performance. For diet formulation, we used 22.46 MJ NE/kg for canola oil (NRC, 1998) instead of the more recent 31.63 MJ NE/kg (NRC, 2012). Using the revised NE value, calculated diet NE values (as fed) decreased from 10.55 to 10.30 in Phase 1 and from 9.92 to 9.71 MJ NE/kg in Phase 2 diets for pigs fed 0 to 240 g extruded *B. juncea* expeller/kg. In conclusion, reduced diet NE value coincided with increased NE and SID Lys intake that consequently increased ADG. The linear increase of ADFI and ADG may have been curved at 240 g extruded *B. juncea* expeller/kg by increased dietary glucosinolates intake that prevented further increases in ADFI.

Abbreviations: ADFI, average daily feed intake; ADF, acid detergent fibre; ADG, average daily gain; *B.*, *Brassica*; BW, body weight; CATTD, apparent total tract digestibility coefficients; CM, canola meal; CP, crude protein; DE, digestible energy; DM, dry matter; EP, extruded-pressed; GE, gross energy; G:F, feed efficiency (ADG/ADFI); Lys, lysine; NDF, neutral detergent fibre; NE, net energy; SID, standardised ileal digestible.

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1. Introduction

Inclusion of canola meal (CM) in swine diets may increase flexibility in feed formulation and provide opportunities to reduce feed cost. A co-product of canola seed, CM is globally ranked as the second protein feedstuff after soybean meal. The low energy value of solvent-extracted *Brassica (B.) napus* CM is due to its relatively high fibre and low ether extract content (Newkirk, 2009).

Yellow-seeded *Brassica juncea* has a thinner seed coat and thus lower fibre content (Khajali and Slominski, 2012). Consequently, digestible energy (DE) and net energy (NE) values were greater for *B. juncea* CM than *B. napus* CM (Le et al., 2012). However, *B. juncea* CM contains double the glucosinolates than *B. napus* CM, with a great share of gluconapin that tastes bitter and reduced the feed intake of young pigs fed up to 240 g *B. juncea* CM/kg (Landero et al., 2013). Oil extraction reduces the energy value of CM. Expeller-pressed CM contains residual oil and thus more DE and ME than solvent-extracted CM (Woyengo et al., 2010). Extrusion of canola seed prior to pressing may increase the feed value of the expeller (Huang et al., 1995; Liang et al., 2002). Extruded canola expeller may contain more ether extract (170 g/kg) than expeller-pressed CM (120 g/kg) or solvent-extracted CM (3 g/kg; Beltranena and Zijlstra, 2011). Hence, extruded *B. juncea* expeller might be valuable for swine feeding; however, its feeding value has not been studied.

Our hypothesis was that weaned pigs fed diets with increasing inclusion of extruded *B. juncea* expeller formulated to equal NE and standardised ileal digestibility (SID) amino acid content would have similar nutrient digestibility and performance. The objectives were to determine the apparent total tract digestibility coefficients (CATTD) of gross energy (GE), crude protein (CP) and dry matter (DM) and DE and calculated NE values of diets; and evaluate the dose response effect of feeding weaned pigs diets including 0, 60, 120, 180 or 240 g extruded *B. juncea* expeller/kg on growth performance.

2. Materials and methods

2.1. Experimental design and diets

The animal care and use was 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 carried out at the Swine Research and Technology Centre, University of Alberta (Edmonton, Alberta, Canada).

In total, 240 crossbred pigs (Duroc × Large White/Landrace F_1; Hypor, Regina, SK, Canada) were weaned at 19 ± 1 days of age. Pigs were selected based on body weight (BW; 7.6 ± 0.85 kg) and average daily weight gain for the first 7 days after weaning. Pigs were sorted within gender into light and heavy BW. Two barrows and two gilts (4 pigs/pen) with light and heavy BW were randomly assigned to one of 60 pens.

Pigs were fed a commercial starter diet for 7 days post-weaning before the two-growth phase feeding study: Phase 1 lasted 14 days and subsequently Phase 2 lasted 21 days. For both feeding phases, five wheat-based diets contained 0 (control), 60, 120, 180 or 240 g extruded *B. juncea* expeller/kg in substitution for soybean meal (Table 1). Canola seed was sourced from southern Saskatchewan, Canada and then extruded (at 90 °C, flow rate 1050 kg/h, model X155, Wenger, Sabetha, KS, USA) before pressing (at 110 °C, flow rate 600 kg/h, model ME-200, Anderson International Corp., Stow, OH, USA) at Apex Nutri-Solutions Inc. (Edberg, AB, Canada). Diets without antimicrobials or growth promoters were formulated to provide 10.0 MJ NE/kg and 1.17 g SID lysine (Lys)/MJ NE for Phase 1 and 9.7 MJ NE/kg and 1.06 g SID Lys/MJ NE for Phase 2. Other amino acids were formulated as an ideal ratio to Lys using established NE and SID amino acid values (NRC, 1998). Acid-insoluble ash (Celite 281; World Minerals, Santa Barbara, CA, USA) was added as indigestible marker at 8 g/kg in diets. Diets were mixed and steam pelleted at 70 °C (70 hp; California Pellet Mill, Crawfordsville, IN, USA). Pellet sizes were 4.5 and 3.5 mm in diameter; 6–10 and 6–12 mm in length for Phase 1 and Phase 2 diets, respectively.

The five dietary treatments were randomly allocated to pens of pigs in a randomised complete block design with 60 pens in three nursery rooms filled two weeks apart, for 12 replicate pens per treatment. Within room, blocks including all five dietary treatments were formed across the ventilation gradient. Pens (1.1 m × 1.5 m) were equipped with polyvinyl chloride partitions, a 4-space dry feeder (model N4-424; Crystal Springs Hog Equipment, MB, Canada), a nipple drinker and plastic slatted flooring. Room temperature was maintained within the thermo-neutral zone of pigs, using a negative pressure ventilation system, with a 12-h light (0600–1800 h) and 12-h dark cycle. Pigs had free access to feed and water during the trial.

Individual pigs, feed added and leftover were weighed weekly to calculate average daily feed intake (ADFI), average daily gain (ADG) and feed efficiency (G:F) for the pen. Freshly voided faeces were collected from 0800 to 1600 h by grab sampling from pen floors on days 12, 13 and 33, 34. Faeces were pooled by pen and stored at −20 °C. Faeces were then thawed, homogenised, sub-sampled and freeze-dried.

2.2. Chemical analyses

Samples of extruded *B. juncea* expeller, diets and freeze-dried faeces were ground through a 1-mm screen in a centrifugal mill (model ZM200, Retsch GmbH, Haan, Germany). The extruded *B. juncea* expeller was analysed for CP (method 984.13A-D), total dietary fibre (method 985.29), acid detergent fibre (ADF) inclusive of residual ash (method 973.18), ash (method 942.05), starch (assay kit STA-20; Sigma, St. Louis, MO, USA), calcium (method 968.08), phosphorus (method 946.06), amino