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Energy and amino acid digestibility of expeller-pressed canola meal and cold-pressed canola cake in ileal-cannulated finishing pigs

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ABSTRACT

Residual oil content that increases the dietary energy value makes expeller-pressed canola meal (EPCM) and cold-pressed canola cake (CPCC) attractive feedstuffs for swine. The energy and amino acid (AA) digestibility of EPCM and CPCC were evaluated feeding six crossbred Hypor barrows (initial weight of 65.7 ± 1.7 kg) surgically fitted with a simple T-cannula at the distal ileum. Pigs were fed twice daily at 2.8 times the estimated maintenance requirement of digestible energy (DE). Diets containing 500 g/kg of either EPCM or CPCC and an N-free diet were tested in a replicated 3×3 Latin square. The oil content of EPCM was half that of CPCC (105 vs. 202 g/kg). Total glucosinolate content of EPCM was double that of CPCC (11.9 vs. 5.6 μmol/g). The apparent total tract digestibility coefficient and apparent ileal digestibility coefficient (CAID) of energy were lower (P<0.05) in EPCM than CPCC. The DE (P<0.05) and calculated net energy (NE) content were lower (P<0.001) in EPCM than CPCC (14.3 vs. 16.5 and 9.0 vs. 11.5 MJ NE/kg as fed, respectively). The CAID of lysine and cysteine was lower (P<0.05) in EPCM than CPCC. The standardized ileal digestibility coefficient (CSID) of alanine, cysteine, glycine, histidine, isoleucine, lysine and valine was lower (P<0.05) in EPCM than CPCC. However, the standardized ileal digestible content of all AA was greater (P<0.05) in EPCM than CPCC. In conclusion, lower residual oil and greater content of antinutritional factors (glucosinolates and fibre) in EPCM compared with CPCC were important factors that lowered energy digestibility and DE and NE values in EPCM compared to CPCC and likely lowered CSID of some indispensable AA in EPCM vs. CPCC, including lysine.

1. Introduction

Canola, also known as low-glucosinolate, low-erucic acid rapeseed, is a major oilseed crop worldwide (Raymer, 2002). From canola seed, several co-products can be obtained after extracting the oil destined for human consumption or biodiesel

Abbreviations: AA, amino acid; CAID, apparent ileal digestibility coefficient; CATTD, apparent total tract digestibility coefficient; CP, crude protein; CPCC, cold-pressed canola cake; CSID, standardized ileal digestibility coefficient; DE, digestible energy; DM, dry matter; EPCM, expeller-pressed canola meal; NE, net energy; SID, standardized ileal digestible.

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production. Commonly, canola seed is crushed in large-scale, solvent-extraction plants, producing food grade oil for human consumption and canola meal for animal feeding (Canola Council of Canada, 2009). However, canola oil is also extracted using less efficient pressing technologies that do not involve solvent extraction.

Expeller-pressed canola meal (EPCM) and cold-pressed canola cake (CPCC) are co-products obtained in small-scale processing plants, after extracting the oil from seed merely using expeller pressing or cold pressing, respectively (Leming and Lember, 2005). Due to the less efficient oil harvest without solvent extraction (Spragg and Mailer, 2007), these canola co-products contain more residual oil and thus may contain more dietary energy than solvent-extracted canola meal. Solvent-extracted canola meal typically contains 20–30 g crude fat/kg representing gums that are added back (Canola Council of Canada, 2009), whereas EPCM contains approximately 120 g oil/kg and CPCC could contain more than 200 g oil/kg (Beltranena and Zijlstra, 2011). Differences in seed quality, pressing equipment and conditions among plants may influence the efficacy of oil removal (Leming and Lember, 2005). Thus, the nutritional quality and content of antinutritional factors in EPCM and CPCC can vary widely. While EPCM is included in new data bases (e.g., NRC, 2012), CPCC is not. Limited information thus exists about the dietary energy and amino acid (AA) digestibility of CPCC, which is required for accurate feed formulation.

The hypothesis tested in the present study was that the greater oil content in CPCC than EPCM results in a greater energy value for pigs, but that digestible AA content are similar. The objectives were to determine the digestible energy (DE) and digestible AA profile and predict the net energy (NE) value of EPCM and CPCC using ileal-cannulated finisher pigs.

2. Materials and methods

The 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).

2.1. Experimental design and diet

Expeller-pressed canola meal (Hartland Colony, Bashaw, AB, Canada) and CPCC (Cansource Biofuels, Mayerthorpe, AB, Canada) were tested in the present study. The EPCM and CPCC were produced by pressing canola seed of different origin either in an expeller press (KEK model P0500, Egon Keller GmbH & Co., Remscheid, Germany; 500 kg/h) or two screw presses (Northern model 4500, Northern Oilseed Mills, Rossendale, Manitoba, Canada; 250 kg/h) setup in tandem, respectively. The temperature of the resulting EPCM and CPCC was 86–88 and 65–72 °C, respectively. Test ingredients were included at 500 g/kg, and mixed with corn starch to prepare the test diets (Table 1). An N-free corn starch-based diet was used to estimate basal endogenous AA losses (Stein et al., 2006). Diets were fortified with vitamin and mineral premixes to exceed requirements (NRC, 2012). Titanium oxide was included at 5 g/kg as an indigestible marker.

2.2. Experimental procedure

The animal experiment was conducted at the Swine Research and Technology Centre of the University of Alberta. Six crossbred Hypor barrows (initial body weight of 65.7 ± 1.7 kg) were surgically fitted with a simple T-cannula at the distal ileum, approximately 5 cm anterior the ileocecal sphincter (Sauer et al., 1983; de Lange et al., 1989). Pigs were fed the three diets in a replicated 3×3 Latin square design to provide 6 observations per diet. Pigs were housed in raised individual metabolism pens that allowed freedom of movement (1.2 m wide, 1.4 m long and 0.94 m high). Pens were equipped with a stainless-steel self-feeder attached to the front of the pen and a cup drinker next to the feeder. Walls were made of polyvinyl chloride with windows and the flooring was plastic-covered woven wire mesh. The test room temperature was maintained at 22.0 ± 2.5 °C. Each 9-d experimental period consisted of a 5-d adaptation to the experimental diets, followed sequentially by a 2-d collection of faeces and a 2-d collection of ileal digesta. Pigs were fed diets at 2.8 times the maintenance requirement for DE (2.8×110 kcal of DE/kg of body weight$^{0.75}$; NRC, 2012) in 2 equal meals at 0800 and 1500 h and had free access to water throughout the experiment.

Faeces were collected using plastic bags snapped between a leather and a Velcro ring attached to the skin around the anus using medical adhesive (van Kleef et al., 1994). Digesta samples were collected for 2 d from 0800 to 1800 h using plastic bags containing 15 mL of 50 g formic acid/kg that were attached to the opened barrel of the cannula with a rubber band. Bags were replaced as soon as filled or after 20 min (Li et al., 1993). Collected faeces and digesta were pooled for each pig within experimental period and frozen at −20 °C. Before analyses, faeces and digesta were thawed, homogenized, subsampled and freeze-dried.

2.3. Chemical analyses

The EPCM and CPCC, diets and lyophilized faeces and digesta were ground through a 1-mm screen in a centrifugal mill (model ZM 200; Retsch GmbH, Haan, Germany). Diets and test ingredients were analyzed for chemically available lysine (method 975.44), crude protein (CP; method 984.13A-D), ash (method 942.05), crude fat (method 920.39A) and crude fibre (method 978.10) as described by AOAC (2006). The EPCM and CPCC were analyzed for calcium (method 968.08), phosphorus (method 946.06), acid detergent fibre inclusive of residual ash (method 973.18) as described by AOAC (2006), neutral detergent fibre assayed without a heat stable amylase and expressed inclusive of residual ash (Holst, 1973), starch