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Effect of tail-end dehulling of canola meal on apparent and standardized ileal digestibility of amino acids when fed to growing pigs

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ABSTRACT

The aim was to determine the effect of tail-end dehulling (dehulling after oil extraction) of canola meal (CM) on apparent (AID) and standardized (SID) ileal digestibility of amino acids (AA) when fed to growing pigs. Three ileal cannulated barrows (initial BW 58 ± 3.6 kg) were assigned to the 3 experimental diets in a replicated 3 × 3 Latin square design using 6 periods to provide 6 replicates per treatment. The use of sieve size 355 μm resulted in the production of 2 CM fractions, a dehulled fraction (DCM) and a coarse fraction (CCM). Diets consisted of a cornstarch-based diet with either regular canola meal (RCM), DCM, or CCM as the only source of protein. All diets contained titanium dioxide (0.3%) as an indigestible marker. In general, there was no effect ($P > 0.10$) of dehulling on the AID of most AA. However, AID of Phe was higher ($P < 0.05$) in RCM, compared to DCM and CCM. The AID of Thr and Trp was greater ($P < 0.05$) in RCM and DCM compared to CCM. However, the AID of Ile and Leu was higher ($P < 0.05$) in RCM and CCM compared to DCM. The SID of indispensable AA was not affected ($P > 0.10$) by dehulling. However, the SID of Phe was greater for RCM ($P < 0.05$) compared to DCM and CCM. Whereas, SID for Thr was higher in RCM and DCM compared to CCM. By removing the fibrous component, dehulling increased ($P < 0.05$) the standardized ileal digestible AA content of DCM compared to RCM by an average of 9%. The standardized ileal digestible His and Lys contents were similar between RCM and CCM, whereas, values for digestible Arg, Leu, Phe, and Thr contents were lower ($P < 0.05$) for CCM than CCM than for RCM and DCM. In conclusion, the results indicate that for most AA, the AID and SID in CM were not affected by dehulling. However, the content of ileal digestible AA can be increased with tail-end dehulling of CM.

1. Introduction

The meal obtained from the crushing of canola seeds is used as a protein source for animal feeding, and it constitutes the second largest protein supplement after soybean meal (SBM) (Canola Council of Canada, 2015). In 2016, the global rapeseed/canola meal consumption was 38.1 million metric tonnes, while soybean meal consumption was 225.1 million metric tonnes (Soystats, 2017). However, compared to SBM, canola meal (CM) has a lower concentration of most amino acids (AA), except Met and Cys (Gonzalez-Vega and Stein, 2012; NRC, 2012; Mejicanos et al., 2016), and lower and less consistent AA digestibility than SBM (Khajali and

Abbreviations: AA, amino acid; AID, apparent ileal digestibility; BW, body weight; CCM, coarse canola meal; CM, canola meal; DCM, dehulled canola meal; EAL, non-specific endogenous loss, RCM, regular canola meal; SID, standardized ileal digestibility; SBM, soybean meal

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Slominski, 2012; Liu et al., 2014). Front-end dehulling (i.e., dehulling preceding oil extraction) can reduce total fiber and ADF content of the dehulled meal by 40 and 35%, respectively; additionally, the AA content can increase by 11% (Kracht et al., 1999). Tail end dehulling (i.e., dehulling after oil extraction) can increase crude protein (CP) by 13%, ether extract (EE) by 37%, total P by 21%, non-phytate P by 24.5%, and can decrease total dietary fiber by 29%, NDF by 37.3%, lignin and polyphenols by 53.4%, and non-starch polysaccharides (NSP) by 12.4% (Mejicanos et al., 2017). Compared to CM, SBM has higher standardized ileal digestibility (SID) for most indispensable AA except for Arg and Trp (Gonzalez-Vega and Stein, 2012). Air classification has been studied to achieve tail end dehulling; the system is based on differences in density between cotyledon and seed hull. The use of air streams partially separated these seed components based on size and density, to produce a low-fiber, light-particle fraction, and a high-fiber, heavy-particle fraction. Digestibility of AA of dehulled CM obtained using air classification of *B. napus* and *B. juncea* has been studied, and results indicated higher SID of protein and AA in the high-protein fraction compared to the high-fiber fraction. However, no differences in SID of AA among the dehulled high-protein fraction and the corresponding parent meal were observed (Zhou et al., 2015). Therefore, the purpose of the present study was to determine the effect of tail-end dehulling of CM using sieving technology, on the apparent ileal digestibility (AID) and SID of AA when fed to growing pigs.

2. Materials and methods

2.1. Animal care

The animal use protocol utilized in the present study was reviewed and approved by the Animal Care Committee of the University of Manitoba. The pigs used in the experiment were cared for following the guidelines of the Canadian Council on Animal Care (CCAC, 2009). The study was conducted at the T. K. Cheung Centre for Animal Science Research.

2.2. Materials

Regular canola meal (RCM) was produced using the pre-press solvent extraction method and was obtained from the Bunge crushing plant, Altona, MB, Canada. The dehulled (DCM), and coarse (CCM) meal fractions were produced at the Canadian International Grains Institute, Winnipeg, Manitoba, Canada using a Plansifter, Model MPAR-8HK, Bühler AG, CH-9240, Uzwil. The use of sieve size 355 μm resulted in the production of 2 CM fractions, a dehulled canola meal (DCM) and a coarse fraction (CCM). The analyzed chemical composition of the meals used in the present experiment is shown in Table 1.

2.3. Animals and housing

Three growing pigs [(Yorkshire-Landrace) × Duroc; Genesus, Oakville, MB, Canada] obtained from the University of Manitoba Glenlea Swine Research Unit were randomly assigned to the experimental diets according to a replicated 3 × 3 Latin square design using 6 periods (in lieu of 6 pigs) to provide 6 replicates per diet. Pigs had an initial average BW of 58 ± 3.6 kg. When pigs were approximately 25 kg BW, T-type cannulas were implanted in the distal ileum, following the procedure described by Nyachoti et al. (2002). However, pigs were used for another experiment before being assigned to the present study. Therefore a 2-week time-lag was applied before the commencement of the study. To prevent infections, reduce irritation and the risk of inflammation, the area where the cannula was fitted was cleaned every day using warm water and a mild detergent, then dried using paper towel; at the end of the cleaning, zinc oxide-lanolin-based cream was applied around the cannula to reduce irritation. Pigs were housed individually in pens (1.7 m^2 per pig) with elevated plastic-coated metal flooring in a temperature-controlled room (20–22 °C). A 16-h light (0600–2200 h) and 8-h dark cycle were provided.

2.4. Diets

Three diets containing RCM, DCM, and CCM as the only source of protein, were prepared. In the formulation of the diets no fat was used, as dietary fat has been identified as a factor modifying endogenous nitrogen excretion (de Lange et al., 1989). However, EE contents of the diets were 15.0, 18.9 and 17.1 g/kg, respectively. Pigs were fed a casein-based diet prior the experiment, to estimate the non-specific endogenous loss of AA at the distal ileum (EAL). Vitamins and minerals were supplied in the diets to meet or exceed NRC (2012) requirements. All diets contained 3 g/kg of titanium dioxide (TiO_2) as an indigestible marker. The composition and calculated nutrient content of the experimental diets are shown in Table 2. The analyzed nutrient content of the experimental diets is shown in Table 3.

2.5. Feeding and sampling

Water and feed were provided using nipple bowl drinkers and metal feed troughs. Pigs were fed 40 g/kg BW (corresponding to the calculated feed intake + wastage when allowed feed ad libitum) with the daily feed allowance offered in two equal portions at 0800 and 1600 h. Water was available *ad libitum* throughout the experiment. Individual pig weights were recorded at the beginning of each period to adjust feed allowance. Each experimental period lasted 7 d, the first 5 d were for adaptation to the experimental diets, while the last two days were the collection period. During the collection period, digesta were collected through the cannulas by removing the caps and attaching plastic bags with hose clamps. Digesta were collected for a total of 12 h in the collection period. Collection