Digestibility energy and amino acids of canola meal from two species (*Brassica juncea* and *Brassica napus*) fed to distal ileum cannulated grower pigs

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ABSTRACT: Yellow-seeded *Brassica juncea* is a novel canola species targeted to grow in the southern Canadian prairies where thermotolerance, disease resistance, and adaptation to dry agronomic conditions are required. The support of its cultivation needs nutritional evaluation of its coproduct. The *B. juncea* canola meal (CM) contains less fiber than conventional, dark-seeded *Brassica napus* CM but also slightly less Lys. In a 6 × 6 Latin square, 6 distal ileum cannulated pigs (47 kg BW) were fed 6 diets to determine the apparent ileal digestibility (AID) and standardized ileal digestibility (SID) of CP and AA, AID and apparent total tract digestibility (ATTD) of energy, and VFA content in digesta and feces. Pigs were fed 6 diets: basal [46% wheat (*Triticum aestivum*) and corn (*Zea mays*) starch], 4 diets with 46% wheat and either *B. juncea* or *B. napus* CM at 25 or 50%, and a N-free diet based on corn starch. The *B. juncea* CM had higher (P < 0.05) ATTD of energy than *B. napus* CM (68.6 vs. 60.3%) likely due to its lower fiber content. Ileal total VFA was lower (P < 0.001) in pigs fed *B. juncea* than *B. napus* CM diets. In pigs fed *B. juncea* CM, the molar ratio in digesta was lower (P < 0.001) for acetate and butyrate whereas the propionate ratio was lower (P < 0.001) in feces than in pigs fed *B. napus* CM diets. The CM species did not affect the AID of energy, SID of AA, and feces VFA content. The DE value was higher (P < 0.05) and content of SID Lys was lower (P < 0.05) for *B. juncea* than *B. napus* CM. In conclusion, availability of *B. juncea* CM, a coproduct of a canola species grown in Canadian prairie land, will increase flexibility in swine feed formulation.

Key words: canola meal, digestibility, volatile fatty acid

INTRODUCTION

Swine feed costs have increased globally; thus, interest to include alternative feedstuffs such as oilseed coproducts in swine diets has consequently increased. Canola meal (CM) is a good substitute for soybean (*Glycine max*) meal, but agronomic conditions (e.g., sufficient water) limit canola cultivation. Canola meal has lower energy and CP values than soybean meal (Bell, 1993). The high fiber content of CM primarily reduces its energy and AA digestibility. Yellow-seeded *Brassica juncea* is a novel *Brassica* species targeted to grow on the southern Canadian prairies where thermotolerance, disease resistance, and adaptation to dry agronomic conditions are required. Therefore, *B. juncea* might become more important for oilseed production and its coproduct requires evaluation as a new feedstuff for pigs. The objective of this study was to determine and compare the energy and AA digestibility of *B. juncea* CM with *Brassica napus* CM and its impact on intestinal VFA content.

MATERIALS AND METHODS

Experimental Design and Diets

The University of Alberta Animal Care and Use Committee for Livestock approved the animal protocols. Six distal ileum cannulated pigs (crossbred barrows; 46.5 ± 0.84 kg initial BW) were fed 6 diets in mash form in a 6 × 6 Latin square arrangement. The 6 diets included a basal (46% wheat and corn starch), 4 diets with 46% wheat and either *B. juncea* or *B. napus* CM at 25 or 50% inclusion, and a N-free diet based on corn starch.
Digestibility of *B. juncea* vs. *B. napus* canola meal on corn starch to quantify basal endogenous CP and AA losses. Pigs were housed in metabolism pens and adapted to diets for 5 d; feces were collected for 2 d and ileal digesta for 3 d. Feces and digesta (with 15 mL of 5% HCOOH) were collected in plastic bags. Feces or digesta were pooled for each pig observation, frozen at −20°C, and later homogenized, freeze-dried, and ground.

Chemical and Statistical Analyses

Test feedstuffs, diets, feces, and digesta samples were analyzed for moisture and chemical components (AOAC Int., 1990). The GE was determined in an adiabatic bomb calorimeter and NE was calculated following the equation number 4 (Noblet et al., 1994). Chromium content was analyzed by spectrophotometry. The AA profile in digesta was determined by HPLC and available Lys was analyzed by spectrophotometry (AOAC Int., 2006). The standardized ileal digestibility (SID) of CP and AA was calculated using the difference method. The VFA were analyzed by gas chromatography (Varian 3400) with 4-methylvaleric acid as an internal standard. Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) with diets as fixed effects and period and pig as random effects. Means of diets or ingredients were separated using PDIFF. Species and CM inclusion levels in the diets were compared using contrasts. Differences were considered significant when *P* < 0.05.

**RESULTS**

The *B. juncea* contained less fiber than *B. napus* CM (19 vs. 26% NDF, as-is), less Lys (2.03 vs. 2.21%), and similar GE and CP. The apparent total tract digestibility (ATTD) but not apparent ileal digestibility (AID) of GE was higher (*P* < 0.01) for *B. juncea* than *B. napus* CM (68.6 vs. 60.3%) and both did not differ between inclusion levels (Table 1). Predicted NE and DE values were higher (*P* < 0.05) for *B. juncea* than *B. napus* CM.

The SID of CP did not differ between *B. juncea* and *B. napus* CM and was not affected by inclusion levels (Table 2). The SID of Lys, available Lys, Met, and Thr did not differ between *B. juncea* and *B. napus* CM. The SID content of CP and Thr did not differ between *B. napus* and *B. juncea* CM. The SID content of Lys (*P* < 0.05; 1.88 vs. 2.00%) and available Lys (*P* < 0.05; 1.79 vs. 1.98%) was lower for *B. juncea* than *B. napus* CM.

Ileal total VFA concentration was lower (*P* < 0.001) in pigs fed *B. juncea* than *B. napus* CM diets (15.1 vs. 20.8 μmol/g of wet digesta; Table 3). In pigs fed *B. juncea* instead of *B. napus* CM diets, the molar ratio of acetate and butyrate in ileal digesta was lower (*P* < 0.001) whereas the molar ratio of propionate was lower (*P* < 0.001) in feces.

**DISCUSSION**

The ATTD but not AID of GE was higher for *B. juncea* than *B. napus* CM likely due to less fiber content. This finding is similar to previous studies (Bell et al., 1998;
Montoya and Leterme, 2009) and may relate to a thinner seed coat of yellow- vs. dark-seeded canola species. The fiber in the two CM had similar fermentability by intestinal bacteria because analyzed hemicellulose (NDF-ADF) did not differ. Therefore, the higher ATTD of GE for *B. juncea* was likely associated with lower cellulose and lignin (ADF) content.

The lack of differences in AA digestibility between the 2 canola species indicates that fiber was less of a hindrance for Lys and Met than energy digestibility. The digestible content of AA was slightly lower in *B. juncea* than in *B. napus* CM in contrast to previous research that reported higher CP content in *B. juncea* than *B. napus* CM (Bell et al., 1998; Montoya and Leterme, 2009). Therefore, digestible AA content was slightly lower in *B. juncea* than *B. napus* CM.

The lower fiber content in *B. juncea* CM was associated with lower ileal total VFA content (Stanogias and Pearce, 1985). Microbial VFA production is influenced by various factors including dietary fiber, passage rate, diversity of intestinal microflora population, and type and rate of VFA absorption (Macfarlane and Macfarlane, 2003). The lower dietary fiber content of *B. juncea* may have provided less substrate for microbial fermentation, leading to reduced butyrate content in VFA (Jha et al., 2010). Total VFA content was much higher in feces than digesta indicating extensive microbial fermentation in the hindgut. However, VFA concentration should be combined with measurements of gas production to confirm fermentability of the 2 CM.

Based on the 2 CM samples evaluated, *B. juncea* CM contained less fiber than *B. napus* CM resulting in higher ATTD of energy, but digestibility of AA did not differ. Hence, novel yellow-seeded *B. juncea* CM is similar in nutrient profile to conventional dark-seeded *B. napus* CM. Its availability will increase flexibility in swine feed formulation and increase meal use of canola species grown in Canadian prairie land.

### Table 3. Molar ratio of acetate, propionate and butyrate (% of total VFA) and total VFA (μmol/g) of wet ileal digesta and wet feces

<table>
<thead>
<tr>
<th>Item</th>
<th>N-free Wheat</th>
<th>25</th>
<th>50</th>
<th>25</th>
<th>50</th>
<th>SEM</th>
</tr>
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<tbody>
<tr>
<td>Digesta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Acetate&lt;sup&gt;1&lt;/sup&gt;</td>
<td>86.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>84.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>89.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>93.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>88.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>92.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
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<td>Propionate&lt;sup&gt;1&lt;/sup&gt;</td>
<td>8.81&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.68&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.09&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Butyrate&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2.62&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.55&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.38&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.12&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.53&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.91&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total VFA&lt;sup&gt;1&lt;/sup&gt;</td>
<td>11.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>22.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>24.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>18.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.1&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
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<td>76.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>62.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>55.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>55.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>59.0&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>Propionate&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>10.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.5&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Butyrate&lt;sup&gt;2&lt;/sup&gt;</td>
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<td>10.8&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>13.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total VFA</td>
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<td>162.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>185.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>158.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>166.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>176.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b,c,d</sup>Within a row, means without a common superscript are not different (*P* < 0.05).

<sup>1,2</sup>Effect of species (*B. napus* vs. *B. juncea*) and of level (25 vs. 50%), respectively (*P* < 0.05).

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**LITERATURE CITED**

AOAC Int. 2006. Official Methods of Analysis. 18th ed. AOAC Int., Gaithersburg, MD.


