Ileal amino acid digestibility in canola meals from yellow- and black-seeded Brassica napus and Brassica junceae fed to growing pigs

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ABSTRACT: Twelve ileal cannulated pigs (30.9 ± 2.7 kg) were used to determine the apparent (**AID**) and standardized (**SID**) ileal digestibility of amino acids in canola meals derived from black- (**BNB**) and yellow-seeded (**BNY**) *Brassica napus* canola and yellow-seeded *Brassica juncea* (**BJY**). The meals were produced using the conventional prepress solvent extraction process (regular meals) or a vacuum-assisted cold process of meal de-solventization (white flakes). Six cornstarch-based diets containing 35% canola meal as the sole source of protein in a 3 (variety) x 2 (processing) factorial arrangement and a 5% casein diet were randomly allotted to pigs in a 6 x 7 incomplete Latin square design to give 6 replicates per diet. The 5% casein diet was fed to estimate endogenous amino acid losses. There was an interaction effect ($P < 0.05$) of canola meal type and processing method on the SID of most amino acids. Among the white flakes, the SID of nitrogen, isoleucine, leucine, lysine, threonine, and valine were similar ($P > 0.10$) in BNY and BNB, but both had higher values ($P < 0.05$) than BJY. However, among the regular meals, the SID of lysine, methionine, threonine, and valine were higher ($P < 0.05$) in BJY followed by BNB and BNY. The SID of methionine (90.2%) was higher ($P = 0.001$) in BNY than in BNB and BJY. The results showed that the SID of nitrogen and amino acids in the meals from the canola varieties studied varied with processing method. Within the white flakes, amino acid digestibility values were similar in BNY and BNB, but both had higher digestibility than BJY. However, for canola processed using the regular method, BJY was similar to BNB in digestibility and both were superior to BNY.

Key words: canola meal types, processing technology, amino acid digestibility, pigs.

INTRODUCTION

Canola meal, which is a by-product of canola oil production, is widely utilized as a protein source in swine diets. However, the utilization of nutrients in canola meal by nonruminant animals is limited by its high dietary fibre content (Pastuszewska et al., 2003) and processing method which may compromise the protein quality (Newkirk and Classen 2002). To address the limitations imposed by the high fibre content, canola cultivars with reduced fibre content have been developed (Relf-Eckstein et al., 2007). Furthermore, processing methods such as the vacuum-assisted cold process have been proposed as a means of producing canola meals with superior feeding value (Canola Council of Canada, 2009). Indeed, in a recent study with growing pigs, Montoya et al. (2009) reported that canola meal derived from the yellow-seeded *Brassica napus* **(BNY)** and *Brassica juncea* **(BJY)** had higher digestible and net energy contents than canola meal from black-seeded *Brassica napus* **(BNB)**. However, the digestibility of protein and amino acids in canola meal derived from different canola cultivars and produced with different processing methods has not been extensively studied. The objective of the present study was to determine, in growing pigs, the standardized ileal digestibility **(SID)** of amino acids in canola meal derived from BNY, BJY, and BNB using the conventional prepress solvent extraction process (regular meals) or a vacuum-assisted cold process of meal de-solventization (white flakes).

MATERIALS AND METHODS

The study evaluated a total of six canola meals derived from BNB, BNY, and BJY using either the conventional solvent extraction (regular meals) or a vacuum-assisted cold process of meal de-solventization (white flakes). In the vacuum-assisted process, oil cells in canola seeds are physically ruptured by roller mills to preserve oil quality. The resulting flakes are passed through a series of steam-heated drum or stack-type cookers to thermally rupture any oil cells that may have survived flaking and to inactivate the myrosinase enzyme present in canola. After cooking for 15 to 20 min at 80 to 105°C, the flakes are pressed to remove 60 to 70% of the oil.

Experimental diets were based on cornstarch and formulated to contain 35% of one of the six canola meals as the sole source of protein. A diet containing 5% casein was used to estimate basal endogenous nitrogen and amino acid losses. Diets were supplemented with minerals and vitamins

according to NRC (1998). Titanium dioxide (0.3%) was used as an indigestible marker. Dietary treatments were randomly fed to 12 ileal cannulated barrows (30.9 ± 2.71 kg BW) in a 3 x 2 factorial arrangement with the factors being 3 canola varieties and 2 processing methods. Dietary treatment were allotted to pigs in a replicated 6 x 7 incomplete Latin square design in which canola diets were fed for six periods and an extra period added for the casein-based diet. Pigs were fed at 2.6 times daily maintenance energy requirement (106 kcal of ME/kg $BW^{0.75}$) based on BW at the start of each 7-day period. Daily feed allowance was provided in 2 equal meals (0800 and 1600 h) and ileal digesta were collected continuously for 12 h on d 6 and 7. The SID of AA was calculated as described by Nyachoti et al. (1997) using the index method. Data were subjected to ANOVA using the GLM procedures of SAS (SAS Inst. Inc., Cary, NC).

RESULTS AND DISCUSSION

The SID values of nitrogen and amino acids are summarized in Table 1. There was an interaction ($P < 0.05$) of canola variety and processing method for the SID of nitrogen. Specifically, the SID of nitrogen in BJY was lower ($P = 0.015$) than that in BNY and BNB, which were in turn similar among the white flakes. However, among the regular meals the SID of nitrogen was lower in BNY (75.5%) compared with BNB (78.0%) and BJY (80.0%) whose values were in turn similar. Except for arginine and phenylalanine, canola variety and processing method interacted to influence the SID of all the essential amino acids measured ($P < 0.05$). Specifically, values for isoleucine, leucine, lysine, and valine were higher ($P < 0.05$) in BNB than in BNY and BJY among the white flakes. However, among the regular meals values for histidine, isoleucine, leucine, methionine, threonine, and valine were higher ($P < 0.05$) in BJY than in BNY; those for BNB were intermediate and not different. There was no interaction of canola variety and processing method on the SID values for arginine and phenylalanine ($P > 0.10$). However, there was an effect of canola variety such that the SID values of arginine and phenylalanine were lower ($P < 0.05$) in BNY (87.2% and 74.9%, respectively) than in BNB (90.2% and 80.6%, respectively) and BJY (89.6% and 84.0%, respectively), whose values were in turn similar.

The results of the present study showing an effect of canola variety independently or in interaction with processing method on the digestibility of nitrogen and amino acids are consistent with previous studies (Pastuszewska et al., 2003; Woyengo et al., 2009). It is noteworthy that the SID values of lysine in white flakes (especially for BNB) tended ($P = 0.07$) to be higher compared with regular meals suggesting that the vacuum-assisted technology may minimize lysine damage by reducing the occurrence of Mailard reactions (Canola Council of Canada, 2009). It is not clear why white flakes from BJY consistently had lower SID values compared with the regular meal from the same canola variety, but this observation deserves further investigations to better understand the potential benefits of the new technology of oil extraction from canola aimed at optimizing oil recovery while maintaining the nutritive value of the meal.

In general, the average SID for the indispensable amino acids measured in BNY (80.4 ± 5.28%), BNB (85.4 ± 3.88%) and BJY (84.6 ± 3.09%) differed from published values (NRC, 1998; Ami Pig, 2000) for canola meal. Similarly, there were differences between the results of the present study and those of others that have examined the effect of canola variety and processing method (Mariscal-Landin et al., 2008; Montoya and Leterme, 2009; Seneviratne et al., 2010; Woyengo et al., 2010). Such differences probably result from experimental variability, canola variety and growing conditions, and the processing conditions used to produce the meal.

The standardized ileal digestible amino acid contents data shown in Table 2, demonstrates that the canola meals derived from the new varieties of canola, have higher concentrations of amino acids compared to published data for regular canola meal (e.g. NRC, 1998; Ami Pig, 2000). The higher standardized ileal digestible amino acid contents makes these canola meals more desirable as protein sources for swine.

An important observation in this study that deserves further assessment is that white flakes for canola meals from BNY and BNB had numerically higher SID values for most amino acids compared with regular meals whereas the opposite was true for BJY. According Newkirk et al. (2002), meals produced from *B. juncea* had considerably higher levels of glucosinolates than *B. napus* although meals from some strains had low to nil glucoinsolate levels. It is possible that the lower SID values in BJY white flakes may have been due to higher glucosinolate content in this meal, but this was not determined in the present study.

In conclusion, the SID of amino acids in the evaluated canola meals changed according to processing method. Within the flake processing, BNY and BNB had similar SID amino acid values which were higher than that observed in BJY. However, for regular processing, SID amino acids values for BJY and BNB were similar and higher than that observed in BNY. Meals from the new

canola types had higher digestible amino acid contents, which make them more desirable as protein sources for swine.

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Table 1. Standardized ileal digestibility (%) of nitrogen and selected amino acids in canola meals fed to growing pigs.

	B. napus Yellow		*B. napus* Black		*B. juncea* Yellow			*P*-value[1]		
Item	REG	FLK	REG	FLK	REG	FLK	SEM	CM	Proc	CxP
N	75.5^{b}	78.0^{x}	78.0^{a}	79.0^{x}	80.0^{a}	74.2^{y}	0.83	0.81	0.52	0.02
Arg	87.4	89.1^{y}	91.0	93.8^{x}	90.1	88.2^{y}	0.77	0.01	0.42	0.20
His	84.4^{b}	86.9^{y}	87.4^{ab}	93.0^{x}	90.6^{a}	88.5^{xy}	0.87	0.01	0.11	0.05
Ile	78.0^{b}	78.1^{y}	82.7^{ab}	86.4^{x}	86.5^{a}	78.9^{y}	1.16	0.01	0.46	0.03
Leu	78.3^{b}	78.8^{y}	82.5^{ab}	87.6^{x}	86.5^{a}	82.0^{y}	1.12	0.01	0.82	0.04
Lys	80.4	81.9^{y}	81.7	88.9^{x}	84.1	83.5^{y}	1.01	0.05	0.07	0.06
Met	83.0^{b}	90.2^{x}	86.8^{ab}	85.4^{xy}	89.5^{a}	80.3^{y}	0.85	0.51	0.38	0.01
Phe	74.0^{b}	75.8	77.0^{b}	84.1	85.6^{a}	82.4	1.41	0.01	0.35	0.12
Thr	75.1^{b}	76.8^{y}	78.8^{ab}	87.6^{x}	84.1^{a}	82.4^{xy}	1.24	0.01	0.10	0.06
Val	74.0^{b}	74.9^{y}	78.0^{ab}	84.2^{x}	83.6^{a}	75.7^{y}	1.40	0.02	0.90	0.02

[1]CM = canola variety, Proc = processing method, CxP = canola variety x processing method interaction

^{ab} = within a row, means for regular **(REG)** processing method without a common superscript letter differ *(P* < 0.05); ^{xy} = within a row, means for flakes **(FLK)** without a common superscript letter differ (*P* < 0.05).

Table 2. Standardized ileal digestible amino acid contents of canola meals, as % fed basis.

Item	*B. napus* Yellow Regular	*B. napus* Yellow Flakes	*B. napus* Black Regular	*B. napus* Black Flakes	*B. juncea* Yellow Regular	*B. juncea* Yellow Flakes
Arg	2.01	2.50	2.06	1.91	2.53	2.43
His	0.81	1.09	0.77	0.87	1.07	1.03
Ile	0.98	1.45	0.90	1.03	1.58	1.47
Leu	1.82	2.59	1.68	1.92	2.74	2.56
Lys	1.49	2.09	1.48	1.78	1.92	1.97
Met	0.53	0.78	0.59	0.58	0.78	0.68
Phe	0.91	1.45	0.81	0.99	1.56	1.43
Thr	0.90	1.51	0.86	1.10	1.56	1.52
Val	1.03	1.63	0.94	1.15	1.73	1.51