Chemical composition and nutritive value of low-fiber yellow-seeded *B. napus* and *B. juncea* canola for poultry

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Abstract

Canola breeding programs undertaken to improve meal quality and oil content in the seed has led to the development of low-fiber yellow-seeded *Brassica napus* and *B. juncea* canola. The objective of the current study was to evaluate the chemical and nutritive composition of meals derived from black- and yellow-seeded *B. napus* canola and canola-quality *B. juncea*. In comparison with its black-seeded counterpart, meal derived from yellow-seeded *B. napus* canola contained more protein (49.8 vs. 43.8% DM), more sucrose (10.2 vs. 8.8% DM) and less dietary fibre (24.1 vs. 30.1% DM). Lower fiber content in yellow-seeded *B. napus* canola was reflected in lower content of lignin with associated polyphenols (3.7 vs. 7.1% DM). *B. juncea* canola showed intermediate levels of crude protein, sucrose and dietary fiber (47.4, 9.2 and 25.8%, respectively). The nutritive value of canola meal samples was investigated with broiler chickens fed corn-based diets containing 30% of canola meals. A significantly higher (P<0.05) lysine (87.9%), methionine (89.1%), threonine (82.2%), and total ileal digestibility of amino acids (87.3%) was observed in birds fed the yellow-seeded *B. napus* diet when compared with those fed diets containing black-seeded *B. napus* (85.5, 87.9, 77.4 and 84.1%, respectively) or *B. juncea* canola (83.1, 87.3, 76.5 and 83.8%, respectively). In another study, apparent metabilizable energy (AME_n) values for yellow- and black-seeded *B. napus*, and *B. juncea* as determined with broiler chickens were 2190, 1904, and 1736 kcal/kg DM, respectively. In the assay with turkeys, the AME_n values for yellow- and black-seeded *B. napus*, and *B. juncea* canola averaged 2166, 2007, and 1877 kcal/kg DM, respectively, and were of the same order of magnitude to those determined with broiler chickens. Multicarbohydrase enzyme addition to broiler chicken diets significantly increased energy utilization (from 1943 to 2249 kcal/kg DM, on average), with the most pronounced effect observed for *B. juncea* canola (from 1736 to 2356 kcal/kg DM).

Key words: Low-fiber canola, Chemical composition, Nutritive value, Fiber, AME_n, Enzyme

Introduction

Earlier research from this laboratory has shown yellow-seeded *B. napus* canola to have superior quality characteristics to that of yellow-seeded *B. rapa*, *B. juncea* and the black-seeded type of *B. napus*, both in terms of chemical composition (i.e., lower fiber, lower phytate phosphorus, lower glucosinolate and higher protein content) and the overall nutritive value as determined with broiler chickens (Simbaya et al. 1995, Slominski, 1997). Over the years, further improvements to the quality of yellow-seeded *B. napus* canola (high yield, high oil and low fiber) have been made at the Saskatoon Research Centre, Agriculture and Agri-Food Canada by Dr. Rakow and his group. The objective of this study was to evaluate the chemical composition and the nutritive value of a newly developed yellow-seeded *B. napus* line YN01-429 canola and the canola type *B. juncea*. The meal derived from the conventional black-seeded *B. napus* canola served as a control.

Materials and Methods

The seed samples (2007 crop year) were obtained from the Agriculture and Agri-Food Canada Research Station in Saskatoon, Canada and were crushed at the POS Pilot Plant in Saskatoon, Canada using the prepress solvent extraction process. The meals were subjected to oil, protein, amino acids, carbohydrates (sucrose, starch, oligosaccharides), glucosinolates, dietary fibre, total and non-phytate phosphorus analysis using the procedures described earlier (Simbaya et al. 1995). The seed samples were also subjected to fractionation to determine the weights and composition of the hull and embryo fractions.

The nutritive value of the meals was determined in a two-week broiler chicken growth performance trial and AME_n determination with broiler chickens (from 14 to 19 d of age) and turkeys (from 21 to 30 d of age). In the first two assays, broiler chickens were fed corn/soybean meal-based diets containing 30% of canola meals. In the AME_n assay the diets contained 2800 kcal/kg available energy and were fed without or with exogenous multicarbohydrase supplementation. In the balance study with turkeys, birds were fed diets containing 93% of test ingredient which served as the only source of protein and energy. All chemical analysis, growth performance and energy utilization data were subjected to GLM procedure of SAS. Differences between means were determined by Tukey's test. The statements of significance are based on P<0.05.

Results and Discussion

Chemical composition of *Brassica* meal samples used in the study is shown Table 1. On average, and in comparison with the conventional meal, meals derived from yellow-seeded *B. napus* and *B. juncea* canola contained more protein, more sucrose, and less fiber. The difference in the total dietary fiber content was reflected in the lower lignin with associated polyphenols content. However, it is of interest to note that the lower fiber content in yellow-*seeded B. napus* and *B. juncea* canola was also associated with the lower content of glycoproteins and minerals.

Seed fractionation demonstrated that the reduction in fiber content of yellow- seeded *B. napus* was a consequence of a bigger seed size, a lower contribution of the hull fraction to the total seed mass, and a lower lignin content of the hull fraction (Table 2).

Table 1. Chemical composition of meals derived from black- and yellow-seeded *B. napus* canola and canola type *B. juncea* (% DM)

Item	*B. napus* black	*B. napus* yellow	*B. juncea*
Crude protein	43.8^c	49.8^a	47.4^b
Fat	1.8^b	1.6^b	1.7^b
Ash	7.3^a	7.0^b	7.2^a
Carbohydrates			
Monosaccharides	0.2^b	0.3^a	0.3^a
Sucrose	8.8^c	10.2^a	9.2^b
Oligosaccharides	3.1^b	2.5^c	3.6^a
Starch	0.4	0.4	0.3
Dietary fiber components			
NSP	20.2^a	18.7^b	20.0^a
Lignin and polyphenols	7.1^a	3.7^c	3.9^b
Glycoproteins	2.1^a	1.5^c	1.7^b
Minerals	0.7^a	0.3^b	0.3^b
Total fiber	30.1^a	24.1^c	25.8^b
Amino acids (AA)(g/16 g N)			
Lysine	6.1^a	5.7^b	5.3^c
Arginine	5.7^b	6.3^a	6.4^a
Methionine	2.1^a	1.9^b	2.0^b
Threonine	4.3	4.3	4.3
Total AA	91.3^b	94.4^a	92.7^{ab}

[abc] Means within a row with no common superscripts differ significantly (P<0.05).

Table 2. Seed, hull and embryo weights and fiber components of the hull fractions (full-fat basis)

Item	*B. napus* black	*B. napus* yellow	*B. juncea*
1000 seed weight (g)	2.9^b	3.9^a	2.5^c
Embryo fraction (g/100g)	84.1^c	89.0^a	86.3^b
Hull fraction (g/100g)	15.9^a	11.0^c	13.7^b
NSP (%)	32.5^b	29.7^c	41.6^a
Lignin and polyphenols (%)	21.4^a	11.1^c	14.7^b

[abc] Means within a row with no common superscripts differ significantly (P<0.05).

Similar body weight gain and FCR data were observed in chickens fed meals derived from yellow- and black-seeded canola (Table 3). The highest coefficients for total and essential amino acids (AA) were observed in broiler chickens fed diets containing yellow-seeded *B. napus*. No difference was found in ileal AA digestibility between black-seeded *B. napus* and *B. juncea* groups and the total AA digestibility, on average, was lower than that of yellow-seeded *B. napus* by 3.3% ($P = 0.01$).

Table 3. Growth performance and amino acid (AA) digestibility in broiler chickens fed diets containing meals derived from black- and yellow-seeded canola

Item	*B. napus* black	*B. napus* yellow	*B. juncea*
Body weight gain (g/bird/14 d)	400	396	405
FCR (g feed/g gain)	1.36	1.38	1.40
AA digestibility (%)			
Lysine	85.5^{ab}	87.9^{a}	83.1^{b}
Methionine	87.9^{ab}	89.1^{a}	87.3^{b}
Threonine	77.4^{b}	82.2^{a}	76.5^{b}
Total AA	84.1^{b}	87.3^{a}	83.8^{b}

^{abc} Means within a row with no common superscripts differ significantly (P<0.05).

Metabolizable energy contents of canola meals as determined in turkeys and broiler chickens are presented in Table 4. The meal derived from yellow-seeded *B. napus* contained the highest amount of AME_n ($P < 0.01$) for turkeys, whereas no significant difference was noticed between those of black-seeded *B. napus* and *B. juncea*. In broiler chickens the highest AME_n value was again found in the meal derived from yellow-seeded *B. napus*. However, it was similar to that of its black-seeded counterpart but higher (P=0.05) than the value of *B. juncea* meal. Enzyme addition increased the AME_n values of test ingredients with the significant increase observed for *B. juncea* canola (P<0.01).

Table 4. Apparent metabolizable energy (AME_n) content of canola meals for turkeys and broiler chickens without or with enzyme supplementation (kcal/kg DM)

Item	*B. napus* black	*B. napus* yellow	*B. juncea*
Turkeys	2007^{b}	2166^{a}	1877^{b}
Broiler chickens			
No enzyme	1904^{aA}	2190^{aA}	1737^{bB}
Enzyme	2019^{A}	2372^{A}	2356^{A}

^{abc} Means within a row with no common superscripts differ significantly (P<0.05); ^{AB} Means within a column and enzyme treatment with no common superscripts differ significantly (P<0.05)

Conclusion

It would appear evident from these studies that the meal derived from yellow-seeded *B. napus* canola would have superior quality characteristics to those from black-seeded *B. napus* or yellow-seeded *B. juncea* canola.

References

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