Chemical composition and nutritive value of yellow-seeded *Brassica napus* canola

Bogdan A. Slominski[1], Xiangfeng Meng[1], Wei Jia[1], Martin Nyachoti[1], Owen Jones[2], Gerhard Rakow[3]

[1]*Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada R3T 2N2*
[2] *Canadian Bio-Systems Inc., Calgary, Alta, Canada T2C 0J7*
[3]*Agriculture and Agri-Food Canada, Saskatoon, SK, Canada S7N 0X2 Email: b_slominski@umanitoba.ca*

Abstract

Plant selection programs directed towards the development of yellow-seeded canola are justified as a means to improve meal quality without compromising oil content in the seed. The objective of this study was to compare a new yellow-seeded *B. napus* line YN01-429 with its black-seeded counterpart *B. napus* line N89-53, both types produced under identical growing conditions in two consecutive years (2003-2004). On average, in comparison to black-seeded, yellow-seeded type contained more oil (46.4 vs 43.1% DM) and less dietary fibre (14.4 vs 18.5%). When expressed on fat free basis, higher amounts of protein (48.6 vs 47.9%), and lower amounts of sucrose (7.5 vs 8.1%), oligosaccharides (2.1 vs 3.6%), starch (2.3 vs 2.8%), total phosphorous (1.14 vs 1.25%), non-phytate phosphorous (0.83 vs 0.93%), and glucosinolates (20.8 vs 27.4 μmol/g) were observed in yellow-seeded canola. Although slightly higher in the content of non-starch polysaccharides (17.5 vs 16.7%), the total dietary fibre averaged 26.4% for yellow- and 32.1% for black-seeded samples. Lower fibre content in yellow-seeded canola was reflected in lower content of lignin with associated polyphenols (4.7 vs 9.8%). When expressed in g/16g N, no major difference in essential amino acid contents was observed. In a two-week feeding trial, broiler chickens were fed corn (50%)/soybean meal (30%) diets containing 15% of ground seed from yellow- or black-seeded canola. The diets were formulated to contain 21% crude protein and 3050 kcal/kg available energy and were fed without or with exogenous enzyme supplementation. On average, chickens fed diets containing yellow seeds showed body weight gain (g/bird/14 days) and feed efficiency (g feed/g weight gain) values of 280.5 and 1.37 which were identical to those of 283.4 and 1.37 for the diets containing black seeds. Regardless of the seed coat color, weight gain and feed efficiency averaged 278.8 and 285.0, and 1.39 and 1.34 for the control and the enzyme supplemented diets, respectively.

Key words: Yellow-seeded canola, *Brassica napus*, chemical composition, nutritive value, broiler chickens, enzyme supplementation

Introduction

Research conducted to date 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 (Slominski, 1997; Jiang et al., 1999). A new and improved yellow-seeded *B. napus* canola has recently been developed at the Saskatoon Research Centre, Agriculture and Agri-Food Canada through crossing breeding of yellow-seeded lines, which in our earlier research were found to have superior quality characteristics.

The objective of this study was to compare a new yellow-seeded *B. napus* line YN01-429 with its black-seeded counterpart *B. napus* line N89-53, both types produced under identical growing conditions in two consecutive years.

Materials and Methods

The seed samples represented composite lines of near-isogenic yellow- and black-seeded *B. napus* canola grown in the field plots of the Agriculture and Agri-Food Canada research station in Saskatoon, Canada under identical growing conditions in years 2003 and 2004. Seed and laboratory prepared 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 (Slominski et al., 1994; Simbaya et al. 1995). The nutritive value of full fat seeds was investigated in a two-week broiler chicken trial. Chickens were fed corn (50%)/soybean meal (30%) diets containing 15% of ground seeds from either yellow- or black-seeded samples. The diets were formulated to contain 21% crude protein and 3050 kcal/kg available energy and were fed without or with exogenous enzyme supplementation. The enzyme supplement contained cellulase, pectinase, mannanase, xylanase, glucanase, galactanase and other enzyme activities. All chemical analysis and broiler chicken performance data were subjected to GLM procedure of SAS (SAS institute, 2003). 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* seed samples used in the study is shown Table 1. On average, in comparison with black-seeded, yellow-seeded type contained more oil (46.4% vs 43.1%), less protein (26.2 vs 27.2%) and less dietary fibre (14.4 vs 18.5%) with the crop year and seed coat color having significant effects on all three parameters measured. This is somewhat contradictory to our earlier research (Jiang et al., 1999) in which higher protein (25.0 vs 22.4%) and lower fat (44.9

vs 49.3%) contents were observed in yellow-seeded when compared with black-seeded samples. However, over the years more emphasis has been put on the improvement in oil content which resulted in the protein content being lower in the newly developed yellow-seeded line. Similar to our earlier research, however, the fiber content was found to be still significantly lower in this type of canola.

Table 1. Fat, protein and dietary fiber content of *B. napus* seeds of different color (% DM; full fat basis)

Seed type	Fat	Crude protein	Dietary fibre[1]
Black-2003	42.5[c]	29.1[a]	17.5[b]
Yellow-2003	43.7[b]	28.7[a]	14.6[c]
Black-2004	43.6[b]	25.3[b]	19.4[a]
Yellow-2004	49.0[a]	23.8[c]	14.1[c]
Pooled SEM	0.2	0.2	0.3
Year	<0.01	<0.01	0.02
Color	<0.01	<0.01	<0.01
Year × Color	<0.01	0.01	<0.01

[1] Includes non-starch polysaccharides, lignin with associated polyphenols, cell wall protein, and minerals; [a,b] Means within a column and within a source with no common superscript differ significantly (P<0.05).

When expressed on fat free basis, meals derived from yellow-seeded canola contained more protein, less starch and less sucrose (Table 2). The low sucrose content of yellow-seeded samples was different from our earlier data (Jiang et al., 1999) showing higher sucrose content in yellow- than black-seeded samples (i.e., 9.0 vs 7.8%). Such a discrepancy could be a consequence of breeding activities which may have influenced certain quality characteristics of the new line. Total and non-phytate phosphorus contents in yellow-seeded samples were slightly but significantly (P<0.05) lower than those present in the black-seeded samples. Lower contents of antinutritional factors, including glucosinolates and oligosaccharides raffinose and stachyose, were also observed in this new yellow-seeded canola.

Table 2. Chemical composition of meals derived from black- and yellow-seeded *B. napus* canola (% DM; fat free basis)

Seed type	Crude Protein	Sucrose	Oligo-saccharides[1]	Starch	Dietary fibre	Gluco-sinolates[2]	Total P	Non-phytate P
Black	47.9[b]	8.1[a]	3.6[a]	2.8[a]	32.4[a]	27.4[a]	1.25[a]	0.93[a]
Yellow	48.6[a]	7.5[b]	2.1[b]	2.3[b]	26.6[b]	20.8[b]	1.14[b]	0.83[b]
Pooled SEM	0.2	0.1	0.1	0.1	0.4	1.2	0.03	0.02

[1] Includes raffinose and stachyose; [2] μmol/g; [a,b] Means within a column with no common superscript differ significantly (P<0.05).

Although higher in the content of non-starch polysaccharides (17.5 vs 16.7 %), the total dietary fibre in yellow-seeded samples was found to be significantly lower, differing by 5.7 percentage points from that of the black-seeded canola (Table 3). Similar to our earlier research (Slominski at al., 1994; Simbaya et al., 1995, Jiang et al., 1999), lower fibre content of yellow-seed canola was associated with lower content of lignin and polyphenols. It could be hypothesized, that the relatively low degree of lignification and/or saturation of the seed coat cell walls with tannins (condensed polyphenols) could result in improved nutritive value of yellow-seeded canola. In addition, lower fibre content of the seed could potentially result in higher nutrient density of meals derived from the yellow-seeded type.

Table 3. Composition of dietary fibre in meals derived from black- and yellow-seeded *B. napus* canola (% DM)

Seed type	NSP[1]	Protein	Ash	Lignin and polyphenols	Total fibre
Black	16.7[b]	4.8	0.8	9.8[a]	32.1[a]
Yellow	17.5[a]	4.0	0.2	4.7[b]	26.4[b]
Pooled SEM	0.1	0.2	0.1	0.7	0.4

[1] Non-starch polysaccharides; [a,b] Means within a column with no common superscript differ significantly (P<0.05).

When expressed in g/16g N, no difference in essential amino acid content was observed except for arginine and valine levels which were slightly, but significantly lower in the yellow-seeded samples (Table 4).

Table 4. Selected amino acid content of *B. napus* canola of different color (g/16g N)

Color	Arginine	Histidine	Lysine	Methionine	Cystine	Threonine	Valine
Black	6.5[a]	2.7	6.2	2.1	2.4[b]	4.6	4.4[a]
Yellow	5.9[b]	2.7	6.2	2.2	2.6[a]	4.5	4.2[b]
Pooled SEM	0.1	0.1	0.1	0.05	0.04	0.1	0.02

[a,b] Means within a column with no common superscript differ significantly (P<0.05).

Chickens fed diets containing seeds of yellow color showed body weight gain and feed efficiency values similar to those fed diets containing black seeds (Table 5).

Table 5. Growth performance of broiler chickens (1-14 days of age) fed diets containing black and yellow *B. napus* seeds without and with enzyme supplementation

Year	Seed Type	Enzyme	Feed Intake (g/bird)	Body Weight Gain (g/bird)	Feed Efficiency
2003	Black	-	384.8 ± 9.6[1]	276.3 ± 9.9	1.40 ± 0.02[a]
		+	378.7 ± 9.6	286.4 ± 9.9	1.33 ± 0.02[b]
	Yellow	-	379.7 ± 10.1	273.1 ± 10.4	1.41 ± 0.02
		+	375.3 ± 9.6	275.9 ± 9.9	1.36 ± 0.02
2004	Black	-	386.7 ± 9.6	276.9 ± 9.9	1.40 ± 0.02
		+	394.6 ± 9.6	293.9 ± 9.9	1.34 ± 0.02
	Yellow	-	392.2 ± 10.1	289.1 ± 10.4	1.36 ± 0.02
		+	379.8 ± 9.6	284.0 ± 9.9	1.34 ± 0.02
Year[2]			NS	NS	NS
Color			NS	NS	NS
Enzyme			NS	NS	<0.01

[1]Mean±SD; [2]All the 2-way and 3-way interactions were tested non-significant; [a,b]Means within a column and within a source with no common superscript differ significantly ($P<0.05$).

Conclusions

Chemical characterization of canola seed samples of different color showed a new yellow-seeded *B. napus* line to contain more oil, less protein, less fibre, and less glucosinolates than its black-seeded counterpart. No differences in growth performance of broiler chickens fed diets containing 15% of either yellow or black seeds was noted. Carbohydrase enzyme addition had a positive effect on feed utilization with more pronounced effect observed for the diets containing black (high fibre) seeds.

References

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