Gastrointestinal tract response of young turkeys fed meals derived from low-fibre yellow-seeded *B. napus* and *B. juncea* canola

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Abstract

The objective of the current study was to evaluate the physiological response of young turkeys to diets containing meals derived from black- and yellow-seeded *Brassica napus* rapeseed/canola and canola-quality *B. juncea*. When compared with the conventional black-seeded *B. napus*, meals derived from yellow-seeded *B. napus* and *B. juncea* contained, respectively, more protein (49.8 and 47.4 vs. 43.8%), less dietary fiber (24.1 and 25.8 vs. 30.1%), and less lignin with associated polyphenols (3.7 and 3.9 vs. 7.1%). The effect of meals on gut function was investigated in the experiment with young male turkeys (from 21 to 30 days of age) fed diets containing 93% of test ingredient, which served as the only source of protein and energy. In comparison to black-seeded *B. napus*, feeding the diet containing meal derived from yellow-seeded *B. napus* canola resulted in a lower pH of the small intestinal contents, an increased mass of caecal contents and a decreased concentration of short chain fatty acids (SCFA). No changes in the caecal SCFA pool were observed. Feeding *B. juncea* meal, on the other hand, caused more significant changes in the intestinal function, including lower hydration and higher viscosity of the small intestinal contents and increased bacterial α- and β-glucosidase, α-galactosidase and β-glucuronidase activities in the caeca. Only a trend in increased SCFA production was noted.

Key words: Low-fiber canola, gastrointestinal tract function, viscosity, SCFA, bacterial enzyme activity, turkeys

Introduction

It is generally accepted that among the factors determining the nutritional value of rapeseed/canola, the content of non-starch polysaccharides (NSP) and other fiber components including polyphenols is of primary importance. High content of dietary NSP, which are known to be indigestible in the upper gut of monogastric animals, could be considered a contributing factor to the low nutritive value of low glucosinolate rapeseed meal for poultry (Bell, 1993). The physiological properties of NSP may be influenced by the presence of polyphenols, known to complex with the cell wall structures. It has been reported that the reduction in crude fiber content by 54% with seed dehulling resulted in an increase in AME content by 15-20 % (Lessire et al., 1986). Therefore, there has been an interest in developing the varieties of rapeseed/canola with reduced dietary fibre and polyphenol content. In the current study, the physiological responses of young turkeys to diets containing meals derived from newly developed yellow-seeded *B. napus* rapeseed/canola and canola-quality *B. juncea* were examined and compared to that of the conventional black-seeded *B. napus* rapeseed/canola.

Material and methods

Forty-two 21-day old male turkeys were randomly assigned to 3 dietary treatments (2 birds per pen, 7 replicate pens per treatment). From d 21, birds were fed experimental diets containing 93% of test ingredient as the only source of protein and energy. There was a 4-day adaptation period and the experimental period lasted for 5 days. On d 30, birds were killed by cervical dislocation and segments of the digestive tract (i.e., gizzard, small intestine, caeca, and colon) with contents were collected. Samples from the same pen were pooled to yield 7 replicates per treatment. Sampling and chemical analyses were conducted using the procedures described by Jankowski et al. (2009).

Results

In comparison with the conventional black-seeded *B. napus* rapeseed/canola, feeding the diet containing meal derived from yellow-seeded *B. napus* canola resulted in a significant decrease (P<0.05) in the small intestinal pH and resulted in the increase in caeca mass, both tissue and digesta (Table 1). In addition, yellow-seeded *B. napus* meal caused a significant increase in α-glucosidase activity in the caeca while the activity of *β*-glucosidase, *α*- and *β*-galactosidase, and *β*-glucuronidase remained unchanged (Table 2).

Table 1. The effect of meals derived from black- and yellow-seeded rapeseed/canola on tissue weight, digesta viscosity, and pH values in turkeys at 30 d of age.

	B. napus black	*B. napus* yellow	*B. juncea*
BW, kg	1.22 ±0.04[1]	1.20 ±0.03	1.23 ±0.03
Gizzard			
pH of digesta	4.36 ±0.06	4.12 ±0.08	4.21 ±0.15
Small intestine			
Full mass, g/kg BW	128 ±1.8[a]	127 ±3.9[a]	102 ±3.8[b]
pH of digesta	6.39 ±0.13[a]	5.92 ±0.07[b]	6.20 ±0.06[a]
Viscosity, mPa s	1.51 ±0.06[b]	1.55 ±0.08[b]	2.32 ±0.09[a]
DM of digesta, %	15.2 ±0.63[b]	15.9 ±0.67[b]	22.5 ±1.45[a]
Caeca			
Tissue weight, g/kg BW	8.5 ±0.25[b]	10.0 ±0.44[a]	8.1 ±0.40[b]
Digesta weight, g/kg BW	2.0 ±0.24[b]	4.2 ±0.24[a]	2.5 ±0.30[b]
pH of digesta	6.96 ±0.12	7.17 ±0.07	7.04 ±0.14
DM of digesta, %	18.2 ±0.38	18.4 ±1.06	20.6 ±1.08
Ammonia, mg/g	0.39 ±0.01	0.40 ±0.02	0.38 ±0.01
Colon			
Tissue weight, g/kg BW	7.4 ±0.37[a]	7.0 ±0.35[ab]	6.2 ±0.40[b]
Digesta weight, g/kg BW	7.3 ±0.40	6.2 ±0.44	7.0 ±1.00
pH of digesta	6.77 ±0.16	6.78 ±0.12	6.63 ±0.18

[1] Mean ± SEM (n = 8); [abc] Means within a row with no common superscripts differ significantly (P<0.05).

In comparison with its black-seeded counterpart, yellow-seeded *B. napus* canola caused a significant decrease in the concentration of caecal short chain fatty acids (SCFA). However, the total caecal SCFA pool, as expressed in µmol per kg of BW, did not differ among the treatments. Feeding *B. juncea* meal, on the other hand, resulted in decreased relative mass of small intestine, increased viscosity and dry matter concentration of the small intestinal contents as well as enhanced activities of bacterial *α*- and *β*-glucosidase, *α*-galactosidase, and *β*-glucuronidase in the caeca (P<0.05). It would appear that such a response could be a consequence of the high water-soluble NSP (i.e., mucilage) content of *B. juncea* meal.

Table 2. The effect of meals derived from black- and yellow-seeded rapeseed/canola on bacterial enzyme activities and short-chain fatty acid (SCFA) contents in the caeca of turkeys at 30 d of age

	B. napus black	*B. napus* yellow	*B. juncea*
Enzyme activity, μmol//h/g of digesta			
α-Glucosidase	9.1 ±0.91[1c]	13.6 ±1.11[b]	17.6 ±1.54[a]
β-Glucosidase	2.2 ±0.11[b]	2.2 ±0.32[b]	14.3 ±1.36[a]
α-Galactosidase	14.0 ±1.71[b]	12.2 ±1.09[b]	25.1 ±2.92[a]
β-Galactosidase	18.0 ±1.75	19.5 ±3.58	25.1 ±2.10
β-Glucuronidase	3.1 ±0.43[b]	5.5 ±1.04[b]	12.7 ±1.16[a]
SCFA, μmol/g of fresh digesta			
Acetic	43.2 ±2.36[a]	21.3 ±0.91[b]	38.5 ±4.33[a]
Propionic	3.4 ±0.44[a]	1.2 ±0.05[b]	3.0 ±0.37[a]
Iso-butyric	0.4 ±0.11[a]	0.2 ±0.02[b]	0.3 ±0.03[ab]
Butyric	8.5 ±0.50[a]	3.9 ±0.44[b]	8.4 ±0.79[a]
Iso-valeric	0.4 ±0.08[b]	0.2 ±0.01[c]	0.6 ±0.04[a]
Valeric	0.7 ±0.08[a]	0.2 ±0.04[b]	0.9 ±0.14[a]
Total SCFA	56.4 ±2.31[a]	26.9 ±1.15[b]	51.8 ±5.38[a]
SCFA profile, %			
C_2	76.2 ±1.20[ab]	79.3 ±1.38[a]	74.1 ±1.09[b]
C_3	6.0 ±0.84[a]	4.4 ±0.27[b]	5.8 ±0.13[ab]
C_4	15.1 ±0.89	14.4 ±1.47	16.5 ±1.24
SCFA, μmol/kg of BW			
Acetic	86.5 ±10.9	89.5 ±9.51	99.3 ±17.3
Propionic	6.9 ±1.43	4.8 ±0.32	7.8 ±1.42
Iso-butyric	0.9 ±0.34	0.6 ±0.07	0.8 ±0.13
Butyric	16.7 ±1.66	16.7 ±2.51	21.9 ±3.32
Iso-valeric	0.8 ±0.27[b]	0.7 ±0.06[b]	1.6 ±0.23[a]
Valeric	1.3 ±0.28[b]	0.8 ±0.18[b]	2.4 ±0.48[a]
Total SCFA	113 ±13.4	113 ±12.1	134 ±22.4

[1]Mean ± SEM (n = 8); [abc] Means within a row with no common superscripts differ significantly (P<0.05).

The results of the present study indicate that, contrary to the conventional black-seeded rapeseed/canola, the meals derived from yellow-seeded *B. napus* and *B. juncea* canola positively influenced the function of the digestive tract of young turkeys. As reported by Slominski et al. (2011), the differences in physiological responses of turkeys could be explained, in part, by differences in chemical composition of the meals evaluated. One important factor could be the lower content of polyphenols in yellow-seeded *B. napus* and *B. juncea*. It is well known that the high dietary fiber content may accelerate the digesta passage rate, which in turn, may result in reduced time for digestion by endogenous enzymes and thus reduced nutrient digestibility. Further research on the composition of NSP and the polyphenol fractions of the meals evaluated in the current study should allow for better understanding of the physiological responses observed in turkeys fed meals from low- and high fiber canola. In light of the gut function parameters reported herein, it is of interest to note that the *B. juncea* meal meal showed the lowest available energy (AME_n) content as determined with broiler chickens and turkys (Slominski et al, 2011).

References

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