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Developments in the breeding of low fibre rapeseed/canola*

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ABSTRACT

Evaluation of the nutritive profiles of the meals derived from yellow-seeded *Brassica napus, B.rapa, B. juncea carinata* and *Sinapis alba* genotypes (27 samples) and conventional brown-seeded canola (7 samples) was undertaken. On average, in comparison to brown-seeded, yellow seeded types contained more sucrose (8.7 vs 7.5%) and protein (44.5 vs 42.7%) but similar amouns of oligosaccharides (2.3 vs 2.5%), ash (6.9 vs 7.0%), a nonstarch polysaccaharides (20.4 vs 19.7%). Total dietary fibre averaged 28% for yellow-seeded samples and 33% for brown-seeded samples and was negatively correlated ($r = -0.71$) with protein content. The negative relationship between protein and dietary fibre contents was also evident for the sample of conventional canola grown under different environment conditions. An *in vitro* digestible protein measurement was used to establish optimal conditions for the processing of canola seed. Digestible protein content of three oil free seed samples increased substantially with increased temperature of moist heat treatment up to 108 ± 1^0C. Heat treatment below 105^0C was not effective in promoting protein digestibility. Application of higher temperatures ($> 110^0$C) resulted in a significant decline in protein digestibility. The optimal moist heat treatment conditions were chosen for processing of the seed samples selected for further evaluation *in vivo*. The samples included the yellow-seeded *B. napus, B. juncea* and *B. rapa* and the brown-seed *B. napus* canola. Availability of energy and amino acids and the overall feeding quality as determined in a 2-week growth trial with 4-day-old broiler chickens were assessed. Two commercial meals from yellow-seeded *B. rapa* and brown-seeded *B. napus* canola served as control samples. Availability of amino acids averaged 84.1% with only minor differences among the samples. True metabolizable energy (AME_N) content was highest in the yellow-seeded *B. napus* sample. There were no differences in weight gain of broiler chickens fed the commercial or laboratory prepared *B. rapa* and yellow- and brown-seeded *B. napus* meals. Chickens fed *B. juncea* meal showed significantly lower feed intake and body weight gain which appeared to be attributed to a relatively high content of aliphatic glucosinolates in particular meal (i.e., 21.7 μmol/g DM). Birds fed the yellow-seeded *B. napus* canola showed the highest feed efficiency value which averaged 1.51 and differed significantly from that of 1.59 and 1.61 for the commercial yellow-seeded *B. rapa* and the laboratory

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prepared brown-seeded *B. napus* canola, respectively. It may be surmised that future cultivars of yellow-seeded canola will have improved nutritive value. Effective introduction of *Brassica juncea* nad *Sinapis alba* as new crops for the Canadian Praires would necessitate further quality improvement by lowering the glucosinolate content.

KEY WORDS: canola, rape seed, chemical composition, seed colour, dietary fibre, *in vitro* protein digestibility, heat treatment, nutritive value

INTRODUCTION

Rapeseed/canola meal is a high quality protein supplement but its use in diets for livestock and poultry has been limited by the relatively high content of fibre resulting in low energy yield and less than optimum protein utilization (Bell, 1993). Various approaches have been undertaken in an attempt to reduce the fibre content, increase the protein content and to improve nutrient utilization. These include breeding for yellow-seeded/low fibre canola, removal of the hull prior to oil extraction, protecting protein from rumen degradation, application of a straight press technology to increase available energy content or the use of fungal and microbial enzymes to enhance nutrient utilization by rapidly growing monogastric animals (Slominski, 1993).

Efforts to breed for yellow-seed coat in rapeseed/canola are justified as a means to improve the meal quality without compromising oil content in the seed (Stringam et al., 1974; Bell and Shires, 1982). It is believed that this could be achieved by decreasing seed fibre and increasing seed protein, with a resultant potential improvement in the available energy and amino acid contents of the meal.

YELLOW-SEEDED RAPESEED/CANOLA

Plant selection programs directed toward development of yellow-seeded *Brassica rapa* (formerly *Brassica campestris*) rapeseed/canola have been underway for quite some time in both Canada and Sweden. Seeds of yellow-seeded varieties of *B. rapa* have been shown to be significantly higher in oil and protein contents. Thinner hulls were reported to be directly responsible for the lower fibre content in yellow-seeded *B. rapa* (Stringam et al., 1974). In addition, the yellow hulls have been found to be low in polyphenols and lignin (Theander et al., 1977) and crude fibre (Daun and DeClercq, 1988) and have been shown to contain less neutral detergent fibre than brown hulls (Bell and Shires, 1982).

A relatively new initiative in plant breeding has been the development of canola quality (i.e., low glucosinolate, zero erucic acid) forms of *B. juncea*, a species known for its pure yellow seed coat. Under western Canadian conditions, *B. juncea* suffers less from heat and drought stress and matures earlier than *B. napus*. Such characteristics are the basis for high yields of oil and low chlorophyll content in the seed. High oleic and low linolenic acid contents are among other improvements to the quality of *B. juncea* (Rakow and Raney, 1993; Raney et al., 1995).

Since the first observation by Olsson on the existence of the yellow-seeded characteristic in progenies of resynthesized *B. napus*, only recently have plant breeders been able to development of yellow seeded *B. napus* from interspecific crosses between yellow-seeded *B. juncea* and *B. carinata* and black seeded *B. napus* has been reported (Rashid and Rakow, 1995; Raney and Rakow, 1995). A successful transfer of yellow-seed trait from *B. carinata* to *B. napus* has also been reported by Poulsen et al. (1991) and Qi Cun-Kou et al. (1995).

The development of a low glucosinolate line of yellow mustard (*Sinapis alba*) in Poland (Krzymanski et al., 1991) and a low erucic acid line of *S. alba* in Canada have been among other advances towards the production of canola quality crop. *Sinapis alba* mustard has superior heat and drought tolerance in comparison to *B. napus* and *B. rapa* canola and is therefore well adopted to dryland agriculture on the Canadian prairies. *S. alba* is also highly shatter resistant and has a large bright yellow seed. Further advantages include tolerance to blackleg and flea beetle attack (Rakow, 1995).

DIETARY FIBRE ISSUE

Selection for low fibre rapeseed/canola is hindered by confusion in the definition and thus the analysis of dietary fibre. While a physiological definition of fibre, as the dietary components resistant to mammalian digestive enzymes, is now widely accepted, only the sum of dietary non-starch polysaccharides and lignin is considered to represent the dietary fibre. However, other substances non-digestible by endogenous enzymes, which could be considered in a broader definition of the term fibre, include wall-inserted protein, arabinogalactan protein, polyphenols other than lignin, minerals associated with the cell walls, galactooligosaccharides, fructosans, resistant starch or Maillard reaction products. The uncertainty as to the relationship between the chemical structure of various fibre components and their physiological effect further limit progress in developing the quality improved plant products. The association of protein with fibre components, the effect of such linkages on the amino acid balance and how individual groups of carbohydrate-protein conjugates and cell wall polysaccharides affect the ingestion, uptake of nutrients and microbial activity is not yet understood.

Although different methodologies have been used in research on rape seed/canola fibre, earlier data on *B. rapa* species (Stringam et al., 1974; Theander et al., 1977; Bell and Shires, 1982; Slominski and Campbell, 1990; Eriksson et al., 1994; Slominski et al., 1994) indicate that there are at least three factors affecting the level and nature of dietary fibre:

a) the colour of the seed (the higher proportion of yellow seeds in the sample, the lower content of lignin and polyphenols),
b) the seed size (the smaller the seed, the more fibre in the resulting meal), and
c) the embryo cell size (the smaller the cells, the more cell-wall polysaccharides and thus dietary fibre in the meal).

Since any of the factors may significantly affect the nutritive value of the meal, all three should be given consideration in developing new varieties of rapeseed/canola.

The research reported in this paper will address some of the relationships between dietary fibre and seed coat colour, protein content, seed size, cotyledon cell size and how the relationship between the dietary fibre and protein can be affected by environmental conditions. The nutritive value of the meals from new lines of yellow-seeded *B. napus, B. rapa* and *B. juncea* will also be reported. Finally, the potential for development of a canola quality *Sinapis alba* for use as a high protein and energy supplement in monogastric animal nutrition will be addressed.

QUALITY CHARACTERISTICS OF YELLOW-SEEDED *BRASSICA* SEED MEALS

Earlier research which involved a number of *B. rapa* samples showed limited advantage of the yellow-seeded characteristic with regard to dietary fibre content and nutritive value of the meal (Slominski and Campbell, 1991; Slominski et al., 1994). Total dietary fibre was found to be only slightly lower than that estimated for brown-seeded canola. Although, in comparison to brown-seeded type, the yellow-seeded *B. rapa* canola was shown to contain much less lignin and polyphenols, the cell wall polysaccharide content was found to be much higher in this type of canola. As was recently investigated in this laboratory, the high content of cell wall polysaccharides was found to result from significantly smaller size of the cells in the cotyledon fraction of *B. rapa* canola. One positive characteristic of fully yellow-seeded *B. rapa* canola was its sucrose content which, in comparison to the brown-seeded canola, was higher by 4 percentage points. However, the first commercially available meal from fully yellow-seeded *B. rapa* (cv. Parkland) was high in fibre and only contained similar available energy and amino acid contents to conventional canola meal (Slominski et al., 1994).

TABLE 1
Protein, carbohydrate and dietary fibre content of meals derived from brown- and yellow-seeded *Brassica* species, %

Species/seed colour	Number of samples	Protein[1]	Sucrose	Oligo-saccharides	Dietary fibre
Brassica napus					
brown	3	42.6[b]	8.3[a]	3.0[a]	34.1[a]
yellow	3	46.3[a]	9.7[a]	3.3[a]	27.5[b]
Brassica rapa					
brown	2	40.5[a]	7.1[b]	2.5[a]	35.0[a]
yellow	6	41.1[a]	9.9[a]	2.6[a]	28.5[b]
Brassica juncea					
brown	1	41,4	7.0	2.0	35.1
yellow	16	44.9	8.3	2.0	27.8
Brassica carinata					
brown	1	48.8	6.1	1.7	27.6
yellow	1	52.6	6.8	1.6	21.9

[1] N x 6.25
[a, b] values within *B. napus* or *B. rapa* species with no common superscripts differ significantly a, b – $P<0.05$

Because of these developments, further evaluation of the nutritive profiles of the meals derived from a large number of yellow- and brown-seeded *Brassica* genotypes has been undertaken. The seed samples represented brown- and yellow-seeded cultivars/strains of *B. napus* (3 brown and 3 yellow), *B. juncea* (1 brown, 16 yellow), *B. rapa* (2 brown, 6 yellow) and *B. carinata* (1 brown, 1 yellow). All plant materials were grown in field plots at the Agriculture and Agri-Food Canada Research Farm at Saskatoon, Canada.

The results of this research (Simbaya et al., 1994) demonstrated favourable characteristics for yellow-seeded canola in comparison to brown-seeded counterparts (Table 1). On average, yellow-seeded canola was shown to contain more protein (44.5% vs 42.7) and sucrose (8.7% vs 7.5%) but similar amounts of oligosacharides (2.3% vs 2.5%) and minerals (6.9% vs 7.0%). Total dietary fibre averaged 28% for yellow-seeded samples and 33% for brown-seeded canola. Lower fibre content in yellow- as compared to brown-seeded samples was reflected in lower content of lignin and polyphenols (4.3% vs 8.2%), wall-inserted protein (2.3% vs 3.3%) and minerals (0.7% vs 2.4%) associated with the cell walls. Dietary fibre was negatively correlated with the protein content (Figure 1). The highest correlation coefficients were found for *B. napus* (Figure 2) and *B. juncea* (Figure 3). Similar to earlier research from this laboratory, the data for *B. rapa* canola were inconclusive in that some lines showed the increased protein content with decreased fibre content and some did not.

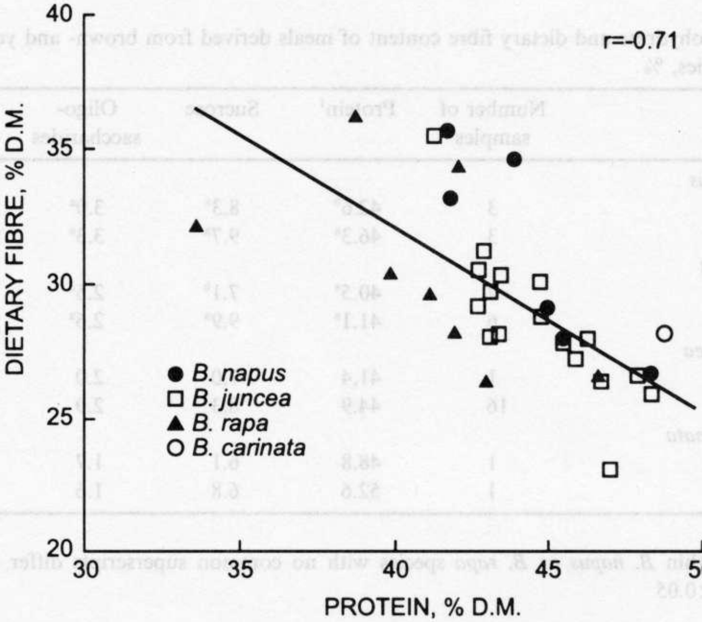

Figure 1. Relationship between the protein and dietary fibre contents of meals derived from selected strains/cultivars of *B. napus, B. rapa, B. juncea* and *B. carinata*

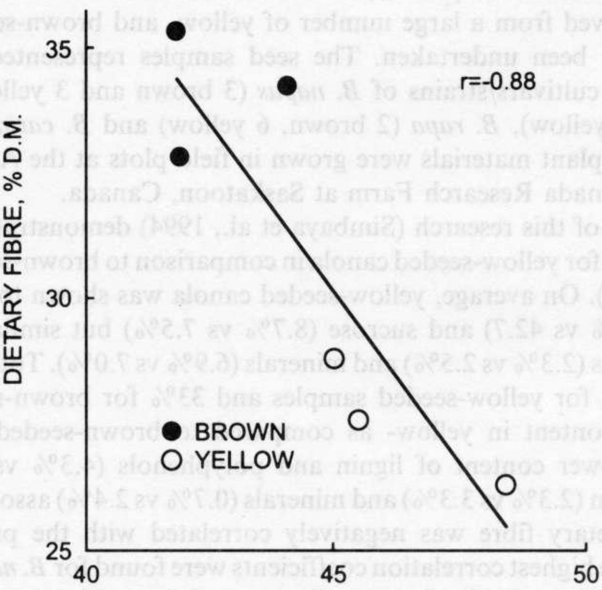

Figure 2. Relationship between the protein and dietary fibre contents of meals derived from brown- and yellow-seeded *B. napus*

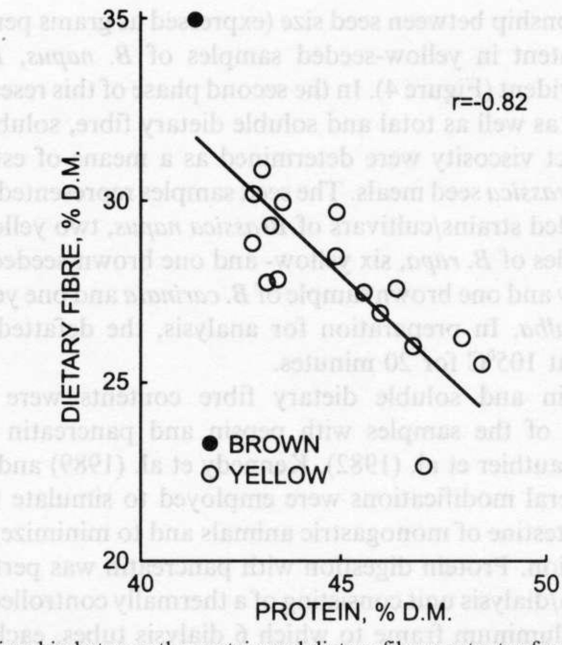

Figure 3. Relationship between the protein and dietary fibre contents of meals derived from yellow- and brown-seeded *B. juncea*

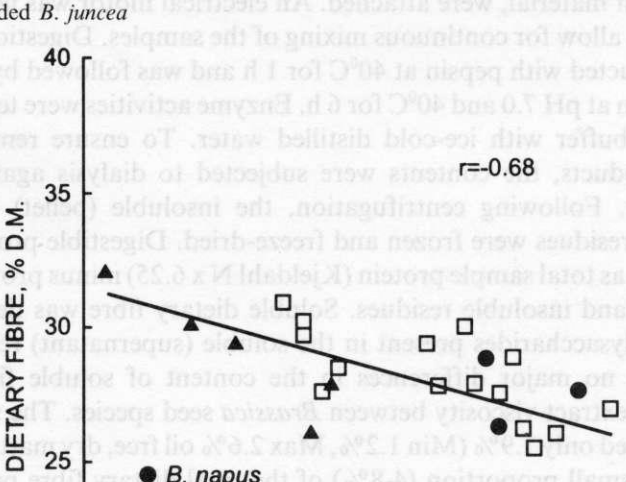

Figure 4. Relationship between the dietary fibre content and seed weight of yellow-seeded strains/cultivars of *B. napus*, *B. rapa* and *B. juncea*

An inverse relationship between seed size (expressed as grams per 1000 seeds) and total fibre content in yellow-seeded samples of *B. napus*, *B. rapa* and *B. juncea* was also evident (Figure 4). In the second phase of this research, *in vitro* protein digestibility as well as total and soluble dietary fibre, soluble phenolics (tannins) and extract viscosity were determined as a means of estimating the nutritive worth of *Brassica* seed meals. The seed samples represented two yellow- and two brown-seeded strains/cultivars of *Brassica napus*, two yellow- and two brown-seeded samples of *B. rapa*, six yellow- and one brown-seeded samples of *B. juncea*, one yellow and one brown sample of *B. carinata* and one yellow-seeded sample of *Sinapis alba*. In preparation for analysis, the defatted seeds were moist-heat treated at 105^{0}C for 20 minutes.

Digestible protein and soluble dietary fibre contents were determined following digestion of the samples with pepsin and pancreatin enzymes as recommended by Gauthier et al. (1982), Kennedy et al. (1989) and Boisen and Eggum (1991). Several modifications were employed to simulate the environment of the small intestine of monogastric animals and to minimize the effect of end product inhibition. Protein digestion with pancreatin was performed with the aid of a digestion/dialysis unit consisting of a thermally controlled water bath and a rectangular aluminum frame to which 6 dialysis tubes, each containing a sample of test material, were attached. An electrical motor was used to rotate a frame and to allow for continuous mixing of the samples. Digestion of protein was first conducted with pepsin at 40^{0}C for 1 h and was followed by incubation with pancreatin at pH 7.0 and 40^{0}C for 6 h. Enzyme activities were terminated by replacing the buffer with ice-cold distilled water. To ensure removal of the hydrolysis products, the contents were subjected to dialysis against ice-cold distilled water. Following centrifugation, the insoluble (pellet) and soluble (supernatant) residues were frozen and freeze-dried. Digestible protein content was calculated as total sample protein (Kjeldahl N x 6.25) minus protein retained in the soluble and insoluble residues. Soluble dietary fibre was defined as the non-starch polysaccharides present in the soluble (supernatant) residue.

There were no major differences in the content of soluble fibre, soluble phenolics and extract viscosity between *Brassica* seed species. The soluble fibre content averaged only 1.9% (Min 1.2%, Max 2.6% oil free, dry matter basis) and represented a small proportion (4-8%) of the total dietary fibre present in the samples. It should be noted that the soluble fibre content determined in this study was similar to that of wheat (2%) and was much lower than that of barley or rye (5%), both known to contain large amounts of water-soluble and viscous polysaccharides (Thomke et al., 1987; Rakowska et al., 1989). The viscosity values were highest for *S. alba* (1.66 cps) and lowest for *B. napus* (1.06 cps) and *B. rapa* (1.15 cps), with no statistical differences between *B. juncea* (1.35 cps) and *B. carinata* (1.36 cps). With the exception of one sample of *Sinapis alba*, there were no major differences within the *Brassica* species with regard to soluble phenolics content (i.e., *S. alba* – 1.8%, *B. napus* – 2.3%, *B. rapa* – 2.2%, *B. juncea* – 2.4%, *B. carinata* – 2.5%). The values were slightly higher than those reported for free phenolics present in canola/rapeseed (1.5 to 1.8%; Kozlowska et al., 1990). However, the current values were similar to those reported by Fenwick and Hoggan (1976).

Soluble phenolics were poorly correlated with digestible protein content (r = –0.08). No relationship was evident between total dietary fibre and *in vitro* protein digestibility (r = 0.11). Soluble fibre was not correlated with digestible protein (r = 0.04) or extract viscosity (r = –0.06). Therefore, it may be inferred that any potential adverse effect of dietary fibre is solely due to nutrient dilution rather than to any anti-nutritive properties associated with the fibre components.

EFFECT OF ENVIRONMENT ON CANOLA MEAL QUALITY

When breeding for new improved varieties of yellow-seeded canola/rapeseed, a serious consideration should be given to environmental and growing conditions as they may significantly affect the chemical composition of the seed. Such factors as water stress, nitrogen or sulphur fertilization, temperature, soil acidity, etc. may not only influence the oil or protein contents but also affect the fibre content. As indicated for a well established canola variety A (Table 2), some

TABLE 2
Protein and dietary fibre content of meals derived from two varieties of canola grown under different environmental conditions, %

	Variety A location			Variety B location		
Component	A	B	C	D	E	F
Protein	46.4	43.8	41.8	40.4	41.9	40.9
Dietary fibre	29.9	30.5	32.1	33.2	32.1	34.5

negative relationship between the protein and dietary fibre contents can exist regardless of the genetic makeup. This was also true for variety B in which the lower protein content, regardless of location, was reflected in high dietary fibre content. Therefore, it is recommended that the effect of environment be minimized by growing the breeding materials under similar soil and climatic conditions.

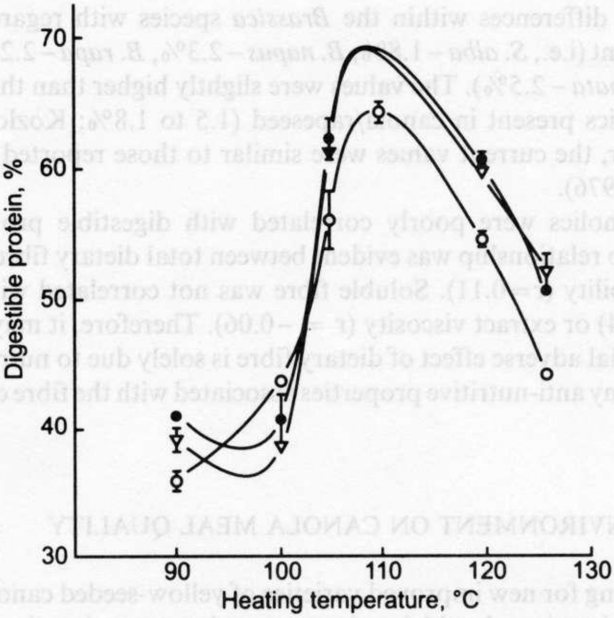

Figure 5. Effect of varying temperatures on digestible protein content in defatted seed samples from three *Brassica* cultivars subjected to moist heat treatment for 20 min

EFFECT OF MOIST HEAT TREATMENT ON MEAL QUALITY

An *in vitro* digestible protein measurement was also used to establish the optimal conditions necessary for processing of large quantities of the seed for animal feeding trials. The effect of moist heat treatment was evaluated by heating each of three different samples of defatted canola seed at 90, 100, 105, 110, 120 and 126^{0}C for 20 minutes.

There was a profound effect of moist heat treatment on meal quality as measured by digestible protein content. As shown in Figure 5, heat treatment below 105^{0}C was not effective in promoting protein digestibility. However, *in vitro* protein digestibility increased substantially with increased temperature up to 107-108^{0}C. Application of higher temperatures ($>110^0$C) resulted in a significant decline in protein digestibility and was also reflected in high protein content in the neutral detergent fibre residue (data not shown). The increase in digestible protein content in moderately heat treated samples is in agreement with earlier reports which demonstrated that some form of heat treatment is required to alter the three-dimensional structure of plant proteins in order to make the protein more susceptible to proteolysis (Nordheim and Coon, 1984). Such a concept was further supported by an *in vitro* digestible protein figure found in the current study for the commercial sample of canola meal (72%). This figure agreed very well with recently reported values when determined *in vivo* at the ileal level of the pig (70 and 72%) for Canadian commercial canola meal (Grala et al., 1993) and the low glucosinolate rapeseed meal from Finland (Nystrom et al., 1995), respectively. This is in agreement with some earlier *in vivo* studies showing unheated or heated under mild conditions meals having a lower nutritive value and lower digestible protein and/or amino acids contents as compared to that of the commercial meal (Slominski et al., 1985, Jensen et al., 1995, Nystrom et al., 1995). The results of the current study indicate the importance of moist heat treatment, with temperatures of 108 ± 1^0C applied for a short period of time (i.e., 20 min) being beneficial to the meal quality. Such conditions were further employed in processing of canola seed for use in the animal feeding trials.

NUTRITIVE VALUE OF RAPESEED/CANOLA OF DIFFERENT SEED COAT COLOUR

Selected *Brassica* seed meals were chosen (see Table 3 for number of samples) for *in vivo* evaluation of metabolizable energy (AME_N) and available amino acid (AAA) contents. In general, the AME_N values for the new meals were higher than those for the conventional meals with yellow-seeded *B. napus* showing the highest metabolizable energy content. The available amino acid content was high in all samples regardless of the species.

TABLE 3

True metabolizable energy (TME_N) and total available amino acids (AAA) of *Brassica* seed meals

Type of meal	TME_N kcal/kg DM	AAA % of total
B. napus – Commercial (brown)	2031^d	83.2^{cd}
B. napus – Excel (brown)	2195^b	85.9^a
B. napus – Y1016 (yellow)	2320^a	84.8^{ab}
B. rapa – Commercial (yellow)	2110^c	84.6^{abc}
B. rapa – Parkland (yellow)	2214^b	$82.2d^d$
B. juncea – J4316 (yellow)	2154^{bc}	84.0^{bc}

[abcd] means with no common superscripts differ significantly at $P < 0.05$

The same *Brassica* seed meals were also fed to broiler chickens. The contribution of canola meals to the total dietary protein content of 22% was from 30 to 34% and the inclusion rate of wheat in all diets was kept constant at 54%. No lysine was added to the diets and the energy content was adjusted so as to reflect the differences in AME_N values. The commercial brown-seeded canola

TABLE 4

Performance of broiler chickens (4-18 days) fed *Brassica* seed meals

Type of meal	Weight gain, g	Feed efficiency
B. napus – Excel (brown)	290^{a}	1.61a
B. napus – Y1016 (yellow)	293^{a}	1.52^{bc}
B. rapa – Commercial (yellow)	310^{a}	1.59^{ab}
B. rapa – Parkland (yellow)	310^{a}	1.56^{c}
B. juncea – J4316 (yellow)	256^{b}	1.63^{a}

^{abc} means with no common superscripts differ significantly at $P<0.05$

was excluded from this trial since the protein content was too low to formulate a comparable ration to other meals.

There were no differences in weight gain of broiler chickens fed *B. napus* and *B. rapa* canola (Table 4). There was, however, a significant reduction in body weight gain of chickens fed *B. juncea* meal. Such a pattern was not necessarily followed by the feed to gain ratio, with the yellow-seeded *B. napus* canola showing the highest feed efficiency value. This value was followed by *B. rapa* meals, with the *B. juncea* sample showing similar feed to gain ration to that of brown-seeded *B. napus* or the commercial *B. rapa* canola.

Since, in this study, the *B. juncea* meal was found to be high in protein and lysine and showed fairly good available energy and amino acid contents, the only factor related to the poor performance of broiler chickens appeared to be a relatively high content of aliphatic glucosinolates (19.3 μM/g).

QUALITY CHARACTERISTICS OF CANOLA TYPE *SINAPIS ALBA*

The *Sinapis alba* (yellow mustard) species has been suggested by the author as a high protein and high energy alternative to full fat soyabean. Since the seed of both species contain similar amounts of protein and oil, only the *S. alba* crop appeared suitable for growth under dryland conditions of Western Canada. The initiative has been recognized by plant breeders of Agriculture and Agri-Food Canada (AAFC) Research Station in Saskatoon and was further substantiated by low oil content making *S. alba* seed economically less feasible for commercial crushing and oil production.

Detailed chemical characterization of the first sample of *S. alba* seed (bulk of single plots from AAFC nursery) has been completed at the University of Manitoba (Kienzle and Slominski, 1996; unpublished). In comparison to the full fat soaybean, *S. alba* seed contained more oil (25.6 vs 20.3 %) but less protein (38.7 vs 42.4%) with the content of the two major nutrients in favour of the *S. alba* sample (64.3 vs 62.7%). Similarly to conventional canola, *S. alba* contained more methionine and cystine (3.60 vs 3.33 g/16g N) and less lysine (5.78 vs 6.49 g/16g N) than soyabean. The sucrose content was lower in *S. alba* than in soyabean (3.3 vs 5.1%) although this was offset by the presence of starch (1.2%) which was not detected in soyabean. Considering the remarkable difference in seed size, *S. alba* having a 20-fold smaller seed than soyabean, only a small difference in the total dietary fibre content was observed (22.4 vs 18.7% for *S. alba* and soyabean, respectively). Soluble dietary fiber content (i.e., mucilage), as determined under simulated conditions of the gastrointestinal tract, was found to be 1.4%. A lower content of oligosaccharide (3.4 vs 5.0%) and higher content of calcium (0.69 vs 0.40%) and available (non-phytate) phosphorus (0.27 vs 0.15%) were among other positive characteristics associated with the *S. alba* crop. Although still relatively high and potentially a limiting factor, the glucosinolate content of the new *S. alba* cultivar was shown to be 35.3 μmol/g which is substantially lower than that present in current condiment varieties.

CONCLUSIONS

The consistently negative relationship between dietary fibre and protein contents exemplify the potential for improved nutritive content of yellow-seeded forms of *B. napus, B. rapa, B. juncea* canola. To achieve maximum results, any reduction in fibre content should be accompanied by quantitative changes in the protein content. Due to relatively similar values obtained for the complex quality characteristics (i.e., soluble and insoluble fibre, digestible protein, available amino acids, phenolics, etc.), it appears valid to use simple protein, oil and seed size analyses as quality criterions for screening a large number of samples at the early stages of selection programs. Further evaluation of the best lines/strains of rapeseed/canola, however, would require more detailed chemical analyses and *in vivo* experimentation. Effective introduction of *B. juncea* and *S. alba* as new crops for the Canadian Prairies would necessitate further quality improvement by lowering the content of undesirable glucosinolates in the seed.

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STRESZCZENIE

Postęp w hodowli rzepaku/canoli o niskiej zawartości włókna

Podjęto badania nad określeniem wartości pokarmowej 27 prób żółto-nasiennych genotypów *Brassica napus, B. rapa, B. juncea, B. carinata* i *Sinapis alba* oraz 7 prób brązowo-nasiennej canoli. Odmiany brązowo-nasienne zawierały więcej niż żółto-nasienne sacharozy (8,7 vs 7,5%) i białka (44,5 vs 42,7%), ale zawartość oligosacharydów (2,3 vs 2,5%), popiołu (6,9 vs 7,0%) i polisacharydów nieskrobiowych (20,4 vs 19,7%) była podobna w obydwóch typach nasion. Zawartość ogólnego włókna pokarmowego w odmianach żółto-nasiennych wynosiła 28%, a brązowo-nasiennych 33% i była ujemnie skorelowana ($r = -0{,}71$) z zawartością białka. Stwierdzono również ujemną zależność między zawartością białka i włókna pokarmowego w próbach powszechnie stosowanej canoli uprawianej w różnych warunkach środowiskowych. Oznaczoną *in vitro* strawność białka przyjęto do określenia optymalnych warunków obróbki technologicznej nasion canoli. Zawartość strawnego białka w trzech próbach nasion ogrzewanych na mokro wzrastała znacząco wraz ze zwiększającą się temperaturą aż do 108 ± 1^0C. Ogrzewanie poniżej 105^0C nie powodowało zwiększenia strawności. Zastosowanie wyższej tempperatury ($>110^0$C) powodawało istotne obniżenie strawności białka. Przyjęto optymalną temperaturę do obróbki wybranych prób nasion do dalszych oznaczeń: z odmian żółto-nasiennych *B. napus, B. juncea* i *B. rapa* oraz brązowo-nasiennej *B. napus*. Dostępność energii i aminokwasów oraz ogólną wartość pokarmową oznaczono w 2-tygodniowym doświadczeniu wzrostowym na 4-dniowych kurczętach brojlerach. Dwie handlowe śruty z odmiany żółto-nasiennej *B. rapa* i brązowo-nasiennej canoli *B. napus* stosowano jako pasze kontrolne. Dostępność aminokwasów wynosiła średnio 84,1% z niewielkim zróżnicowaniem w obrębie prób. Zawartość rzeczywistej energii metabolicznej (TME_N) była największa w odmianie żółto-nasiennej *B. napus*. Nie stwierdzono różnic w przyrostach masy ciała kurcząt brojlerów żywionych śrutami handlowymi lub przygotowanymi laboratoryjnie z *B. rapa* oraz żółto- i brązowo-nasiennej *B. napus*. Kurczęta żywione śrutą z *B. juncea* pobierały istotnie mniej paszy i miały mniejsze

przyrosty, co prawdopodobnie było spowodowane względnie wysoką zawartością (21,7 μmol/g SM) alifatycznych glukozynolanów w tych paszach. Wykorzystanie paszy przez kurczęta żywione śrutą z żółto-nasiennej odmiany canoli *B. napus* było najlepsze (średnio 1,51) i różniło się istotnie od wartości 1,59 i 1,61 otrzymanych odpowiednio przy skarmianiu handlowej żółto-nasiennej *B. rapa* i przygotowanej laboratoryjnie brązowo-nasiennej canoli *B. napus*.

Można spodziewać się, że przyszłe odmiany żółto-nasiennej canoli będą miały wyższą wartość pokarmową. Efektywne wprowadzenie *Brassica juncea* i *Sinapis alba* jako nowych upraw na preriach kanadyjskich wymaga dalszej poprawy ich jakości przez obniżenie w nich zawartości glukozynolanów.