The potential of mustard (*Brassica juncea* (L.) Coss) as an edible oil crop on the Canadian Prairies

Woods, D. L., Capcara, J. J. and Downey, R. K. 1991. **The potential of mustard (*Brassica juncea* (L.) Coss) as an edible oil crop on the Canadian Prairies.** Can. J. Plant Sci. **71**: 195–198. The performance of mustard (*Brassica juncea* (L.) Coss) was compared with that of canola (*B. napus* L. and *B. rapa* L.) on the western prairies. Mustard had a higher yield and protein content and was intermediate in maturity. Improvement in oil content will probably be required.

Key words: Mustard, *Brassica juncea*, edible oil crop

Woods, D. L., Capcara, J. J. and Downey, R. K. 1991. **Possibilités d'utilisation de la moutarde (*Brassica juncea* (L.) Coss) comme culture oleagineuse dans les prairies Canadiennes.** Can. J. Plant Sci. **71**: 195–198. Le productivité de la Moutarde (*Brassica juncea* (L.) Coss) a été comparé à celle du Colza (*B. napus* L.) et de la Navette (*B rapa* L.) sur les Prairies de l'ouest. Le rendement et la teneur en protéines étaient plus élevés chez la Moutarde que chez le Colza et la Navette; la maturité de la Moutarde était intermédiaire entre celle du Colza et de la Navette. Il sera problablement nécessaire d'améliorer la teneur en huile de la Moutarde.

Mots clés: Moutarde, *Brassica juncea*, culture oléagineuse

Some 50 000 ha of mustard (*Brassica juncea*) are grown annually in Western Canada to supply the world condiment market. Although agronomically well-adapted, the presence of the high level of glucosinolates (approx. 200 μmoles g^{-1} of oil-free meal) and the occurrence of a significant amount (approximately 25%) of erucic acid makes the seed unsuited for edible oil processing in western countries. In North America it is essential that *Brassica* oilseeds destined for the edible oil market be of canola quality, i.e., that the oil contain no more than 2% of the total fatty acids as erucic acid and that the oil-free meal contain no more than 30 μmoles g^{-1} of aliphatic glucosinolates (Regulations of the Seeds Act 1989).

In order to overcome the nutritional objections to the use of *B. juncea* as an edible oil crop, germplasm evaluations have been conducted at a number of laboratories. Kirk and Oram (1981) reported the identification of two *B. juncea* strains, believed to have originated in China, that were free of erucic acid. The report of a low glucosinolate *B. juncea* strain by Cohen et al. (1983) proved to be unfounded. However, Love (1988) has derived a new low (< 15 μmoles g^{-1}) glucosinolate source of *B. juncea* from interspecific crosses. In anticipation that canola quality traits would be available for the conversion of *B. juncea* from a condiment crop to a Western Canadian edible oil source, the performance of two high erucic, high glucosinolate *B. juncea* cultivars were compared with the most widely grown canola cultivars of *B. napus* and *B. rapa* (synonym *B. campestris* L.) to determine the relative performance of the three species and the production potential for canola quality *B. juncea*.

In 1985 and 1986 comparative trials of *B. juncea*, *B. napus* and *B. rapa* were sown at several locations in Western North America (Saskatchewan, Alberta and North Dakota). Cultivars and strains of each species were sown in separate but adjacent tests on the same day with the same seeder. Each test consisted of plots 5 m long with four or six rows spaced 30 cm apart and replicated three or four times. Although the primary purpose of these trials was to evaluate the performance of entries within a species, comparison between species is possible when the data for selected

entries at each site is considered as a single replicate, as apart from blocking by species the entries were treated similarly. As the total number of entries in the tests were 12 and 11 in 1985 and 1986, respectively, the extreme separation of plots of interest did not exceed 20 m. Only locations where all three species were successfully harvested were included in the analysis.

Westar and Tobin cultivars of the *B. napus* and *B. rapa* species, respectively, were compared with two yellow-seeded *B. juncea* cultivars, Cutlass and Donskaja (Table 1). Westar and Tobin were chosen because between them they occupied 90% of the acreage of canola sown in Western Canada. Cutlass was chosen as a condiment cultivar well adapted and widely grown in Western Canada. The Russian cultivar, Donskaja, although late in maturity was also included for comparison primarily because of its high oil content. The yellow-seeded form of mustard was chosen in preference to the brown form because of its high oil content, and because the meal would be low in fibre and a highly desirable light colour.

For each trial, oil content was determined on two samples of each cultivar using a Newport MkIII NMR analyzer. Protein content was determined by micro-Kjeldahl digestion followed by colorimetry using the indophenol reaction on either two or four samples of each cultivar.

Ten sets of comparative data for yield were available in 1985 and 14 in 1986, although fewer data were available for the other attributes examined. The data were analyzed as a randomized complete block design, using individual location-years as blocks. It should be noted that the choice of data may be biased against *B. juncea* entries since at more than one location the *B. juncea* portion of the test survived whereas one or the other of the canola species, usually *B. napus*, were not harvested due to drought or seed shattering. In all, eight sites were discarded because of losses to the canola entries only, three sites due to losses of the mustard entries, and two sites due to losses of both canola and mustard entries. No tests were lost due to frost in 1985 or 1986.

The two mustard cultivars significantly outyielded the best canola cultivar, Westar, by an average of 14.3% (Table 2).

Protein content of the mustards was higher than that of the canola species, although only Cutlass protein was significantly higher (Table 2). Higher protein levels in mustard than in rapeseed has been reported previously by the Canadian Grain Commission (1976, 1978, 1980), where the mustard crop protein exceeded the rapeseed levels by 66, 61, and 34 g kg^{-1} for the years 1976, 1978, and 1980.

The cultivar Donskaja was not significantly different in oil content from the best canola cultivar, Westar. Cutlass, which has been bred for the low oil content desired in condiment mustard, produced seed with less oil than either canola cultivars. Although the high oil content of Donskaja suggests that a canola quality *B. juncea* cultivar could be bred with

Table 1. Characteristics of the four *Brassica* cultivars studied

Characteristic	Cultivar name			
	Westar	Tobin	Cutlass	Donskaja
Species	*B. napus*	*B. rapa*	*B. juncea*	*B. juncea*
Origin	Canada	Canada	Canada	Soviet Union
Seed colour	Black	Yellow/brown	Yellow	Yellow
Glucosinolates[z]	10	20	200	c. 170
Erucic acid %[y]	< 1	< 1	25	c. 25

[z] Glucosinolates are expressed as μmoles aliphatic glucosinolates per gram of dry, oil-free meal, and are typical values from western Canadian co-operative trials, except that the Donskaja value is only based on various trials at Saskatoon.

[y] Erucic acid values are expressed as percent of total fatty acids in the oil, and are typical values from western Canadian co-operative trials, except that the Donskaja value is only based on various trials at Saskatoon.

Table 2. Comparative performance of canola and mustard

Cultivar	Yield (24)[z] (kg ha^{-1})	Oil (20) (g kg^{-1})	Protein (12) (g kg^{-1} meal)	Maturity (11) (d)
Westar	2104*b*	431*a*	397*b*	101*a*
Tobin	1959*b*	411*b*	391*b*	90*c*
Donskaja	2362*a*	434*a*	416*ab*	100*a*
Cutlass	2450*a*	385*c*	428*a*	94*b*

[z]Numbers in parentheses are station years of data for that character.
*a-c*Means in the same column followed by the same letter are not significantly different (Duncan's new multiple range test) at a probability level $P=0.05$.

an oil content equal to Westar, it should be noted that reducing the erucic acid level from the 25% contained in Donskaja oil to less than 2% could also lower the potential oil content by 11–22 g kg^{-1} (Woods and Rakow 1987). A reduction of this magnitude would result in an oil content equal to or slightly better than the cultivar Tobin (Table 2). An improvement in oil content would be needed quickly, as the newer cultivars of *B. rapa* are higher in oil content than Tobin by 10 g kg^{-1} or more.

Generally in the canola species an increase in oil content has been associated with a decrease in protein content (Downey 1966; Downey et al. 1975); however, simultaneous selection for improved levels of both oil and protein has been shown to be effective (Grami and Stefansson 1977). There is no reason to assume that these associations would not apply to *B. juncea*.

There is a wide range of maturity within *B. juncea* (Table 2). The combination of the yield and maturity of Cutlass with the oil content of Donskaja would have great potential in Western Canada and other parts of the world.

Mustard is also known to be more heat and drought tolerant than canola. These characteristics may extend the range of *Brassica* oilseed production into areas of Western Canada currently unable to cultivate canola. At present, condiment mustard is primarily produced in the drier areas of the Prairie Provinces, south of the main canola producing zone.

Canadian condiment mustards presently grown are more resistant to seed shattering than either canola species and have a high resistance to blackleg disease (*Leptosphaeria maculans* (Desm.) Ces. de Not.). Indeed *B. juncea* has been used as a source of blackleg resistance in *B. napus* breeding programs (Roy 1984). Although many *B. juncea* cultivars are susceptible to the disease white rust (*Albugo candida* (Pers. ex Lev.) Ktze.) race 2, resistance is available, e.g., the white rust-resistant cultivar Scimitar (Woods and Petrie 1989).

The range of fatty acid composition which may be available in zero erucic acid *B. juncea* is currently unknown. Our own observations indicate a higher proportion of linoleic acid in this species than in *B. napus*, with a concurrent reduction in oleic acid. Typical values for oleic, linoleic and linolenic acids which we obtain for Westar *B. napus* are 61, 21, and 9% of total fatty acids, whereas for *B. juncea* the values are 42-43, 38-32, and 11-17% of total fatty acid, respectively.

With both canola quality characteristics now available in *B. juncea*, development of this species as an oil crop is receiving major emphasis.

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