DEVELOPMENT OF ZERO ERUCIC, LOW LINOLENIC *BRASSICA JUNCEA* UTILIZING INTERSPECIFIC CROSSING

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ABSTRACT

A cross was made between zero erucic, low glucosinolate *Brassica juncea* and low linolenic *Brassica napus*. The F_1 plants were backcrossed to zero erucic, low glucosinolate *B. juncea* to develop high oleic, low linolenic *B. juncea* (canola *B. napus*-like oil). Selection for high oleic, low linolenic *B. juncea* has been carried out utilizing half-seed analysis for several generations. The success of this approach is discussed.

INTRODUCTION

Canadian condiment mustard cultivars of *Brassica juncea* are well adapted to dryland agriculture on the Canada prairies. They are higher yielding than canola cultivars, resistant to blackleg, early maturing, drought tolerant and resistant to seed shattering (Woods et al. 1991, Love et al. 1991). Zero erucic and low glucosinolate (canola quality) lines of *B. juncea* do exist (Kirk and Oram, 1981, Love et al., 1990, Love et al., 1991). Unfortunately, the fatty acid profile of these lines is more unsaturated (contain more linoleic and linolenic acid) than canola cutivars of *B. napus* and *B. rapa*. As increased unsaturation, particularily increased linolenic acid levels, is associated with decreased stability of oil (Eskin et al. 1989, Przybylski et al. 1993), the oil of these lines is considered to be of lower quality than normal canola and therefore is difficult to integrate into the mainstream canola crop. In an attempt to decrease linoleic and linolenic acid levels of canola quality *B. juncea* to *B. napus* levels or lower an interspecific cross was made between a zero erucic, low glucosinolate *B. juncea* line and a zero erucic, low linolenic, low glucosinolate line of *B. napus* obtained from R. Scarth of the University of Manitoba. This paper discusses the progress made so far with this cross.

EXPERIMENTAL

Materials and Methods

The fatty acid composition of whole seeds and half seeds was determined by the method of Thies (1971), except that gas chromatography of the methyl esters was performed with a Supelcowax 10 (0.5 µm by 0.32 mm by 15 m) fused silica capillary column at 210 ° using hydrogen as the carrier gas. The transesterification reagent was 0.8% sodium metal in methanol.

25 plants of the zero erucic, low glucosinolate line of *B. juncea* (J90-4253) screened for white rust resistance were crossed with the low linolenic *B. napus* selection (C92-0226). The F_1 interspecific seed from 20 plants was backcrossed to J90-4253. The BC_1F_1 seed was planted and selfed, then 72 of BC_1F_2 seeds were half seed analysed for fatty acid composition. 29 were selected on the basis of low linolenic acid content (<7%). These half seeds were planted and selfed. Seed was harvested from 25 plants. Six seeds from each of the 25 BC_1F_3 seedlots were half seed analysed. It appeared that there was segregation for either high oleic types or high linoleic types. So, 26 half seeds (13 high oleic and 13 high linoleic) from 17 different BC_1F_3 seedlots were selected for selfing and backcrossing to another zero erucic acid, low glucosinolate line (J92-223). Selfed seed was harvested and 5 seeds of individual plants with sufficient seed to spare (5 high oleic and 2 high linoleic) were analysed for fatty composition. The BC_2F_1 seed is being used to grow plants for selfing and to be taken through microspore culture with reselection of high oleic, low linolenic phenotypes again. Table 1 summarizes the fatty composition data for the parents used in the cross and their progeny.

Discussion

Linolenic acid (18:3) is much higher in the zero erucic *B. juncea* parental lines than the the low linolenic *B. napus* parental line. Table 1 also shows that oleic acid (18:1) is much reduced in the *B. juncea* lines. The half seeds analysed from the BC_1F_2 generation had a mean level of linolenic acid intermediate between that of the *B. napus* parent and the *B. juncea* parent. Linolenic acid has not been decreased much more in succeeding generations, but this intermediate level is well within the range of standard canola cultivars. Selection for higher oleic acid has been successful in that individual half seed and whole seeds were found containing greater than 60% oleic acid and average of the BC_1F_4 High 18:1 generations is 53.7% oleic at least 15% higher than the J90-4253 *B. juncea* parent. All backcross 1 generations have show increased saturated fatty acids levels. This is probably the result of the poor quality of seeds obtained from these plants. So far, all generations of backcross 1 material have demonstrated a much depressed fertility with poor seed set. The morphology of the plants was extremely varied. However, the fatty acid profiles could not be correlated with morphology. Further backcrossing to zero erucic *B. juncea* should eliminate this problem.

Table 1. Fatty acid composition (% of total ± SD) of parental lines and progeny

Generation (seed)	16:0	18:0	18:1	18:2	18:3	20:1	22:1
C92-0226	4.0	1.9	69.3	20.7	1.8	1.2	0.1
J90-4253	4.5	2.0	35.2	43.7	13.1	0.8	0.0
J92-223	3.8	2.2	42.5	36.5	12.7	1.1	0.0
BC_1F_2 mean	4.4±0.7	2.9±0.9	48.7±7.5	34.4±6.0	7.2±2.2	1.4±2.1	0.0±0.0
BC_1F_2 <7% 18:3	4.3±0.6	3.2±0.9	53.0±6.7	31.9±6.5	5.5±0.8	1.1±0.4	0.0±0.0
BC_1F_3 mean	5.4±1.4	3.2±1.4	43.8±8.7	37.7±8.3	6.9±2.0	1.1±0.2	0.0±0.0
BC_1F_3 High 18:1	5.1±1.0	4.3±1.4	61.0±4.3	21.6±4.9	4.7±1.2	1.2±0.2	0.0±0.0
BC_1F_3 High 18:2	6.1±1.7	2.4±0.7	30.4±2.7	50.2±2.4	8.4±1.3	1.0±0.2	0.0±0.0
BC_1F_4 High 18:1	5.4±1.0	4.3±1.8	53.7±9.7	26.9±8.2	6.2±2.3	1.0±0.2	0.1±0.3
BC_1F_4 High 18:2	5.3±1.0	3.9±1.2	47.2±6.1	35.7±6.2	5.5±1.2	0.9±0.1	0.0±0.0

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REFERENCES

Eskin, N.A.M., Vaisey-Genser, M., Durance-Todd, S. and Przybylski, R. (1989). Stability of low linolenic acid canola oil to frying temperatures. Journal of American Oil Chemists' Society, 66, 1081-1084.

Kirk, J.T.O. and Oram, R.N. (1981). Isolation of erucic acid free lines of *Brassica juncea*: Indian mustard now a potential oilseed crop in Australia. The Journal of the Australian Institute of Agricultural Science, 47, 51-52.

Love, H.K., Rakow, G., Raney, J.P. and Downey, R.K. (1990). Development of low glucosinolate mustard. Canadian Journal of Plant Science, 70, 419-424.

Love, H.K., Rakow, G., Raney, J.P. and Downey, R.K. (1991). Breeding improvements towards canola quality *Brassica juncea*. Proceedings of the Eight International Rapeseed Congress, Saskatoon, 1, 164-169.

Przybylski, R., Malcolmson, L.J., Eskin, N.A.M., Durance-Tod, S., Mickle, J. and Carr, R. (1993) Stability of low linolenic acid canola oil to accelerated storage at 60 °C. Lebensmittel-Wissenschaft und -Technologie. Food Science and Technology, 26, 205-209.

Thies, W. (1971). Schnelle und einfache Analysen der Fettsäurezusammensetzung in einzelnen Raps-Kotyledonen I. Gaschromatographische und papierchromatographische Methoden. Zeitschrift für Pflanzenzüchtung, 65, 181-202.

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. Canadian Journal of Plant Science, 71, 195-198.