VARIABILITY IN ERUCIC ACID, OIL AND PROTEIN CONTENT IN BROWN AND BLACK MUSTARD GERMPLASM COLLECTIONS

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INTRODUCTION

Brown mustard [Brassica juncea (L) Czern and Coss] is a major edible-oil crop of the Indian subcontinent. Mustard oil, with its pungency, is prized by the people of India, but the nutritional value of oils containing very-long-chain fatty acids has been questioned (Vles, 1974). Although rapeseed oil low in erucic acid, when fed to male rats, produced results similar to those of regular rapeseed oil (Kramer et al., 1973), the development of such strains has generally been considered desirable for the nutritional improvement of rapeseed oils.

In India, however, due to a chronic shortage of edible oils, the prime concern is to evolve high-yielding cultivars with increased oil content and with high-quality protein. Our long-term objective, however, is to eliminate genetically or reduce the levels of erucic acid and other long-chain fatty acids in seed oil of brown mustard cultivars to a minimum. Zero-erucic lines were identified in B. campestris as well as B. napus (Downey, 1971), but not yet in brown mustard. That is why the oil and protein content and fatty acid composition of brown and black mustard germplasm were investigated.

MATERIALS AND METHODS

Seed material: Thirty-seven collections of brown mustard and 38 of black mustard, obtained from various European sources, were provided by Dr. F. Heyn, and the rest were by courtesy of Dr. W. Thies. One hundred and fourteen brown mustard collections, most of which were high-yielding mutants selected after mutagen treatment of Punjab brown mustard cultivar RL 18, were sent by Prof. K.S. Gill through Dr. K.S. Labana. All other collections were available at the Department of Plant Breeding, Punjab Agricultural University, Ludhiana.

Analytical methods: The fatty acid composition of seed oils was determined with a Perkin-Elmer F 30 gas-liquid chromatograph equipped with an auto-sampler (AS 41) and Pep-1 data system. Analysis, identification, and quantification of the fatty acids was, as previously described, by Thies (1971). The oil content was determined by the cold percolation method, and the protein content was determined indirectly by the micro-Kjeldahl procedure (N x 6.25).

RESULTS AND DISCUSSION

High-seed yield, increased oil content (with a minimum of very-long-chain fatty acids and linolenic acid, but with increased proportions of saturated and essential fatty acids), higher protein content and improved quality of seed meal are the main breeding objectives for brown mustard. The great variability in seed weight, oil content and protein content

found in this study (Table 1) should be very useful in achieving these goals. This variability is comparable to that found in a similar analysis of United States Department of Agriculture brown mustard introduction (Goering et al., 1965). The lines in the present study which had a high seed oil content had reddish-brown to black testa, but imparting a yellow seed color to them may further improve their oil content and seed meal quality. Since seed protein and oil content, in our material, had highly significant negative association (-.327), their simultaneous improvement will require screening of large populations.

TABLE 1

SEED WEIGHT, OIL AND PROTEIN CONTENT IN BROWN MUSTARD COLLECTIONS

Seed trait	Collections (Nos.)	Mean	Range	Coefficient of variability
1000 seed wt(g)	450	3.8	1.6 - 6.8	17.6
Oil content (%)	450	37.7	33.0 - 45.2	8.0
Protein content (N x 6.25)	400	28.4	20.0 - 40.5	14.5

TABLE 2

SEED OIL FATTY COMPOSITION OF BROWN MUSTARD COLLECTIONS (63) FROM EUROPE (A), OF SINGLE SEEDS (74) OF LOW ERUCIC ACID COLLECTIONS (B), OF BROWN MUSTARD COLLECTIONS (114) FROM INDIA (C), AND OF BLACK MUSTARD COLLECTIONS (D)

Group	Variable	16:0*	18:1	18:2	18:3	20:1	22:1
A	$\bar{X}$	3.9	17.3	20.8	12.8	10.2	31.0
	R	2.8-5.5	8.2-25.3	13.8-25.5	6.5-17.4	5.4-13.7	18.4-45.4
	CV	13.6	27.6	16.4	15.0	21.8	29.7
B	$\bar{X}$	3.8	21.9	23.7	11.4	12.1	22.5
	R	2.8-5.2	14.0-29.0	19.7-28.8	8.2-15.4	8.9-14.6	17.7-28.4
	CV	14.5	13.9	7.2	19.6	9.3	11.1
C	$\bar{X}$	2.8	9.7	17.7	12.2	6.0	47.2
	R	1.0-4.0	7.3-13.0	13.3-28.2	6.5-24.9	4.0-8.5	33.0-56.5
	CV	17.7	15.7	17.6	31.4	13.3	12.7
D	$\bar{X}$	4.4	10.2	16.3	15.5	7.7	39.2
	R	3.3-5.3	6.9-23.2	12.1-22.9	7.2-19.4	5.5-11.8	21.4-48.9
	CV	10.1	39.5	15.3	16.2	23.0	15.3

*Fatty acids (%), carbon chain length and double bonds respectively 16:1, 18:0, 20:0, 20:2 and 22:0 were also present in small amounts
$\bar{X}$= Mean, R = Range, CV = Coefficient of variability

Analysis of 63 brown mustard collections of European origin revealed large variability in long-chain monounsaturated and polyunsaturated fatty acids (Table 2A). High and low values for linoleic and linolenic acids were similar to those reported for turnip rape and oilseed rape (Downey, 1971), but none of the lines were free of erucic and eicosenoic acids. To assess variability in fatty acid composition among seeds of these collections, single seeds of ten lines containing 20-25% erucic acid were analysed (Table 2B). None of the seeds analysed, however, contained less than 17% erucic acid, and most seeds were higher in eicosenoic acid as well as oleic, linoleic and linolenic acid than the seeds of high erucic acid lines.

Brown mustard collections from India were high in erucic acid but had low levels of eicosenoic acid (Table 2C). In comparison with European lines, variability was low for oleic acid, comparable for linoleic acid and high for linolenic acid. Frequency distribution showed that 75% of the collections had 50 $\pm$ 6% erucic acid, and the rest had 37 $\pm$ 4% erucic acid. This material seemed best suited for developing high-erucic cultivars for industrial uses, whereas the European lines containing 20% or less erucic acid may be used to develop cultivars for edible oils.

"Zero-erucic" lines have not been found in brown mustard, an amphiploid of B. nigra (black mustard) and B. campestris, such lines, however, are available in B. campestris (turnip rape). Now, if zero-erucic acid lines could be found in B. nigra, new amphiploids with zero erucic acid could be bred. Analysis of available black mustard collections, however, failed to reveal any zero-erucic acid genotype (Table 2D), but two lines containing 21-22% erucic acid were identified. All other lines had 41 $\pm$ 7% erucic acid. In turnip rape, erucic acid is controlled by a single gene with additive effects; assuming that this is true in black mustard (also a diploid species) as well, lines containing 21-22% erucic acid would be heterozygous for genes controlling erucic acid. Therefore, the selfing of these lines should give segregants containing "Zero-erucic acid". This approach is being vigorously pursued. Variability for other fatty acids in black mustard was similar to that found in brown mustard (Table 2D).

Comparisons of fatty acid composition in lines divergent for erucic acid in European and Indian material revealed the following: in Indian materials reduction in erucic acid has resulted in a corresponding increase in linoleic and linolenic acid, whereas in brown as well as black mustard lines of European origin, reduction in erucic acid has led to increased levels of oleic, linoleic and eicosenoic acids.

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