Breeding Oilseed Brassica for Modified Fatty Acid Composition in the Indian Context

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In India, Oilseed Brassicas, commonly known as rapeseed - mustard, occupy an important position in the oilseed economy of India. India is the largest rapeseed-mustard growing country in the world next to China and ranks third in production after Canada and China. It accounts for 25.6 per cent (6.4 m ha) and 14.7 per cent (4.94 fit) of world area and production (33.6 mt), respectively under rapeseed-mustard. It is primarily used for edible purposes, while the defatted meal rich in protein with well balanced amino acid, is utilized as animal feed. The presence of undesirable long chain fatty acids like eicosenoic acid (about 10%) and erucic acid (40-50%) in the seed oil and the presence of toxic glucosinolate (63 J.l moles to 102 J.l moles / g on seed basis) limit the utilization of Indian oilseed Brassicas in the international trade. This makes it imperative for the National Agricultural Research System (NARS) of India to embark upon the research programme develop canola type rapeseed-mustard by to reducing the level of erucic acid « 2 per cent) and toxic glucosinolate « 30 J.l moles / gm deffated seed meal) so that it may command premium in the international market.

Research

Early phase

The research work on improvement of quality characters particularly erucic acid and glucosinolate content started in seventies, was confined to the screening of indigenous and exotic cultivars, wild species and available germplasm (Kumar, 1978, Kumar and Tsunoda 1979, 1980, Tsunoda and Kumar, 1976, Kumar and Singh, 1979). During this period, genetical studies carried out in *Brassica campestris* cv. Pusa Kalyani indicated that a single recessive gene controlled the erucic acid synthesis (Kumar, 1978). Subsequently, erucic acid alleles in digenomic rapeseed *(Brassica napus)* were reported (Anand and Downey, 1981).

Evaluation of exotic material

The exotic germplasm / strains / cultivars of *B. campestris, B. napus* and *B. juncea* possessing single and double low characteristics including those strains developed under the bilateral collaborative Indo - Swedish Project in Sweden were evaluated in India for quality and yield at different locations in the country during 1986-93. The results of trials have indicated that the performance of exotic strains was in no way superior to the existing national cultivars. They were mostly of late maturing types, poor in growth with poor seed set and poor in adaptability. Few strains marginally out yielded the national standards at one or two locations.

Development of cultivars with improved oil quality

Systematic breeding programme work on the development of single low (low erucic acid / low glucosinolate content), double low (low erucic acid and low glucosinolate content) varieties of rapeseed - mustard was initiated in late eighties under the network of the All India Coordinated Research Project on Rapeseed - Mustard. Five centres, PAU, TERI, Ludhiana; Indian Agricultural Research Institute, New Delhi, Tata Energy Research Institute, New Delhi, GBPUA&T, Pantnagar and National Research Centre on Rapeseed - Mustard, Bharatpur are involved in this project. A large number of indigenous rapeseed-mustard germplasm lines were analysed for a fatty acid composition. The results indicated the absence of germplasm with significantly lower levels of these toxic compounds. In order to develop '00' varieties with higher seed yield and suitable to fit into the prevailing cropping pattern in various agro-climatic zones of the country, concerted efforts were made by all the five cooperating centers to develop rapeseed- mustard cultivars having improved nutritional value. In *Brassica rapa*, one of the exotic varieties, Tobin which performed well in Himachal Pradesh, was identified for Large Scale field testing in H.P. In *B. juncea,* the screening of germplasm has led to the identification lines with desired level fatty acid (Table 1) which can be profitably utilized in food and other industries. To develop *B. juncea* possessing desirable quality attributes high yielding locally adapted cultivars like Rajat (PCR 7), RLM 619, RL 1359, Varuna, RH 30, etc, were used as female parents and Zem 1, Zem 2, TERI (OE) M 08, TERI (OE) M 21, PBCM 1150-6, NRCQ 1, QM 14, BJ 1058, Shiva, EC287711, EC322090, EC322091, *(B.juncea);* cultivars Altex Tower, We star, EC339092, etc. *ofB.napus* and Candle, Tobin, Torch, Parkland cultivars of *B.rapa* were used as the donor parents. Hybridization followed by simple pedigree selection, recurrent selection and backcrossing aided by half seed analysis is now being used. Interspecific hybridization *(B.juncea x rapa* cv. Tobin) was resorted also for development low glucosinolate *B.juncea.* These breeding efforts have led to the development of a large number of segregants having improved oil (Table 2) and meal quality besides higher yield, But in majority of the cases, the improved fatty acid composition was accompanied by delayed maturity and susceptibility to powdery mildew. In order to diversify the sources of '0' erucic acid, a number of programmes of selfing followed by selection and also mutagensis were initiated. This has led to the identification of *B.juncea* lines having less than 2 per cent and more than 55 per cent erucic acid (Table 3). Though some lines with low erucic acid have been identified in *B.juncea* but these are not accompanied by low glucosinolates of desired level. Efforts made for combining both these characters have resulted in transfer of genes for low glucosinolate from *B.rapa* cv. Tobin to *Bjuncea* cv. RLM 61.9 and RLM 514. Now genetic blocks having '0' or low glucosinolate with less than 2 per cent erucic acid are available in Varuna. Efforts are also under way to convert *mori (Moricandia arvensis),* and *lyr (Enarthocarpus lyratus)* cms / restorer lines to '0' / '00' types. The breeding material is at BC2 to BC4 stages. Advanced progenies with low erucic acid and high oleic / low linoleic acid has been developed in *B.juncea* cultivar Varuna, Rajat, Pusa bold and Kranti. Promising yellow seeded *B.juncea* with '0' erucic acid having high oleic acid have been reported by Kumar and Chauhan (2000) They have found that the yellow seed coat colour is controlled by two recessive genes.

Multilocation testing

Large number of single zero *B.juncea* and single/ double zero B. napus developed, have further been improved upon for raising the yield level. Some of the high yielding lines of *Bjuncea* possessing zero erucic acid viz. TERI (M 9901); PRQ 9701; LEB 15; LES 39; CRL 1359-19; YSRL 9-18-2; PBLM 8-2 (TERI M - 9902); were evaluated during 1999-2000 crop season (Table 4 & 5). The performance of YSRL 9-18-2, LES 39, LEB 15 in North-Western Zone II and Central Zone III. was satisfactory and thus these entries WERE promoted for advance stage of testing during 2000-2001.

In *B. napus,* a good number of early maturing and dwarf strains possessing low erucic acid / or low glucosinolate were tested during 1999 – 2000 crop season under the Network of the All India Coordinated Project on Rapeseed-Mustard (Table 6). The promising strains at advance stage of testing (A VT I) are: TERI (OE) R 03; TERI (00) R 985; 4-09-A-41; GSC 865-2 (Hill Zone I); TERI (00) R 985 and GSC 3 A (00) (North-Western Zone II); TERI (OE) R 9903; TERI (OE) R 984; TERI (OE) R-983; TERI (00) R 986 TERI (00) R 985 and GSC 864-6: Furthermore, GSC 964-61 (Central Zone III) and TERI (OE) R 03 in A VT II (Central Zone III).

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Table 1. Fatty acid composition of 474 germplasm /breeding materials of *B. juncea*

Fatty Acid	**Range (%)**	**Mean + / - SEm**	**CV (%)**
Palmitic (C 16:0)	**0,7 - 11,6**	**3,12 +/- 0,06**	**41,9**
Stearic (C 18 : 0)	**0,1 - 3,6**	**0,96 + / - 0,02**	**45,3**
Oleic (C 18:1)	**6,3 - 83,2**	**18,03 + / - 0,49**	**59,1**
Linoleic (C18 : 2)	**9,2 - 58,0**	**20,78 + / - 0,43**	**45,0**
Linolenic (C18 :3)	**2,7 - 48,5**	**14,39 + / - 0,30**	**45,2**
Eicosenoic (C20:1)	**0,5 - 18,5**	**5,38+ / - 0,13**	**54,1**
Erucic (C22:1)	**0,0 - 61,4**	**42,02 + / - 0,91**	**47,1**

Table 2. Characteristics of promising black /brown seeded lines of the cross TERI (OE) M21 x Varuna with zero erucic acid having high oleic acid

Progeny	**Generation**	**Oleic acid (%)**	**Maturity (days)**	**Seed Weight (g)**	**Seed yield/plant**	**Oil content (%)**
166-26	F3 F4	45,2 47,6	131	2,5	19,6	33,4
166-50	F3 F4	45,0 48,7	133	4,5	11,3	35,9
205-25	F3 F4	45,9 46,5	135	3,4	13,7	35,2
205-64	F3 F4	48,9 53,9	132	3,1	14,2	35,9
Varuna TERI (OE) M21		9,3 43,5	148 127	5,7 2,9	- -	39,8 38,2

Table 3. Accessions of B. *juncea* having high erucic acid

Fatty Acid

Acc.no	16:0	18:0	18:1	18:2	20:1	22:1
RC-2	2,28	0,81	17,23	9,42	73,57	55,65
RC-11	2,14	1,03	8,05	15,65	15,36	56,92
RC-13	2,23	0,93	9,89	13,67	16,56	56,67
RC-29	2,19	0,87	11,32	12,84	18,38	55,72
RC-41	2,23	1,08	11,33	13,52	16,65	55,80
RC-76	2,12	1,09	10,90	13,02	16,27	55,38

4. Performance of quality *B. juncea* strains in initial multilocation varietal testing in irrigated North-Western Zone of India (1999-2000)

Strain	Maturity (days)	Seed weight (g)	Yield (kg/ha)	Oil content (%)	Status
TERI (M) 9902	147	3,2	1564	36,8	'0' EA
LEB 15	150	2,9	2388	38,0	'0' EA
LES 39	149	3,3	2506	38,0	'0' EA
PBCM 8-2	149	3,6	2134	35,9	'0' EA
TERI (M) 9901	149	3,2	1922	37,2	'0' EA
YSRL 9-18-2	150	3,0	2406	37,6	'0' EA
CRL 1359-19	149	3,6	2276	35,8	'0' EA
PRQ 9701	159	4,5	1548	38,2	'0' EA
Varuna (NC)	148	4,5	2284	39,2	High
Kranti (NC)	147	4,0	2551	39,5	High
RL 1359 (ZC)	147	4,4	2683	40,0	High

NC - National Centre ZC - Zonal Check

Table 5. Performance of quality *B. juncea* strains in initial multi-location varietal tesing in irrigated Central India (1999-2000)

Strain	Maturity (days)	Seed weight (g)	Yield (kg/ha)	Oil content (%)	Status
TERI (M) 9902	120	3,2	1242	39,5	'0' EA
LEB 15	133	3,4	1933	40,6	'0' EA
LES 39	131	3,8	2055	40,0	'0' EA
PBCM 8-2	121	4,0	1840	38,6	'0' EA
TERI (M) 9901	117	3,0	1638	38,1	'0' EA
YSRL 9-18-2	129	3,9	2044	39,3	'0' EA
CRL 1359-19	118	3,7	1778	38,5	'0' EA
Varuna (NC)	123	5,2	2034	39,7	High
Kranti (NC)	123	4,0	1829	41,3	High
Rohini 1359	125	4,9	2151	42,3	High

(ZC)					