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Oil and Erucic Acid Content in Oilseed Crucifers

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The fatty acid composition of the crucifer oil is genetically more variable than probably the composition of any other major vegetable oil (Matti, 1993). Palmitic, stearic, oleic, linoleic, linolenic, eicosenoic and erucic acid are the major fatty acids present in the oil extracted from members of family Cruciferae. Fatty acids are formed by step-wise biosynthetic pathway in which oleic acid either undergoes decreasing saturation to form linoleic acid and then linolenic acid or there is further chain elongation to form eicosenoic acid and then to erucic acid. Crucifers, compared to other oilseed crops are quite unique for exhibiting very high proportion of erucic acid (anti-nutritional factor). Erucic acid constitutes about 50% of the total fatty acids. It is considered as anti-nutritional because heavy accumulation of triglycerides and cholesterol esters containing erucic acid is observed in the heart of the rats fed with rapeseed oil (Saur and Kramer, 1983). This is mainly because erucic acid is metabolically inert, as it does not enter into the β-oxidation pathway to produce ATP (Joyee, 1978). Ziemlanski *et al.* (1995) also concluded some harmful effects of high erucic rapessed oil on the body. Although major breakthrough has been achieved with the production of low erucic acid and also low linolenic acid rapeseed varieties (Prevot, 1990) but most of the accessions with lower erucic acid are not acceptable for commercial production partially because of late maturity and lower oil yield under normal cultivation practices (Rucker and Robblen, 1996).

In the present communication, 153 accessions of different *Brassica* and alien species were studied for their total oil percentage and erucic acid concentration. Erucic acid content of species as well as high and low erucic acid containing *B. napus* lines were compared on the basis of their mean values.

One hundred and fifty three collections of rapeseed-mustard were built up through introduction, exchange and exploration activities of NBPGR, New Delhi. Germplasm comprising of *Brassica juncea* (47), *B. napus* (17), *B. campestris* var. *yellow sarson* (30), *B campestris* var. *toria* (17), *B campestris* var . brown sarson (12), *B. carinata* (4), *B. nigra* (7), *B. rapa* (1), *Eruca sativa* (6), *Sinapis alba* (4), *Crambe abyssinica* (1), *B. juncea* ssp *rugosa* (1), *B. chinensis* (3), *Raphanus caudatus* (1) and *Raphanus sativus* (2), were grown during *rabi* season 1999-2000 at Issapur experimental farm, NBPGR, New Delhi. Three rows of each accessions were planted with recommended basal dose of fertilizer, following normal cultural practices and plant protection measures. Seeds were harvested when plants attained complete physiological maturity. The data on five plants in each genotype was recorded. The mature seed were used for oil and fatty acid analysis. The presented data are the mean of analysis performed in triplicate. Seeds were dried to 4-5% moisture level in oven at 108°C for 16-18 h. The oil content of the seed samples were determined by non-destructive method using Newport NMR analyzer

(model-4000) from Oxford Analytical Instruments Ltd. U.K. after calibrating with pure *Brassica* oil.

Samples of rapeseed-mustard were freshly ground (Remi homogenizer) and weighed so that 40 mg oil is obtained when extracted with 10 ml solvent mixture consisting of chloroform: hexane: methanol (8:5:2 v/v). The extracts obtained were dried at 60°C in nitrogen gas for 30 min. Methyl esters of oil samples were prepared according to the method of Neff *et al.* (1994) with slight modifications. Transmethylation was performed by heating the oil samples in 0.5 N KOH in methanol at 60°C for 30 min. The reaction mixture was neutralized to pH 7.0 with 0.5 N HCl. The neutralized mixture was extracted with 10 ml petroleum ether: diethyl ether (1:1 v/v) and washed 3 times with water. The extract was dissolved in 5 ml acetone and dried in nitrogen gas. The residue was dissolved in hexane.

One µl of the hexane extract was injected onto highly polar Innowax capillary column of 30 m length, inner diameter of 0.32 m and film thickness of 0.5 µm, through a splitter (1/80) in a Hewlett Packard model 6890 gas chromatograph equipped with flame ionization detector (FID). The injector and detector temperature were 260°C and 275°C, respectively. Oven temperature was maintained between 150°C (1min) to 210°C at 15°C/min., followed by 210°C to 250°C (12min) at 5°C/min.

Fatty acid peaks were identified by comparing their retention time with that of the known standards, run in similar instrument conditions. Peak integration was done with the help of HP 3398A software.

Oil Content in the Cruciferae: Species wise the range of oil and erucic acid content and the respective mean values of the collections of 153 accessions are shown in Table 1. Among the most commonly grown *Brassica* species in India, *campestris* with all its morphotypes, is the richest oil bearing species followed by *B. juncea, B. napus* and *B. carinata*. Similar results were reported in one of our earlier observation. (Mandal *et al.* 2000).

Erucic Acids: Out of the 17 *B. napus* collections, about 50% collections were found to have low erucic acid within the range of 1.56 to 4%. Fatty acid composition of high and low erucic acid containing lines under *B. napus* species and overall other species in the crucifers calculated on the basis of mean values of any given species are shown in Fig. 1 and Fig. 2, respectively. Only five lines were identified among the 47 *B. juncea* collections which had low erucic acid concentration (<40%). Other low erucic acid containing species among the crucifers were *Sinapsis alba, Raphanus caudatus* and *Raphanus sativus* where mean percentages were found within the range of 32.21 to 39.79%. Maximum erucic acid content of 59.55% was observed in one genotype under *Crambe abyssinica*. Wang-YouPing *et al.* 1995 and 1997 have reported as high as 62% erucic acid in *C. abyssinica*. Mean erucic acid level among other collections were found to vary from 43.17 to 51.69%. Low erucic acid level of the oil was found

Table 1. Total oil and erucic acid content in crucifers

Cruciferas species	Species code	Oil (%)		Erucic Acid (%)	
		Range	Mean	Range	Mean
B. juncea (47)*	BJN	27.91-41.3	37.24	8.25-53.4	48.17
B. napus (5) High erucic acid >35%	BNP	23.97-42.72	35.24	35.34-45.40	40.54
B. napus (12) Low erucic acid <18%	BNP			1.56-17.8	6.81
B. campestris var. *Yellow sarson* (30)	BYS	34.71-46.72	43.20	45.38-57.05	51.69
B. campestris var. *Toria* (17)	BCT	38.45-44.83	41.98	42.53-51.55	47.99
B. campestris var. *Brown sarson* (12)	BCS	36.27-44.21	40.96	39.79-53.25	47.49
B. nigra (7)	BNR	23.63-38.69	30.91	35.93-53.46	43.29
B. carinata (4)	BCN	27.81-31.76	29.81	42.29-55.69	50.00
Crambe abyssinica (1)	CAS		33.69		59.55
Eruca sativa (6)	ESV	23.71-29.52	25.79	41.16-44.81	43.17
Sinapsis alba (4)	SAB	21.5-33.96	25.59	39.16-47.26	39.79
B. chinensis (3)	BCH	41.0-41.47	41.28	39.58-49.79	45.72
B. juncea (ssp. *rugosa*) (1)	BJR		47.02		47.02
B. rapa (1)	BRP		45.87		45.87
Raphanus sativus (2)	RSV	30.76-35.65	33.05	31.76-33.62	32.69
Raphanus caudatus (1)	RCD		33.62		32.21

* No. of accessions are in parentheses.

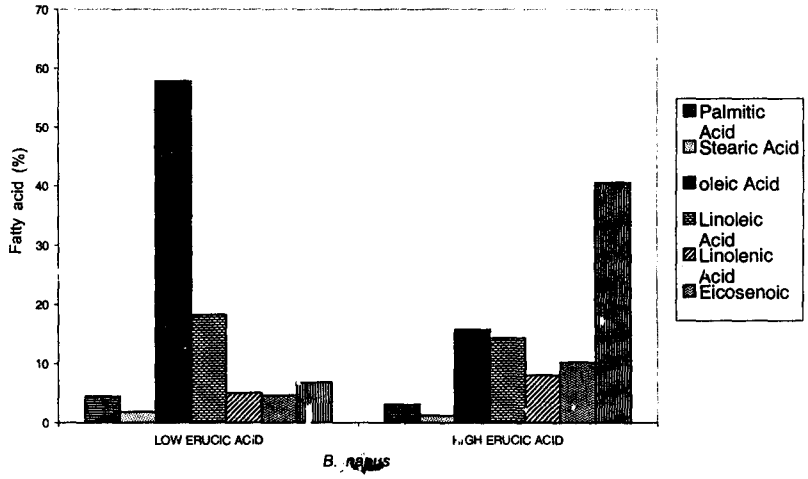

Fig. 1. Fatty acid profile of low and high erucic acid B. napus lines

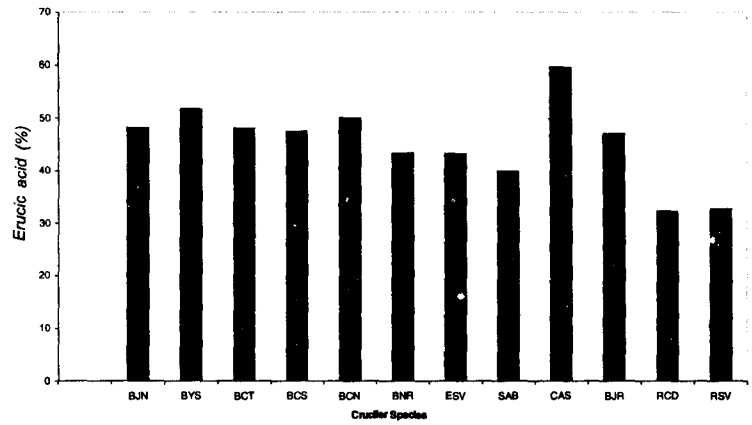

Fig. 2. Erucic acid content in different Brassica species

associated with high percentage of palmitic and oleic acid. Maximum oleic acid content of 66.68% was found in one low erucic acid containing line under *B. napus* germplasm. Oil content of present crucifer collections did not show any significant relationship with erucic acid concentration of the oil. But significant positive correlation was observed only in the collections of *B. juncea* and *B. nigra* species.

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