BREEDING FOR HIGH ERUCIC ACID CONTENT IN BRASSICA JUNCEA

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For more than twelve years rapeseed-oil has no longer been a resource for erucic acid in Middle Europe. But recently the chemical industry has again demanded for vegetable oils with a high erucic acid content. The production of rapeseed free of erucic acid and at the same time of rapeseed with a high erucic acid content in one country reveals many problems in breeding, seed-multiplication, storage and processing. Therefore, interest in Brassica juncea as an alternative resource for erucic acid for industrial purposes is growing.

Mainly three points are important, if a seedoil is to be used as a resource for an industrially used fatty acid. Firstly, a high content of erucic acid is necessary. Many studies of variability are already published (table 1). Some authors have found values higher than 60 percent.

Secondly, the crops must have a high seed yield to be competitive to other crops. The reported seed yields are lower in Germany than those in Spain or California (table 2).

Thirdly, the quality of the meal must be sufficient. In Brassica juncea it is possible to breed for low glucosinolate content (Cohen et al., 1983) or to detoxificate the meal technically (Mc Gregor, 1983). Also there are many lines with a yellow seed coat.

Table 1: Range of erucic acid content in Brassica juncea

Range of erucic acid content	No. of lines	Authors
22	1	Mikolajczak et al., 1961
23 - 25	2	Downey, 1971
20 - 68	35	Nyaradi et al., 1975
16 - 61	523	Knowles et al., 1981
17 - 52	11	Rahman & Quddus, 1981
18 - 35	7	Kirk & Oram, 1978
0 - 23	3	Kirk & Oram, 1981
0 - 51	11	Kirk & Hurlstone, 1983
0 - 55	many	Olsson, 1984

Table 2: Reports of seed yields

Range of yield (kg/ha)	No. of lines	Country	Authors
1200	-	D	Boguslawski, 1952
1800	1	AUS	Kirk & Oram, 1978
1700 - 2500	-	USA	Knowles et al., 1984
470 - 1800	4	D	Schuster & Kübler, 1981
2500	2	E	Fereres et al., 1983

Material and methods

Different accessions of Brassica juncea were evaluated for agronomic characteristics at Braunschweig-Völkenrode in small plots with two replications. The determination of the fatty acid composition was done by standard gas-chromatography. The individuals of crossing progenies were selected for high single plant yield and then erucic acid content was determined.

Results

The seed yields of selected lines are presented in table 3. The mean yield of two years and six strains is about the half of winter rapeseed in northern Germany.

Table 3: Seed yields at Braunschweig-Völkenrode

Line	Country of origin	Seed yield (kg/ha) 1984	1985	mean
Hatano	-	1820	1600	1760
Aurea	D	2400	1520	1960
Domo	CDN	1770	1300	1540
Kanniaja	SU	2100	1160	1630
-	PAK	-	800	
-	NPL	2250	1370	1810
Mean		2070	1290	1640

The range in erucic acid content of 52 accessions is from 17.4 % to 48.1 %, the mean is 30.3 % (fig. 1). If the accessions are arranged after their country of origin (fig 2), it is obvious that the European accessions have low and the ones from India, Pakistan and Nepal have high erucic acid values. Kirk and Hurlstone published very similar results in 1983. But some accessions from India have comparable values to European strains.

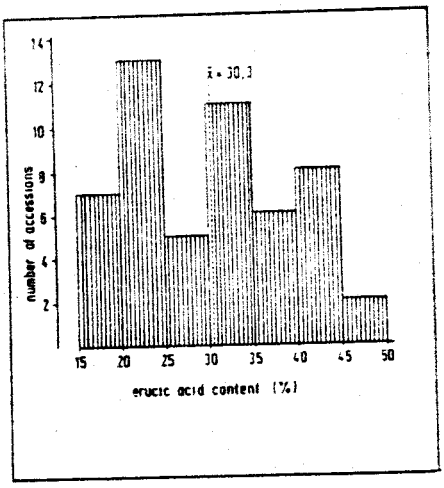

Fig. 1: Frequency distribution of erucic acid content in Brassica juncea (n = 52, 1983, 1986)

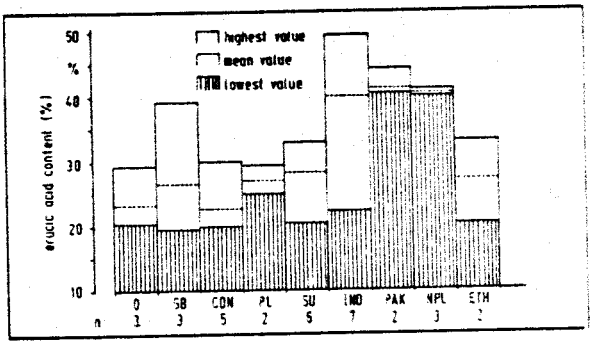

Fig. 2: Variability in erucic acid content of Brassica juncea arranged after country of origin (n = 52, 1983, 1986)

In fig. 3 the frequency of distributions of erucic acid content of individual plants from two bulk populations are compared.

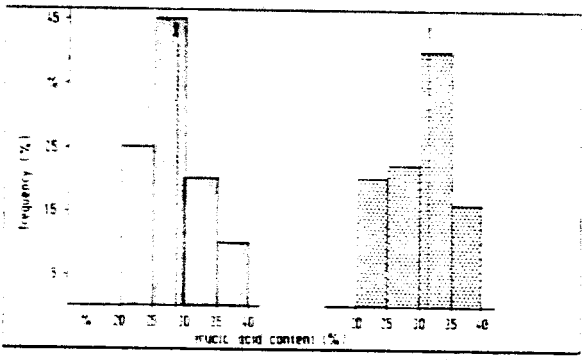

Fig. 3: Frequency distribution of erucic acid content of single plants from two Brassica juncea bulk populations

In two bulk populations from different crossing progenies the individual plant values showed no transgressions in erucic acid content over the value of the parent with the highest value of 44.6 %. The first population consisted of 60 for yield selected plants in the F_3-generation, and the second population was the same in the F_4-generation. The five to six parents showed a variation in erucic acid content of 18.7 % to 44.6 %, or 21.0 % to 44.6 %, respectively.

The results of specific crosses are presented in table 5. The crosses low x medium (1 x 2) and high x low (3 x 4) erucic acid content showed nearly the same mean, range and standard deviation. Only the first cross had plants with clear transgressions over the parent with the highest value. The third cross, done by crossing F_1-plants of the two other crosses, had a smaller range and a lower standard deviation, but nearly the same mean as the first cross.

Table 5: Erucic acid content of single plants from three crosses

Parent/Cross	No. of plants	Generation	Erucic acid content % mean	range	standard deviation
1 Domo			21.5		
2 Hatano			32.3		
3 PAK			44.6		
4 TR			21.0		
1 x 2	30	F_4	30.5	18.4 - 47.6	9.47
3 x 4	30	F_4	32.4	22.0 - 46.4	8.08
(3 x 4) x (1 x 2)	30	F_4	29.1	20.7 - 37.4	5.18

Conclusions

The yield level of Brassica juncea is higher in Spain, California and parts of Australia than in Germany. Therefore, it is necessary to select intensively for high yield and good agronomic characteristics. Perhaps in the near future the yield level can be strongly raised by producing hybrid varieties using cms-mechanisms (Banga and Labana, 1984).

An erucic acid content of 50 % to 60 % seems to be the maximum which can be achieved in a good breeding line. Some outstanding lines, quoted in literature, have more than 65 % erucic acid content. Also in crosses between lines with low (European type) and high (Indian type) erucic acid content selection for high erucic acid content is successful.

Selection for low glucosinolate content is possible, but not absolutely necessary, because the meal can be technically detoxificated or the meals can be mixed with others. The production of erucic acid for industry will grow steadily so that the quantities of meal will be low in total.

Literature

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