Plant Foods for Human Nutrition 37: 33–40 (1987)

The oil content and fatty acid composition of various genotypes of cauliflower, turnip and radish

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Received 12 February 1986; accepted in revised form 16 September 1986

Key words: *Brassica oleracea* L. var. *botrytis*, *Brassica campestris* L. var. *rapa*, *Raphanus sativus* L., seed oil, fatty acids, composition

Abstract. Seeds of thirteen genotypes of cauliflower, four of turnip and seven of radish were analysed for oil content and fatty acid composition. Turnip and radish had higher oil content as compared to cauliflower. Oleic, linoleic + eicosenoic and erucic acids were the major fatty acids in the oils of these seeds. Levels of erucic acid were in the order of radish < turnip < cauliflower. Compared to cauliflower and turnip seeds, radish seeds contained higher amounts of palmitic, oleic, and linolenic + eicosenoic acids and lower amounts of linoleic and erucic acids.

Introduction

In India, cauliflower (*Brassica oleracea* L. var. *botrytis*), turnip (*Brassica campestris* L. var. *rapa*) and radish (*Raphanus sativus* L.) are important vegetable crops. Surplus seeds after sowing of these vegetables remain unutilised because they lose viability with time. The possibility of using these seeds as a source of edible oil needs to be explored. Moreover, the information on fatty acid composition of oil in the case of turnip and radish seeds [7, 12, 13] is limited and that of cauliflower is lacking. Currently, research is oriented towards an improvement in quantity and quality of oil of rapeseed and mustard. Hence, to find some new sources of oil with a desirable quality and possibly new material for breeding purposes, the present study was undertaken on the seeds of some promising genotypes of cauliflower, turnip and radish.

Materials and methods

Seeds of a few promising genotypes of cauliflower, turnip and radish (produced at the Research Farm of Punjab Agricultural University, Ludhiana, India during 1983–84) were analysed for oil content and fatty acid composition. Oil content was estimated by use of a wide-line NMR Newport Analyser, Model MKIIIA, England. For fatty acid analysis, oil was extracted by the method of Kartha and Sethi [4]. Fatty acid methyl esters were prepared by the method of Luddy et al. [8] and analysed by gas liquid chromatography using an AIMIL 5700 series gas chromatograph with flame ionization detector, having a

Table 1. Oil content and fatty acid composition (%) of 13 cauliflower genotypes.

Genotype	Oil content %)	Lower chain (C12–14)	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic	Linolenic + eicosenoic	Arachidic	Behenic	Erucic	Higher chain (C > 22)
Early Kumari	37.3	0.13	4.62	0.06	0.78	11.55	13.27	17.51	0.32	0.17	51.50	0.54
S 21–5	36.2	0.09	3.74	0.08	0.89	13.84	11.38	15.47	0.45	0.56	51.43	1.03
Mahadev Maghi	37.6	0.45	5.83	0.02	0.97	13.14	11.48	14.78	0.17	0.31	51.98	0.44
Pusa Katki	41.5	0.09	3.83	0.08	0.84	12.68	10.92	14.86	0.37	0.41	54.27	0.78
Pusa Beauty	35.5	0.14	3.96	0.09	0.78	13.15	10.82	14.90	0.32	0.49	53.69	0.81
A 3	40.2	0.13	3.56	0.14	0.73	13.03	10.84	14.40	0.25	0.38	54.95	0.78
Pb. Giant 35	38.1	0.12	3.90	0.16	0.75	14.15	10.12	14.51	0.28	0.41	54.41	0.60
Giant Snow Ball	37.1	0.13	3.93	0.12	0.86	13.77	10.72	14.65	0.34	0.65	53.63	0.61
Hissar 1	38.4	1.99	4.51	0.10	1.71	15.71	12.11	14.92	1.27	1.05	46.42	0.31
Snow Ball 16	40.4	0.13	4.22	0.02	0.71	13.34	11.64	15.49	0.13	0.22	54.03	0.09
114 S	39.3	0.21	5.40	0.07	0.50	15.13	13.70	14.41	0.07	0.40	50.00	0.05
Late Patna	41.8	0.16	3.93	0.07	0.65	13.28	11.49	15.99	0.30	0.24	53.32	0.28
Punjab Giant 26	39.3	0.18	4.05	0.02	0.65	13.26	10.48	16.13	0.25	0.22	54.12	0.32
Mean	37.7	0.22	4.27	0.08	0.83	13.51	11.46	15.23	0.35	0.42	52.58	0.50

6 mm × 2 m column packed with 15% (W/W) diethylene glycol succinate (DEGS) on 80 to 100 mesh chromosorb W supplied by Nucon Engineers, New Delhi. The instrument was operated at 190° with a nitrogen flow of 60 ml/min and a hydrogen flow of 30 ml/min. The peaks were identified by comparison of their retention times with those of standard fatty acid methyl esters. The peak area and the relative percentage of each fatty acid was calculated with data processor Chromatopac Model EIA. Determinations were carried out in triplicate and data were statistically analysed according to Miller et al. [9].

Results and discussion

Data given in Table 1 show wide variation in oil content and concentration of major fatty acids in seeds of cauliflower genotypes. Major fatty acids were comprised of oleic, linoleic and linolenic + eicosenoic and erucic acids. Linolenic + eicosenoic acids could not be separated on DEGS column, hence their combined concentration is reported. Oil content varied from 35.5 (cv. Pusa Beauty) to 41.8% (cv. Late Patna). The percentage fatty acid composition varied, viz. oleic acid from 11.55 (cv. Early Kumari) to 15.71 (cv. Hissar 1), linoleic acid from 10.12 (cv. Pb. Giant 35) to 13.70 (cv. 114S), linolenic + eicosenoic acid from 14.40 (cv. A 3) to 17.51 (cv. Early Kumari) and erucic acid from 46.42 (cv. Hissar 1) to 54.95 (cv. A 3). These results show that among the cauliflower genotypes variety Hissar 1 had the maximum content of oleic acid and the minimum concentration of erucic acid. Cauliflower cultivars were in general rich in erucic acid and present at concentrations comparable to most of the *Brassica* oilseeds, namely, toria (*Brassica campestris* L.) and mustard (*Brassica juncea* L. coss) [1, 2].

In turnip (Table 2), oil content varied from 40.1 (cv. L 1) to 46.1% (cv. Red 4). The percentage fatty acid composition varied, viz. oleic from 16.77 (cv. L 1) to 19.50 (cv. Purple Top White Globe), linoleic from 13.30 (cv. Red 4) to 16.15 (cv. L 1), linolenic + eicosenoic acid from 16.10 (cv. Purple Top White Globe) to 20.80 (cv. White 4) and erucic acid from 42.82 (cv. White 4) to 46.96 (cv. Purple Top White Globe). Stefanov and Gyurov et al. [13] reported 40.46% oil content in seeds of forage turnip; levels reported included oleic acid 25.50%, linoleic acid 20.00%, behenic acid 13.21% and erucic acid 18.26%. The genotypes used in the current study, however, exhibited lower contents of oleic, linoleic and behenic acids and a higher content of erucic acid.

In radish seeds (Table 3), oil content varied from 39.8 (cv. S 2) to 44.0% (cv. S 6). The percentage fatty acid composition varied, viz. oleic acid from 17.52 (cv. Punjab Sufed) to 26.40 (cv. Japanese White), linoleic acid from 11.66 (cv. Punjab Sufed) to 17.50 (cv. White 5), linolenic + eicosenoic from 18.81 (cv. Pusa Chetki) to 23.38 (cv. White 5) and erucic acid from 31.85 (cv. 24-2) to 38.98 (cv. Punjab Sufed). Sengupta and Roy [12] reported 19.1% oleic, 11.5% linoleic, 11.2% linolenic and 38.0% erucic acid in radish seed oil. The results show that radish oil had a lower proportion of erucic acid than that present in mustard oil

Table 2. Oil content and fatty acid composition (%) of 4 turnip genotypes.

Genotype	Oil content (%)	Lower chain (C12–14)	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic	Linolenic + eicosenoic	Arachidic	Behenic	Erucic	Higher chain (C > 22)
Red 4	46.1	0.28	3.11	0.05	1.04	17.40	13.30	20.45	0.09	0.23	43.70	0.36
White 4	41.2	0.42	3.24	0.07	0.90	17.00	14.20	20.80	0.07	0.28	42.82	0.20
LI	40.1	0.15	3.70	0.05	0.86	16.77	16.15	18.51	0.10	0.19	43.30	0.22
Purple Top White Globe	43.0	0.10	3.12	0.03	1.31	19.50	12.00	16.10	0.15	0.43	46.96	0.32
Mean	42.6	0.23	3.29	0.05	1.03	17.67	13.91	18.91	0.09	0.28	44.20	0.27

Table 3. Oil content and fatty acid composition (%) of 7 radish genotypes.

Genotype	Oil content (%)	Lower chain (C12–14)	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic	Linolenic + eicosenoic	Arachidic	Behenic	Erucic	Higher chain (C > 22)
White 5	41.8	0.09	4.81	0.12	1.47	17.76	17.50	23.38	1.37	1.09	37.50	0.89
S 2	39.8	0.05	5.31	0.02	1.57	20.90	11.88	20.00	0.19	1.07	37.87	1.08
Japanese White	40.6	0.07	5.91	0.04	1.86	26.40	11.97	19.57	0.22	0.79	32.74	0.83
Punjab Sufed	42.1	0.28	6.97	0.11	1.62	17.52	11.66	20.15	0.56	0.88	38.98	0.97
S 6	44.0	0.07	6.56	0.06	1.39	20.00	12.60	19.31	0.17	0.55	38.60	0.62
S 24–2	43.7	0.15	6.18	0.11	2.28	26.01	13.14	18.94	0.31	0.90	31.85	0.78
Pusa chetki	42.0	0.07	5.54	0.05	1.48	21.09	13.20	18.81	0.39	0.83	37.72	0.80
Mean	42.0	0.12	5.90	0.07	1.64	21.38	13.13	20.02	0.46	0.87	36.33	0.85

Table 4. Correlation coefficients between oil and different fatty acids present in cauliflower, turnip and radish.

	Lower (Acids) (C12–14)	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic	Linolenic + Eicosenoic	Arachidic	Behenic	Erucic	Higher fatty acids (C > 22)
Oil content	−0.196	0.146	−0.135	0.410*	0.545**	0.344	0.578**	−0.099	0.078	−0.544**	−0.327
Lower acids (C 12–14)		0.125	0.108	0.315	−0.043	−0.005	−0.108	0.517**	0.317	−0.068	−0.249
Palmitic			−0.051	0.593**	0.502*	0.075	0.311	0.125	0.527**	−0.086	−0.120
Palmitoleic				0.038	−0.143	−0.057	−0.114	0.432*	0.277	0.099	0.455*
Stearic					0.843**	0.220	0.550**	0.370	0.796**	−0.861**	−0.106
Oleic						0.299	0.610**	−0.031	0.568**	−0.918**	−0.267
Linoleic							0.684**	0.281	0.159	−0.531**	−0.136
Linolenic + Eicosenoic								0.196	0.394	−0.819**	−0.030
Arachidic									0.648**	−0.163	0.416*
Behenic										−0.638**	0.308
Erucic											0.213

* Significant at $p = 0.05$.
** Significant at $p = 0.01$.

[1] and toria oil [2]. This suggests that the quality of radish oil is better as compared to that of mustard and toria oils.

The means for three different groups revealed that, in general, turnip genotypes had the highest oil content followed by radish and cauliflower. The oleic and linolenic + eicosenoic acid concentrations in oils were in the order of radish > turnip > cauliflower. A reverse trend was observed in the case of erucic acid. Palmitic acid concentration was highest in radish seed oil followed by cauliflower and turnip seed oil.

Correlation coefficients among oil content and various fatty acids are presented in Table 4. Oil content had a significant positive association with oleic and linolenic + eicosenoic acids and a significant negative correlation with erucic acid level. However, Klassen [5] reported a significant positive correlation between erucic acid and oil content in rapeseed (*Brassica campestris*). Oleic and linoleic acids had highly significant positive correlations with linolenic + eicosenoic acid but significant negative correlations with erucic acid. The significant negative correlation between oleic and erucic acid can be attributed to the fact that erucic acid is biosynthesized from oleic acid [3]. There was a significant negative correlation between linolenic + eicosenoic and erucic acid. Koyama et al. [6] found significant negative correlation between erucic acid and oleic acid (−0.983) in rapeseed. Rahman [11] showed that oleic acid had a negative correlation with linoleic acid. Similarly, Nagamani et al. [10] reported that the increase in erucic acid was associated with decreases in oleic, linoleic and linolenic acids in *Brassica juncea*. In the present study, varieties having low oleic, linoleic and linolenic + eicosenoic acids had high erucic acid. Thus a line with desirable traits could be developed in all of these vegetables. Quantity and quality of oil in rapeseed and mustard could also be improved by crossing it with turnip.

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