Pakistan J. Sci. Ind. Res., Vol. 30, No. 1, January 1987

CRAMBE ABYSSINICA – A RICH SOURCE OF ERUCIC ACID, ITS OIL PERCENTAGE, FATTY ACID COMPOSITION AND AGRICULTURAL DATA

Sadaqat Hamid, Salma, Abdul Waheed Sabir and Shafiq Ahmad Khan

PCSIR Laboratories, Lahore-16

(Received October 27, 1985; revised July 23, 1986)

Crambe abyssinica (N.O. Brassicaceae) imported from USA, has been grown in Pakistan. Its agricultural characteristics yield and fatty acid composition have been determined. It has been found that *C. abyssinica* seeds contain 44% oil, about 60% of it as erucic acid.

Key words: Crambe abyssinica, Ecometeorological, Brassicaceae, Esterification and Germination.

INTRODUCTION

In a recent study the Cruciferous seeds of Pakistan were evaluated for their fatty acid composition [1]. The main objective of the project was to select a low erucic acid germplasm for commercial cultivation to provide a nutritionally superior edible oil. During this survey it was observed that a large variety of seeds belonging to *Brassica campestris, B. juncea* and *Eruca sativa,* the common Cruciferous oilseed crops of Pakistan, have a rather higher erucic acid percentage (50-60%) in them. Since erucic acid rich oils find commercial applications [2] it was desirable also to identify such a germplasm and *C. abyssinica* is reputed for this character [3]. For this reason, the seeds of *C. abyssinica* obtained from the USA were cultivated in the experimental fields of the PCSIR Laboratories, Lahore. The present report, therefore, describes the cultivation data, seed and oil yield and also the fatty acid composition of *C. abyssinica* seed oil. The seed oil (44%) is composed of erucic (59.3%), palmitic (2.07%), oleic (22.13%), linoleic (11.58%) and linolenic (1.31%) acids.

The seeds were sown in October and their germination was observed to be 90-100/. The plants matured in almost 6 months' time and the crop was harvested in April. The per acre yield was calculated to be 1500 lb.

MATERIALS AND METHODS

Materials

The seeds were supplied by United States Department of Agriculture (USDA). They were clean and neat and ready to be sown. The optimum temperature for germination on 22nd October was 34°C when seeds were planted.

Methods

(i) *Soil Preparation.* The soil was thoroughly ploughed, made loose, mixed with cow dung manure and then levelled.

(ii) *Sowing.* The seeds were sown with a graindrill having appropriate outlets plugged to give the desired row width. The seeding was done about 3 cm deep in a firm and well prepared seedbed in rows 20-30 cm apart and 15-35 cm wide.

(iii) *Germination.* The seeds were sown in the second week of October (temperature maximum 34°C, minimum 13.7°C, humidity maximum 75%, minimum 39%). Germination started 12 days after sowing and was observed to be 90-100%.

(iv) *Irrigation.* The field was irrigated at time intervals as given in econometeorological data in Table 1.

(v) *Flowering and fruiting.* Flowering occurred in the last week of January (temperature maximum 29.9°C, minimum 9.4°C, humidity maximum 90%, minimum 30%) and continued till the last week of February. Fruiting started in the first week of March (temperature maximum 32°C, minimum 11.4°C, humidity maximum 76%, minimum 26%). It reached maturity in the second week of April.

(vi) *Harvesting.* Harvesting was done in the second week of April (160-180 days) (temperature maximum 30.7°C, minimum 16.7°C, humidity, maximum 66%, minimum 39%).

(vii) *Yield.* An yield of 1500 lb/acre was obtained. This yield/acre is compared with other places [2, 4] in Table 2.

(viii) *Oil extraction.* Ripe dry and clean seeds were crushed with a pestle in a mortar and then extracted with hexane b.p. 65-70°) in a Soxhlet [5]. The solvent was

Table 1. Ecometeorological data for the cultivation of *Crambe abyssinica*

Sr. No.	Cultivation state	Date	Temperature (°C)		Humidity (%)		Soil type	Irrigation
			Min.	Max.	Min.	Max.		
1.	Sowing	09.10.84	15	34.1	34	75	Loamy	Monthly
2.	Germination	22.10.84	13.7	34.0	39	75		Monthly
3.	Flowering	25.01.85	9.4	29.9	31	90		Fort-nightly
4.	Fruiting	05.03.85	11.4	32.0	26	76		Fort-nightly
5.	Harvesting	15.04.85	16.7	30.7	39	66		–

removed under tap water pressure to yield a clear light yellow coloured oil (44.1%).

(ix) *Physico-chemical properties of the oil.* The seed oil was evaluated by determining its various physico-chemical characteristics. This and the already reported data are given in Table 3 for comparison.

(x) *Chemical Composition of the oil.* (a) *Saponification.* Fatty acide were obtained from the oil saponified with alcoholic potassium hydroxide (0.5N) solution. The non-saponifiable matter was extracted with ether after removing alcohol from the saponified oil. The soap solution was then decomposed by the addition of sulphuric acid (2N). The liberated fatty acids were extracted with ether, dried over anhydrous sodium sulphate and kept under nitrogen atmosphere.

(b) *Esterification.* The methyl esters of the fatty acids were prepared as reported previously [6]. The identity and percentage of the component fatty acids were worked out from the retention times and peak areas of the methyl esters when examined by gas chromatography under the following conditions:

Glass column (1.5 m x 4 mm) packed with diethylene glycol succinate (DEGS 10%), injector port, 220°, flame ionisation detector, 220°, column oven, 220°, Flow rate (N_2), 40 ml/min, (H_2), 40 ml/min., air 550 ml./min.

The fatty acid composition (percentage) so determined is compared with the earlier reported composition in Table 4.

Table 2. Comparative seed yields of *Crambe abyssinica*

Work reported from	Yield per acre
1. Lahore (Pakistan)	1500 lb.
2. Montana (USA) [4]	600 "
3. Indiana (USA)	2400 "
4. California (USA)	4200 "
5. USSR	1450 "

Table 3. Physico-chemical properties and oil percentage of *Crambe abyssinica.*

Characteristics and values	Present work	USA [6]
1. Oil yield	44.1%	45%
2. Colour	Light yellow	–
3. Appearance	Liquid	–
4. Sp. gr.	0.912	0.808
5. Iodine value	95	93
6. FFA	17%	–
7. Refractive Index (40°C)	1,471	1.466

DISCUSSION

Ecometeorological data (Table 1) for the cultivation of *C. abyssinica* shows that the seeds adapted easily to the Pakistani environment. This was expected because most of the crucifers are cultivated at about the same time (October) in Pakistan.

The seed and oil yields of *C. abyssinica* are also comparable (Tables 2 and 3). Seed yield (per acre) is about the same as in the USSR and much less than that of the USA (Indiana and California). It is, however, much more (two and a half times) than in Montana.

Differences in soils and environments could very well cause these yield variations. Another factor responsible for

Table 4.

Component acids	Present work composition	USA [6]
1. Capric	0.15	–
2. Myristic	0.11	–
3. Palmitic	2.07	2
4. Palmitoleic	0.21	–
5. Stearic	0.14	–
6. Oleic	22.13	15
7. Linoleic	11.58	10
8. Erucic	59.31	64
9. Linolenic	1.31	–
10. Eicosenoic	–	3
11. Behenic	–	2
12. Tetracosenoic	–	3
13. Free fatty	–	0.2
14. Unsaponifiables	–	0.5
15. Unknown	2.99	–

this might perhaps be the frequency of irrigation. More experiments are however, required to understand this issue more cleary.

The seed oil (44%) has the usual characteristics as determined by the standard techniques (Table 3). The fatty acid composition is also similar to the one already reported elsewhere [6] (Table 4). A perusal of the data thus indicates that the *C. abyssinica* seed oil is a rich source of erucic acid. Erucic acid rich oils either as such or after chemical transformations generally find extensive use as lubricants and rubber additives [2, 3]. It is, therefore, proposed that large scale cultivation of *C. abyssinica* and other high erucic acid germplasm of the local crucifers be considered as an oil crop having industrial application.

It is also of interest to mention here that this crop should not be mixed with the one sown exclusively for edible purposes and low or zero in erucic acid. Since they both require similar environment to grow, it will be advantageous to cultivate them in separate zones. By this practice the country can have two crops at the sametime, meeting two different but vital needs – the low erucic acid oil for edible and high erucic acid oil for industrial purposes.

REFERENCES

1. S.A. Khan, S. Akhtar, I. Waheed and A.H. Khan, Pakistan J. Sci. Ind. Res., **28**, 279 (1985).
2. V.J. Codin and O.S. Spensley, "*Crop and Product Digest, No. 1, Oils and Oilseeds*, (Tropical Products Institute, London, 1971), p. 41.
3. I.A. Wolff, J. Am. Oil Chem. Soc., **48**, 723 (1971).
4. L.H. Princen, "*Potential Wealth in New Crops, Research and Development*," reprinted from Crop Resources (Academic Press, Inc. New York, San Francisco, 1977).
5. L.V. Cock and C. Van Rede, *Laboratory Hand Book for Oil and Fat Analysis*". (Academic Press, London, New York, 1966), p. 401.
6. M. Salim, M. Ashraf, S.A. Khan and M.K. Bhatty, Pakistan J. Sci. Ind. Res., **9**, 347 (1966).
7. S.A. Termazi, "*Vegetable Oils and Fats*" (Ferozesons Ltd., Lahore, 1983), p. 114.
8. Crambe, Published by USDA, Agricultural Research Service, North Regional Research Laboratory Peoria, Illinois 61604, June, 1972.