Characteristics and Composition of Newer Varieties of Indian Castor Seed and Oil

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ABSTRACT

Seventeen newer varieties of castor seed grown in different parts of India and the oils extracted therefrom were analyzed. The seed characteristics varied as follows: 100-seed weight, 15.2-30.2 g; 100-seed volume, 15.0-32.5 ml; kernel, 64-75%; oil, 46.0-51.8%; protein, 17.1-24.4%; crude fiber, 18.2-26.5%, and ash, 2.1-3.4%. Oil characteristics were: acid value, 1.0-2.9; saponification value, 176.2-183.7; iodine value, 81.4-88.1, and hydroxyl value, 159.2-167.1. Ricinoleic acid content varied from 87.4% to 90.4%.

INTRODUCTION

India and Brazil are the leading producers of castor (*Ricinus communis*, L.) seed and exporters of castor oil (1-4). Castor oil, either as such or in the form of various derivatives, is used extensively in many industries because of the predominant presence of ricinoleic (12-hydroxy-*cis*-9-octadecenoic) acid (1-4). To improve the economics of castor seed production, a number of newer, early-maturing and high-yielding varieties have been developed in India in recent years (2,4). No information is available on the characteristics and composition of these newer varieties of seeds and the oils extracted therefrom, particularly on the fatty acid composition which has a bearing on the yield and quality of castor oil and its derivatives. Such data on 17 newer varieties of castor seeds grown in different parts of India are reported in this communication.

EXPERIMENTAL

Materials

Seventeen varieties of castor seed grown in different states were collected as follows: Aruna (NPH-1), Bhagya (63) and Sowbhagya (157 B) from the Regional Station of the Indian Agricultural Research Institute, Rajendranagar, Hyderabad, Andhra Pradesh; GAUC-1, GAUCH-1, GCH-3, VHB-62, VHB-158 and VHB-106 from the Pulse Research Station, All India Coordinated Research Project on Castor, Gujarat Agricultural University, Sardar Krishinagar, Gujurat; RC-8 and KRC-1 from the Regional Research Station, Raichur, Karnataka; SA-2 from the Castor Research Station, Pottaneri, Tamil Nadu; LC-1 from Bhami, Tamil Nadu; LC-2 from Sankari, Tamil Nadu; Girija and Phule Erandi-1 from the Mahatma Phule Krishi Vidyapeeth, Jalgaon, Maharashtra and CH-1 from the Haryana Agricultural University, Hissar, Haryana. Methyl ricinoleate was obtained by partition of castor oil methyl esters between n-hexane and methanol containing 20% water and subsequent purification by preparative thin layer chromatography (TLC) on Silica gel G using n-hexane-diethyl ether (70:30, v/v). Methyl stearate was prepared from technical stearic acid by fractional distillation of its methyl ester under vacuum.

Methods

The 100-seed volume was determined by noting the increase in volume on immersing seeds in methyl esters of castor oil. Proximate composition of seeds and chemical characteristics of oils were determined according to AOCS methods (5). Oil content was determined in a Soxhlet using n-hexane (5).

Castor oil was converted to methyl esters by refluxing with methanolic sodium methoxide as described by Schneider et al. (6). Trimethylsilyl (TMS) ether derivatives of the methyl esters were prepared using *bis* (TMS) trifluoroacetamide in the presence of pyridine at room temperature (7). Gas liquid chromatography (GLC) was carried out using a Hewlett-Packard 5840A unit coupled with a flame ionization detector and a data processor. A glass column (1.8 m × 6 mm) packed with 10% EGS on Chromosorb W, HP, 80-100 mesh was used for analysis of derivatized methyl esters. A stainless steel column (0.6 m × 6 mm) packed with 5% SE-30 on Chromosorb W, AW DMCS 80-100 mesh was used for analysis of methyl esters. For both columns the temperature was maintained at 200 C and the flow rate of nitrogen at 30 ml/min. Standard methyl esters were used for reference. Mixtures of pure methyl ricinoleate (79.4, 85.4, 85.9, 89.7 and 89.9%) and methyl stearate were prepared and analyzed on an EGS column after derivatization of ricinoleate as the TMS ether. The peak area for the TMS ether was corrected for the response due to silyl methyl groups but not for silicon, which apparently does not ionize (8), and the area percentages were calculated. In all 5 mixtures, which contained approximately the same percentage of ricinoleic acid as castor oil, the peak area percentage for ricinoleate was less than the actual and a correction factor of 1.04 was found necessary. GLC of the derivatized castor oil methyl esters on the EGS column gave separate peaks for methyl palmitate, stearate, oleate, linoleate, arachidate and a combined peak for linolenate and TMS derivatives of methyl ricinoleate and dihydroxystearate. Wood et al. (9) also did not record separate peaks for dihydroxystearate and linolenate in GLC analysis of TMS ether derivatives on a polyester column. Dihydroxystearate was estimated separately by GLC of underivatized methyl esters on the SE-30 column. No correction factor was applied since it was present in less than 1%. The presence of linolenate was confirmed by GLC and argentation TLC of nonhydroxy fatty acid esters. The methyl linolenate content was calculated from the difference in total peak areas of C_{18}-nonhydroxy fatty acid esters from EGS and SE-30 columns. The total content of methyl dihydroxystearate and linolenate was subtracted from the combined content of methyl ricinoleate, dihydroxystearate and linolenate obtained on the EGS column to get the methyl ricinoleate content. After multiplying the ricinoleate content with the correction factor of 1.04, the percentage fatty acid composition was recalculated. Argentation TLC on Silica gel G using n-hexane-diethyl ether (70:30, v/v) was carried out to separate nonhydroxy fatty acid esters.

RESULTS AND DISCUSSION

Appreciable variations were found by Rao et al. (10) in 32 commercial samples of castor seed grown in Andhra Pradesh State in the year 1960. We also found appreciable variation in characteristics and proximate composition of seeds as follows: 100-seed weight, 15.2-30.2 g; 100-seed volume, 15.0-32.5 ml; kernel, 64-75%; oil, 46.0-51.8%; protein, 17.1-24.4%; crude fiber, 18.2-26.5%, and ash, 2.1-3.4% (Table I). However, we observed only marginal variations in oil characteristics as follows: acid value, 1.0-2.9; saponification value, 176.2-183.7; iodine value, 81.4-88.1, and hydroxyl value, 159.2-167.1 (Table I). These ranges generally fit in with international specifications (1). No correlation could be discerned between the characteristics of

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TABLE I

Physiochemical Characteristics of Newer Varieties of Castor Seed and Oil

Variety	100-seed wt. (g)	100-seed vol. (ml)	Kernel %	Moisture %	Oil[a] %	Protein[a] %	Crude fiber[a] %	Ash[a] %	AV[b]	SV[b]	IV[b]	HV[b]
Aruna (NPH-1)	15.2	15.0	71	4.9	49.2	21.3	22.9	2.5	2.9	180.9	81.6	162.0
Bhagya (63)	22.5	26.0	75	4.9	50.3	18.9	22.0	2.5	1.5	179.4	84.1	164.0
Sowbhagya (157 B)	17.1	20.0	69	4.9	46.0	19.8	26.5	2.9	2.4	178.1	84.3	163.0
GAUC-1	26.5	27.5	68	3.5	47.5	19.4	20.8	2.5	1.6	179.5	83.1	162.0
GAUCH-1	26.8	30.0	69	4.5	47.0	17.7	24.0	2.9	2.1	177.4	84.5	160.4
GCH-3	26.0	30.0	69	5.1	46.5	22.6	18.7	2.5	1.5	183.7	86.1	160.1
VHB-62	29.5	32.5	72	4.7	47.5	22.7	21.7	2.3	1.5	178.4	84.6	160.2
VHB-158	28.4	27.5	75	5.5	47.9	23.9	18.3	2.9	2.3	178.3	85.4	160.3
VHB-106	27.0	30.0	72	4.5	48.2	18.9	22.1	2.4	1.0	178.7	88.1	161.5
CH-1	18.9	20.0	74	3.8	51.1	23.0	18.2	3.2	2.5	179.1	84.9	160.4
RC-8	16.1	20.0	70	5.3	50.7	17.4	22.5	3.2	2.4	183.5	83.9	162.4
KRC-1	22.8	25.0	69	6.3	51.8	18.6	23.0	3.4	2.3	177.9	84.1	167.1
Girija	26.3	30.0	68	3.4	48.9	18.6	23.5	2.1	1.3	179.0	84.6	161.5
Phule Erandi-1	28.4	30.0	73	4.6	47.5	18.8	22.7	2.2	2.7	177.7	86.3	161.9
SA-2	25.0	25.0	64	5.2	46.3	24.4	23.4	2.6	1.7	181.4	85.1	160.4
LC-1	30.2	28.7	72	3.5	48.0	18.4	24.5	3.1	1.5	176.2	81.4	159.2
LC-2	28.0	30.0	66	3.6	50.8	17.1	21.6	2.8	1.1	180.0	83.8	161.5

[a]Dry basis.

[b]AV = acid value; SV = saponification value; IV = iodine value; HV = hydroxyl value. The difference between the experimental value and the calculated value from GLC data (Table II) varied from 0.2 to 3.8 for SV to 0.4 to 2.4 for IV and 0.1 to 3.4 for HV.

TABLE II

Fatty Acid Composition of Newer Varieties of Castor Seed Oils

Variety	Fatty acid (wt %)							
	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Arachidic	Ricinoleic	Dihydroxystearic
Aruna (NPH-1)	1.1	1.1	3.0	3.6	0.7	1.0	88.8	0.7
Bhagya (63)	0.9	1.0	2.8	3.0	1.0	1.0	89.7	0.6
Sowbhagya (157 B)	1.0	1.1	4.0	3.5	0.3	1.3	88.3	0.5
GAUC-1	0.9	1.1	3.5	3.4	0.8	1.3	88.3	0.7
GAUCH-1	0.8	0.9	2.8	3.0	1.0	0.8	89.9	0.8
GCH-3	0.9	1.1	2.9	3.3	0.4	0.6	90.2	0.6
VHB-62	0.8	0.9	2.5	3.1	0.7	1.1	90.4	0.5
VHB-158	1.0	1.0	2.6	2.9	0.5	0.9	90.4	0.7
VHB-106	1.2	1.1	3.5	3.6	0.4	1.4	88.2	0.6
CH-1	1.3	0.9	2.9	2.9	0.7	1.3	89.5	0.5
RC-8	1.0	1.0	2.8	3.8	0.6	1.5	88.5	0.8
KRC-1	1.0	1.0	2.6	3.4	0.6	0.4	90.3	0.7
Girija	1.1	1.3	3.5	4.0	0.4	1.6	87.4	0.7
Phule Erandi-1	0.8	1.0	3.0	3.6	0.3	1.0	89.6	0.7
SA-2	1.0	1.1	3.3	3.5	0.1	1.1	89.3	0.6
LC-1	1.0	1.0	3.4	3.0	0.8	1.0	89.0	0.8
LC-2	0.9	1.0	3.1	3.6	0.7	1.2	88.7	0.8

seed and oil.

Differences in fatty acid composition of castor oil, regardless of the origin, are reported to be relatively minor (11). The minor differences found in the literature could be due partly to the use of different methods (11). Among the methods employed, GLC appears to be simplest and most direct. Even by this method, ricinoleic acid content was found to vary depending on detector response of the derivatives. TMS ethers were shown to give the highest response, followed by acetates and underivatized methyl esters (3,9). We have standardized the analysis of TMS ethers by GLC using prepared mixtures of methyl ricinoleate and methyl stearate and applied a correction factor of 1.04 for methyl ricinoleate in the analysis of castor oil methyl esters. The ranges for fatty acid percentages (wt.) thus determined, were as follows: palmitic, 0.8-1.3; stearic, 0.9-1.3; oleic, 2.5-4.0; linoleic, 2.9-4.0; linolenic, 0.1-1.0; arachidic, 0.4-1.6; ricinoleic, 87.4-90.4 and dihydroxystearic, 0.5-0.8 (Table II). The fatty acid compositions of the newer varieties are almost the same as those of older varieties. The ranges for all the fatty acids are narrow, though the oils were obtained from 17 varieties grown in different states of India, thus confirming that castor oil fatty composition is practically constant.

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REFERENCES

1. Weiss, E.A., Castor, Sesame and Safflower, Leonard Hill, London, 1971, pp. 10-44, 286-308.
2. Kulkarni, L.G., and G.V. Ramanamurthy, Castor, Indian Council of Agricultural Research, New Delhi, 1977, pp. 2-6, 44-57, 74-88.
3. Sonntag, N.O.V., in Bailey's Industrial Oil and Fat Products, Vol. 1, 4th Ed., edited by D. Swern, John Wiley & Sons, New York, 1979, pp. 453-456.
4. Lakshminarayana, G., J. Oil Technol. Assoc. India, 13:75 (1981).
5. Official and Tentative Methods of the American Oil Chemists' Society, 1958, 3rd ed. (revised 1973) AOCS, Champaign, IL.
6. Schneider E.L.; S.P. Loke and D.T. Hopkins, JAOCS 45:585 (1968).
7. Gleispach, H., J. Chromatog. 91:407 (1974).
8. Tallent, W.H.; R. Kleiman and D.G. Cope, J. Lipid Res. 7:531 (1966).
9. Wood, R.D.; P.K. Raju and R. Reiser, JAOCS 42:81 (1965).
10. Rao, S.K.; B.A. Rao, A. Krishnamurthy, S.D.T. Rao and K.S. Murti, Indian Oilseeds J. 4:225 (1960).
11. Binder, R.G.; T.H. Applewhite, G.O. Kohler and L.A. Goldblatt, JAOCS 39:513 (1962).

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