Characteristics and Fatty Acid Composition of *Brachychiton* Species Seeds and the Oils (Sterculiaceae)

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The percentage contents of oil and protein in the seeds of *Brachychiton rupestris*, *Brachychiton australis*, *Brachychiton acuminatus*, and *Brachychiton gregori* (Sterculiaceae) were 28.7, 29.6, 32.5, and 29.8% and 23.6, 23.5, 22.0, and 22.0%, respectively. The major fatty acid was oleic in *B. acuminatus* and linoleic in the other three seed oils. Cyclopropene fatty acids, malvalic and sterculic, were present in appreciable concentrations (6.6–10.6% and 0.5–2.2%). Cyclopropene fatty acids were identified and estimated by using combination of spectroscopic, chemical, and chromatographic analyses.

INTRODUCTION

In my survey of newer oil seeds for augmenting oil and protein resources I have come across *Brachychiton rupestris*, *B. australis*, *B. acuminatus*. and *B. gregori* (Sterculiaceae). Some of the *Brachychiton* species plants are used in indigenous food (James and Forbes-Ewan, 1982), while others are cultivated as ornamentals. Seed oils of the Sterculiaceae, Malvaceae, and Bombacaceae families are reported to contain cyclopropene fatty acids (Smith, 1970), which have adverse biological activity (Phelps et al., 1965; Lee et al., 1971). This paper reports for the first time the fatty acid compositions of *Brachychiton* species seed oils.

MATERIALS AND METHODS

Materials. Seed samples were purchased from Nindethana Seed Service, Woogenilup, Western Australia, Australia.

Methods. *Official and Tentative Methods of the American Oil Chemists' Society* were followed for the determination of moisture, oil, protein, ash contents of the seeds, and acid value and unsaponifiable matter of the oils (AOCS, 1973). The oils were treated with diazomethane to esterify the free fatty acids and then with methanolic sodium methoxide (1.0%) to convert glycerides to methyl esters (Schneider et al., 1968). The methyl esters were qualitatively examined for the presence of hydroxy, epoxy, and cyclopropene fatty acids (CPFA) by the sulfuric acid turbidity test (Lakshminarayana, 1968), Fioriti's picric acid test (Fioriti et al., 1966), the Halphen test (AOCS, 1973), and ultraviolet (UV), infrared (IR), and ^{1}H NMR spectroscopies.

Fatty acid methyl esters from each of the four seed oils responded positively to the Halphen test and hence were treated with anhydrous methanol saturated with silver nitrate for 20 h at ambient temperature to convert CPFA esters into stable ether and keto derivatives for gas–liquid chromatography analysis (Schneider et al., 1968). Other experimental procedures were described in detail in an earlier paper (Sundar Rao and Lakshminarayana, 1984). GLC analysis was carried out by using a Hewlett-Packard 5840A unit fitted with a flame ionization detector (FID) and a data processor. Helium was used as carrier gas, and the column, injection port, and detector were maintained at 200, 210, and 210 °C, respectively. A polar (BP-20) capillary column (25.0 m × 0.25 mm, SGE Scientific, Melbourne) was used for the analysis. The peaks were identified by comparison with standard fatty acid methyl esters.

RESULTS AND DISCUSSION

The characteristics of the seeds and oils are given in Table I. The oil contents were sufficiently high for economic recovery of oil by solvent extraction. The fatty acid methyl esters from all the samples responded positively to the Halphen test, indicating the presence of

Table I. Characteristics and Fatty Acid Composition of Seeds and Oils of *Brachychiton* Species

	B. rupestris		*B. australis*		*B. acuminatus*		*B. gregori*	
	mean	SD	mean	SD	mean	SD	mean	SD
moisture,[a] %	1.2	0.1	1.5	0.2	2.6	0.2	1.9	0.1
oil,[a,b] %	28.7	1.2	29.6	1.6	32.5	0.9	29.8	0.8
protein,[a,b] %	23.6	1.5	23.5	0.9	22.0	1.1	22.0	0.7
ash,[a,b] %	3.8	0.2	3.1	0.2	4.0	0.1	4.6	0.2
acid value[a]	2.3	0.4	4.7	0.2	3.2	0.0	3.9	0.3
unsaponifiable matter[a]	4.0	0.3	4.8	0.4	2.5	0.2	1.4	0.1
fatty acids,[a] area %								
14:0	0.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0
16:0	15.3	0.6	18.9	0.4	20.0	0.8	14.9	0.8
16:1	0.4	0.6	0.7	0.2	0.9	0.0	1.3	0.5
17:1	0.7	0.0	0.6	0.0	0.9	0.1	0.5	0.1
18:0	2.7	0.4	3.1	0.4	2.9	0.6	2.0	0.4
18:1	26.3	0.6	27.6	0.3	36.2	0.1	28.5	0.7
18:2	41.2	0.4	37.9	0.1	30.2	0.7	38.7	0.9
18:3	0.6	0.2	1.0	0.2	0.7	0.2	1.0	0.4
20:0	0.4	0.0	0.2	0.0	0.2	0.0	0.2	0.0
20:1	0.0	0.0	0.2	0.0	0.2	0.0	0.1	0.0
malvalic[c]	8.7	0.1	8.0	0.1	6.6	0.1	10.6	0.0
sterculic[c]	2.2	0.0	1.2	0.0	0.5	0.2	1.8	0.1
dihydrosterculic	tr	0.0	tr	0.0	tr	0.0	tr	0.0
unknown	1.2	0.3	0.4	0.0	0.5	0.0	0.3	0.0

[a] Average of two determinations of each composite sample. [b] Dry basis. [c] Ether plus keto derivatives.

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CPFA. The IR spectra showed a band at 1008 cm^{-1} and the NMR spectra a signal at 9.2τ, characteristic of the cyclopropene moiety. The sulfuric acid turbidity test, picric acid test, and IR spectra did not indicate the presence of hydroxy and epoxy fatty acids. The UV and IR spectra showed no conjugation or trans unsaturation.

The fatty acid compositions are also presented in Table I. Linoleic acid was predominant (37.9–41.2%) except in *B. acuminatus*, in which oleic acid (36.2%) was the major component. Appreciable concentrations of palmitic acid were found in all the seed oils (14.9–20.0%). The total concentration of the CPFA varied from 7.1 to 12.4%. In each case, a greater amount of malvalic acid was present than sterculic acid. The fatty acid compositions of the seed oils of the four *Brachychiton* species of the Sterculiaceae family studied in this investigation fit into this general pattern and resemble those of other *Brachychiton* species (Sundar Rao et al., 1989).

LITERATURE CITED

AOCS. *Official Methods and Recommended Practices of the American Oil Chemists' Society*; Link, W. E., Ed.; AOCS: Champaign, IL, 1958 (revised 1973).

Fioriti, J. A.; Bertz, A. P.; Sims, R. J. The reaction of Picric Acid with Epoxides II. The Detection of Epoxides in Heated Oils. *J. Am. Oil Chem. Soc.* **1966**, *43*, 487–488.

James, K. W.; Forbes-Ewan, C. H. In *Nutritional Evaluation of Survival Foods*; Conference of the Commonwealth Defence Science Organization, Australia, May 1982, Food Study Group papers; Australian Government Publishing Service: Canberra: 1982; pp 345–365.

Lakshminarayana, G. Applicability of the Turbidity Test for Castor Oil to some other Hydroxy - and Epoxy - Fatty compounds. *J. Am. Oil Chem. Soc.* **1968**, *45*, 523–524.

Lee, D. J.; Wales, J. H.; Sinnhuber, R. O. Promotion of Aflatoxin-Induced Hepatoma Growths in Trout by Methyl Malvalate and Sterculate. *Cancer Res.* **1971**, *31*, 960–962.

Phelps, R. A.; Shenstone, F. S.; Kemmerer, A. R.; Evans, R. J. A Review of Cyclopropenoid Compounds: Biological Effects of Some Derivatives. *Poult. Sci.* **1965**, *44*, 358–394.

Schneider, E. L.; Loke, S. P.; Hopkins, D. T. Gas-Liquid Chromatographic Analysis of Cyclopropenoid Fatty Acids. *J. Am. Oil Chem. Soc.* **1968**, *45*, 585–590.

Smith, C. R., Jr. *Progress in the Chemistry of Fats and Other Lipids*; Pergamon Press: New York, 1970; pp 139–177.

Sundar Rao, K.; Lakshminarayana, G. Characteristics and Composition of Six Malvaceae Seeds and the Oils. *J. Am. Oil Chem. Soc.* **1984**, *61*, 1345–1346.

Sundar Rao, K.; Jones, G. P.; Rivett, D. E.; Tucker, D. J. Fatty Acid and Amino Acid Compositions of *Brachychiton discolor*, *Brachychiton diversifolius*, and *Brachychiton acerifolius* Seeds. *J. Agric. Food Chem.* **1989**, *37*, 916–917.

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Registry No. Oleic acid, 112-80-1; linoleic acid, 60-33-3; sterculic acid, 738-87-4; malvalic acid, 503-05-9; dihydrosterculic acid, 5711-28-4.