Fatty Acid and Amino Acid Compositions of *Brachychiton discolor*, *Brachychiton diversifolius*, and *Brachychiton acerifolius* Seeds

Koyyalamudi Sundar Rao,* Gwyn P. Jones, Donald E. Rivett, and Daryl J. Tucker

The oil contents in seeds of *Brachychiton discolor*, *Brachychiton diversifolius*, and *Brachychiton acerifolius* (Sterculiaceae) were 29.3, 32.1, and 30.5%, respectively. Linoleic and oleic acids were the predominant fatty acids in the triacylglycerols. Cyclopropene fatty acids, malvalic and sterculic, were present in small concentrations (4.6–5.6%, 0.7–1.1%). The protein contents of the three seeds were 26.9, 38.1, and 35.0%, respectively. Amino acid analysis showed that the proteins contained nutritionally useful quantities of most of the essential amino acids except for those containing sulfur.

Cyclopropene fatty acids (CPFA) are constituents of seed oils in the botanical families Sterculiaceae, Malvaceae, and Bombacaceae (Smith, 1970), which have been shown in animal feeding trials to have adverse biological effects (Phelps et al., 1965; Lee et al., 1971). However, seeds of one *Brachychiton* species, *Brachychiton diversifolius*, are indigenous food eaten by Australian Aborigines (James and Forbes-Ewan, 1982). This paper reports for the first time the fatty acid and amino acid compositions of *B. diversifolius*, *Brachychiton discolor*, and *Brachychiton acerifolius* seeds.

MATERIALS AND METHODS

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

Methods. Standard methods were used to deterimine moisture, oil, protein, and ash contents (AOCS, 1973). Fatty acid methyl esters were prepared by treatment of the oil with methanolic sodium methoxide (Schneider et al., 1968). The oils and methyl esters were qualitatively examined for the presence of hydroxy, epoxy, and CPFA components 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 spectroscopy.

Fatty acid methyl esters from each of the three 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 into stable ether and keto derivatives for analysis by gas–liquid chromatography (GLC). GLC was carried out on a Varian 3700 chromatoraph fitted with a flame ionization detector and data processor. Helium was used as carrier gas, and the column, injection port, and detector were maintained at 200, 240, and 280 °C, respectively. A polar (BP-20) capillary column (12.0 m × 0.25 mm; SGE Scientific, Melbourne) was employed to separate the esters. Peaks of the usual acids were identified by comparison of retention times with those of commercially available fatty acid methyl esters. CPFA methyl esters were identified by comparison of retention times with those of authentic CPFA. The latter were isolated from *Lagunaria patersonii* seed oil methyl esters by alumina column chromatography (Schneider et al., 1968) and their structures established by IR and ^{1}H NMR. Dihydrosterculic acid was separated by argentation thin-layer chromatography and estimated by GLC (Sundar Rao and Lakshminarayana, 1984).

Amino acid analysis was conducted on defatted, comminuted seeds. These were heated in sealed glass tubes containing 6 M HCl for 24 h at 110 °C. The hydrolysates were chromatographed on a Waters (Milford, MA) computer-controlled ion-exchange high-pressure liquid chromatography amino acid analysis system using two buffers at pH 2.9 and 6.5.

School of Sciences, Deakin University, Geelong, Victoria, 3217, Australia (K.S.R., G.P.J., D.J.T.), and CSIRO Division of Wool Technology, 343 Royal Parade, Parkville, Victoria, 3052, Australia (D.E.R.).

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

	B. discolor	*B. diversifolius*	*B. acerifolius*
moisture, %	3.7	2.0	4.2
oil,[a] %	29.3	32.1	30.5
protein,[a] %	26.9	38.1	35.0
ash,[a] %	4.7	5.7	5.0
unsaponifiable matter	2.7	4.2	4.8
fatty acids,[b] wt %			
16:0	13.8	18.8	19.5
16:1	0.5	0.5	0.2
18:0	0.9	1.1	0.3
18:1	31.6	28.6	37.8
18:2	46.7	43.1	34.6
18:3	1.1	1.1	0.6
20:0	0.4	0.4	0.8
20:1	0.2	0.1	0.2
malvalic[c]	5.6	4.9	4.6
sterculic	0.9	0.7	0.1
dihydrosterculic	0.3	0.7	0.3

[a] Dry basis. [b] Expressed as mean of duplicated values (GLC analysis varied within 10% for minor components found at levels less than 5% of the total and within 3% for others). [c] Ether plus keto derivatives.

RESULTS AND DISCUSSION

Fatty Acid Composition. Proximate and fatty acid compositions of the seeds are given in Table I. The oil and protein contents are appreciable compared with those of conventional oil seeds. The oils from all the three samples responded positively to the Halphen test, indicating the presence of CPFA. This was further confirmed by an IR band at 1008 cm^{-1} and an NMR signal at δ 0.8. No other unusual fatty acids were identified. The predominant fatty acids were linoleic, oleic, and palmitic. Total CPFA constituents varied from 5.6 to 6.5%. Malvalic acid was present in greater amounts than sterculic acid, an unexpected finding since *Brachychiton* species being members of the family Sterculiaceae may be expected to have more sterculic than malvalic acid. Dihydrosterculic acid was found only in very small amounts (0.3–0.7%). The presence of CPFA in these three seeds is consistent with their general distribution in Malvaceae Bombacaceae, and Sterculaceae families (Smith, 1970).

Amino Acid Composition. The amino acid compositions of these seeds are given in Table II. Compared with the WHO recommended pattern for an ideal dietary protein (WHO, 1973), the three seeds are good sources of most essential amino acids with the exception of cystine and methionine. For example, they all contain an appreciable concentration of lysine compared to conventional food

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Table II. Amino Acid Composition (mol %) of Proteins in *Brachychiton spp.*

amino acid	*B. discolor*	*B. diversifolius*	*B. acerifolius*
Asp	9.37	9.12	8.96
Thr	3.33	3.20	3.27
Ser	5.60	3.20	5.56
Glu	14.0	16.4	14.3
Pro	3.83	3.68	4.39
Gly	6.86	6.41	6.26
Ala	6.20	5.65	5.43
$^1/_2$Cys	0.87	1.05	1.05
Val	5.09	5.39	5.11
Met	1.24	1.44	1.07
Ile	3.52	3.64	3.59
Leu	6.29	6.38	5.85
Tyr	2.14	1.85	2.09
Phe	3.29	3.12	3.32
His	1.86	1.71	1.59
Lys	4.89	5.31	5.18
ammonia	11.6	12.3	11.2
Arg	9.95	7.41	11.9

crops such as soybeans, indicating their potential for future utilization as feed supplements. The values obtained for methionine and cystine are perhaps lower than the actual content since a small proportion of these acids could have been oxidized during acid hydrolysis and not shown in the chromatographic analysis. The edibility of the seed proteins and possible toxicity have yet to be ascertained.

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

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Overestimation of the Cholesterol Content of Eggs

R. Scott Beyer and Leo S. Jensen*

The current estimate of the cholesterol of eggs is based primarily on data obtained by colorimetric determinations, which are subject to interference from non-cholesterol substances. Studies were conducted to evaluate the cholesterol content of eggs by the use of high-performance liquid chromatography (HPLC) and to compare this method to a commonly used colorimetric procedure. The HPLC method resulted in a cholesterol content of 10.97 mg of cholesterol/g of wet yolk compared to 13.86 mg/g of wet yolk estimated by the colorimetric method on saponified yolk extracts. Recovery of added cholesterol to yolk samples was nearly quantitative. Separation of the cholesterol from the remaining unsaponifiable yolk fraction by HPLC revealed that 17.5% of the chromogens present in the colorimetric assay were in the non-cholesterol fraction. A reevaluation of the cholesterol content of eggs should be conducted using methods based upon prepurification of the cholesterol fraction from interfering chromogens prior to detection.

High blood plasma levels of cholesterol have long been associated wtih increased incidence of coronary heart disease in humans. Although the role of dietary consumption of cholesterol in heart disease is subject to considerable debate, consumer interest in lowering blood cholesterol levels has contributed to a steady decrease in the consumption of eggs and egg products. The estimated cholesterol content of 274 mg/egg set by the Consumer and Food Economics Institute of the U.S. Department of Agriculture (1976) is used as the current standard by the medical community to determine the recommended daily intake of cholesterol. This value was obtained by the compilation of data from various published and unpublished investigations prior to the last revision of this handbook in 1976, before more precise methods of cholesterol determination had become available.

Colorimetric determinations have been commonly used in the past to determine the cholesterol content of eggs although the absence of interfering compounds, which may increase the apparent cholesterol concentration, has not

Department of Poultry Science, University of Georgia, Athens, Georgia 30602.

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