

octadecadienic and octadecatrienic acids formed during the Kraft process, was very satisfactory. This stationary phase therefore seems very well suited to analyze the complex changes in fatty and resin acid composition during tall oil isolation and distillation processes. More detailed information on these isomerization and disproportionation reactions will be reported in a forthcoming publication.

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✂ Fatty Acid Composition and Cyclopropene Fatty Acid Content of China-Chestnuts (*Sterculia monosperma*, Ventenat)

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ABSTRACT

The China-chestnuts (*Sterculia monosperma*, Ventenat) were examined for their fatty acid composition by gas liquid chromatography, infrared and nuclear magnetic resonance spectroscopy. The oil in nuts contained cyclopropene fatty acids (CPFA) determined as silver nitrate derivatives of their esters. The values (area %) for the major fatty acids as methyl esters were 23.47% C16:0, 1.25% C16:1, 2.56% C18:0, 24.89% C18:1, 18.24% C18:2, 5.40% dihydrosterculic, 3.21% C18:3 + C20:0 and 19.15% sterculic. The proportion of CPFA in the oil did not decrease upon cooking the nuts.

INTRODUCTION

Sterculia monosperma, Ventenat (China-chestnut) is a small evergreen tree found in the home gardens of Chinese people in Malaysia. The ripe fruits are scarlet-colored pods containing 1 to 3 glossy black nuts. The nuts are oblong shaped measuring 1 to 3 cm long and 1.5 to 2.5 cm wide. Each nut contains a mealy kernel surrounded by 3 layers of skin with a black sticky resinous substance on the outermost shell. The nuts are consumed after boiling or roasting and removing the 3 outer skins, and are reported to taste pleasant, resembling the European chestnut (1).

The chemical composition of these nuts has not been investigated. As they belong to the family *Sterculiaceae*, they may contain cyclopropene fatty acids (CPFA) in their oil. The adverse physiological effects of CPFA in experimental animals are well documented (2,3). Sinnhuber and coworkers (4,5) have found these fatty acids to be carcinogenic in rainbow trout, and atherosclerotic to rabbits. Of the 2 CPFA, sterculic and malvalic acids, the sterculic has

been reported to exhibit higher biological activity in animals (2,6,7). In view of these reports, this study was prompted to examine China-chestnuts for their fatty acid composition and CPFA content.

EXPERIMENTAL PROCEDURES

Materials

China-chestnuts and *Sterculia foetida* L. seeds were procured locally. Methyl fatty acid ester standards were obtained through Sigma Chemical Co., St. Louis, MO. Sodium methoxide reagent (0.5 N) was purchased from Supelco, Inc., Bellefonte, PA. All other reagents required for analyses were of analytical grade.

Extraction of Oil and Analyses

Fresh, whole nuts were weighed and average nut weight calculated. The nuts were then divided into 2 equal portions of which one portion was boiled in distilled water for 40 min. All the nuts were dried in the oven at 45°C. The dried nuts were shelled manually, and kernel-to-shell ratio was calculated. The kernels were pulverized in a mortar and extracted for oil as described previously (8). The moisture and protein content of kernels were determined according to AOAC (9) procedures 7.008 and 2.049, respectively.

The Halphen color test, preparation of methyl esters plus argentation, infrared (IR) and nuclear magnetic resonance (NMR) spectroscopies and gas chromatographic (GC) analyses of the mixture of normal fatty acid methyl esters and CPFA ester derivatives were done as described elsewhere (8).

RESULTS AND DISCUSSION

Seed Composition

A fresh China-chestnut weighs ca. 4 g (average), of which ca. 59% by wt is kernel. The kernels were found to be a fair source of protein and essential fatty acids, but they contained cyclopropene fatty acids in their oil (Table I).

Fatty Acid Composition

The oil from both raw and cooked nuts responded positively to the Halphen color test, indicating the presence of CPFA. The oil fatty acid methyl esters exhibited the characteristic IR band for cyclopropene (CP) moiety at 1008 cm^{-1} , and a pronounced signal in the NMR spectrum at 9.28 τ , which represents the CP group.

The GC peaks of normal fatty acid methyl esters and CPFA ester derivatives were identified as described previously (8). The oil fatty acid composition of both raw and cooked nuts is presented in Table I. The ratio of malvalic to sterculic acid was found to be ca. 1:49. In most plant oils containing CPFA, malvalic acid has been found to predominate over sterculic acid (2). But, as in *S. foetida* seeds, the concentration of sterculic acid in China-chestnuts is much higher than that of malvalic acid. Of the cyclopropene fatty acids, dihydrosterculate, measuring 5.4% of the total fatty acids, appeared as a partially resolved peak and was identified as already described.

The effect of heat on CPFA has been described elsewhere (8).

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TABLE I

Analytical Data on China-Chestnut and Its Oil

Property	Value ^a	
	Raw nuts	Boiled nuts
Composition (%) ^b		
Moisture	9.67	ND
Crude oil	3.09	ND
Protein (N \times 6.25)	10.00	ND
Fatty acid composition (area %)		
14:0 ^c	0.15	0.18
15:0 ^d	0.19	0.16
15:1 ^d	0.26	0.31
16:0	23.47	22.30
16:1	1.25	1.35
17:0	0.17	0.16
17:1 ^d	0.73	0.69
18:0	2.56	2.12
18:1	24.89	22.62
18:2	18.24	19.79
Dihydrosterculic	5.40	5.17
18:3 + 20:0	3.21	3.17
Malvalic	0.39	0.61
Sterculic	19.15	21.39

^aAverage of 3 determinations.

^bOven-dried basis

^cNo. carbons no. double bonds.

^dTentative identification.

ND-not determined

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