Fatty Acid and Glyceride Composition of *Jubaea spectabilis* Palm Oil

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ABSTRACT

Determination of the fatty acid distribution in three samples of oil from the kernels of the palm *Jubaea spectabilis* shows that the uniquely low melting point of the oil is due to a higher content of shorter chain fatty acids than other members of the subclass *Cocoideae.*

INTRODUCTION

The palm, *Jubaea spectabilis [J. chinensis,* fam. Palmae, subclass *Cocoideae* (1)], native to certain parts of Chile, but subject to suitability of climate, able to grow in other parts of the world, is the only species of the genus *Jubaea.* Anatomical and morphological features are in accord with the rather restricted distribution (2). The fruit, (average weight ca. 7.5 g) has been described as a miniature coconut (3). The oil from the kernels is unique for an oil from the family Palmae because it remains fluid at low temperatures. The present work provides an exercise in taxonomy in correlating the classification of the palm with the composition of the oil.

EXPERIMENTAL

The samples, from which damaged material was removed, were obtained from two States of Australia (Royal Botanic Gardens, Sydney, N.S.W., and the Botanic Gardens, Adelaide, South Australia) and from Chile, South America. Oil was obtained from the dry kernels by soxhlet extraction with light petroleum (b.p. 40–60 C) for 4 hr.

Analytical constants were determined by standard methods. Gas liquid chromatography of fatty acid methyl esters prepared by the boron trifluoride-methanol method (4,5) was carried out at 180 C with a glass column (180 x 0.6 cm) of 20% ethyleneglycol succinate on Chromasorb W (100/120 mesh) previously treated with hexamethyldisilazane. Esters were identified by cochromatography with reference materials. Peak areas of methyl myristate, present in intermediate amount, were used to correlate areas of all peaks (6) and ultimate calculation of relative peak areas (7). Weight per cent of each methyl ester was calculated with the carbon number correction factors (8).

Gas liquid chromatography of the triglycerides was carried out by applying a 10% solution of the oil in carbon disulfide to a stainless steel column (30 x 0.6 cm) of 1% SE-30 on Celite 545, previously acid washed and treated with hexamethyldisilazane. The chromatography, with injection temperature at 320 C, was programmed from 150 to 350 C at 6 C/min following 4 min holding time at lowest temperature. Peak areas were automatically counted by an integrator.

Hydrolysis of lipase at 40 C in N-tris buffer (pH 8) used a bile salt suspension of the oil in the presence of calcium chloride and freshly prepared suspension of pancreatin (9). Digestion, carried on until 50 ± 5% hydrolysis (10), was stopped by the addition of hydrochloric acid-ethanol. An ether extract of the hydrolyzate was fractionated on a column of silica gel using benzene, benzene/ether, (9:1) and ether for the elution of tri-, di-, and monoglycerides respectively (11). Fatty acids were separated from the monoglyceride fraction by the addition of a slurry in ether of Dowex 2X8 anion exchange resin in hydroxyl form. Each

TABLE I

Analytical Data on *Jubea spectabilis* Oils

	Jubea oils						*Cocoideae* oils	
	N.S.W.		South Australia		Chile		*Cocois mecifora*	*Elaeis guinaensis*
Fatty acids	Wt %	Mole %	Wt %	Mole %	Wt %	Mole %	Mole %	Mole %
$C_{6:0}$	1.9	2.86	1.5	2.4	2.1	3.4	0.6	0.4
$C_{8:0}$	17.5	22.2	14.5	18.9	13.4	17.7	10.1	5.9
$C_{10:0}$	19.0	20.4	17.3	19.2	15.9	17.9	6.8	4.8
$C_{12:0}$	43.5	40.7	44.8	43.2	41.3	40.3	47.7	53.9
$C_{14:0}$	4.9	4.8	6.1	5.1	7.4	6.4	18.8	16.2
$C_{16:0}$	2.8	2.1	3.1	2.4	4.0	3.1	7.9	6.6
$C_{18:0}$	1.6	1.1	1.4	0.9	1.8	1.3	2.0	1.7
$C_{18:1}$	7.4	5.0	9.7	6.8	12.0	8.5	4.7	8.9
$C_{18:2}$	1.4	0.9	1.6	1.1	2.1	1.5	1.4	1.6
Whole nuts Shell %	53.5		57.5		57.0			
Kernel %	41.5		42.5		43.0			
Kernel Moisture %	11.6		12.1		12.6			
Oil %	54.8		51.1		52.5			
Refractive index (40 C)	1.4437		1.4462		1.4480			
Saponification value	265		271		268			
Iodine value	9.1		11.4		14.8			

TABLE II

Fatty Acid Distribution in 2-Monoglycerides from *Jubaea spectabilis* Oil (Chile)

Fatty acid	Wt %	Mole %	Enrichment factor E[a]	Molar % of acid at 2-position[b]
$C_{6:0}$	0.45	0.75	0.22	7.4
$C_{8:0}$	5.8	8.0	0.453	15.1
$C_{10:0}$	16.4	19.1	1.067	35.6
$C_{12:0}$	52.2	52.9	1.312	43.7
$C_{14:0}$	4.4	3.9	0.611	20.4
$C_{16:0}$	1.5	1.2	0.383	12.8
$C_{18:0}$	0.3	0.2	0.164	5.5
$C_{18:1}$	15.7	11.5	1.354	45.1
$C_{18:2}$	3.3	2.5	1.662	55.4

$$a_E = \frac{\text{Mole \% at 2-position of triglycerides}}{\text{Mole \% of same acid in total triglycerides}}$$

[b]Molar % acid at 2-position

$$= \frac{\text{Mole \% of acid in monoglyceride}}{\text{Mole \% of same acid in triglyceride x 3}} \times 100$$

fraction thus prepared was checked for purity by thin layer chromatography on Silica Gel G plates using light petroleum/ether (3:2) as developing solvent (12) followed by sulfuric acid treatment for location of spots. Fatty acids of the monoglyceride fraction were converted to methyl esters as described above.

RESULTS AND DISCUSSION

Palm kernels from the subfamily *Cocoideae* are distinguished by high oil content. In the present work, three *Jubaea* samples from different sources had similar analytical constants and fatty acid compositions (Table I).

Kernel oils of the *Cocoideae* have hitherto been noteworthy for a much higher content of C_{12} acid and a lower content of unsaturated acids than are present in oils from the *Arecoideae, Coryphoideae* and *Phyoeicoideae* groups (13). Within the *Cocoideae* subfamily itself, the *Jubaea* oils can now be distinguished from other members by higher saponification, Reichert-Meissl and Polenské values and by lower melting points. The basis for this uniqueness is evident from Table I, which shows the oils with much higher content of C_8 and C_{10} acids and lower content of C_{12} and more markedly, of C_{14} and C_{16} acids. Indeed the novelty of composition of the *Jubaea* oils is that low molecular weight acids (C_{8-12}) constitute the major portion of the total fatty acid mixture.

Information regarding the 2-monoglycerides of the Chilean oil is given in Table II with the composition of triglycerides given in Table III. Despite the general similarity of the present oils, the Chilean sample was distinguished by a slightly lower content of C_8 and C_{10} acids and higher content of $C_{18:1}$ and $C_{18:2}$ acids than the Australian oils.

The enrichment factors (Table II) show that the *Jubaea* oils maintain the tendency of all members of the *Cocoideae* for unsaturated acids to appear at the 2-position—to the extent of 45 mole % and 55 mole % for the $C_{18:1}$ and $C_{18:2}$ acids, respectively. An approximately symmetrical distribution of enrichment factors appears for the saturated acids at this position, with the peak value 1.312 for C_{12} acid. This value, taken with that for the C_{10} acid (1.07) and, to a lesser degree, with the C_8 value, represents a greater enrichment with short chain acids. With other members of the *Cocoideae*, greater enrichment occurs with C_{12} and C_{14} acids (13).

A gas liquid chromatogram of the triglycerides was in accordance with fatty acid content and distribution, and was different from those recorded for palm kernel oil (14) and for coconut oil (15). The recognizable concentration of 24-C glycerides again reflects the greater abundance of lower molecular weight acids, and the dimensions of the 26-C and 28-C peaks provide a marked contrast with the levels of these peaks from the other oils, where recognizable peaks start with 26-C for the coconut oil and at 30-C for the palm kernel oil (Fig. 1).

TABLE III

Triglyceride Distribution According to Carbon Number in *Jubaea spectabilis* Oil (Chile).

Triglyceride	Wt %	Mole %
24-C	0.22	0.29
26	1.76	2.14
28	9.37	10.83
30	14.96	16.39
32	22.38	22.36
34	15.61	15.55
36	10.90	10.37
38	8.62	7.86
40	4.76	4.17
42	3.72	3.13
44	2.41	1.96
46	1.58	1.23
48	1.98	1.49
50	0.71	0.51
52	0.52	0.37
54	0.50	0.35

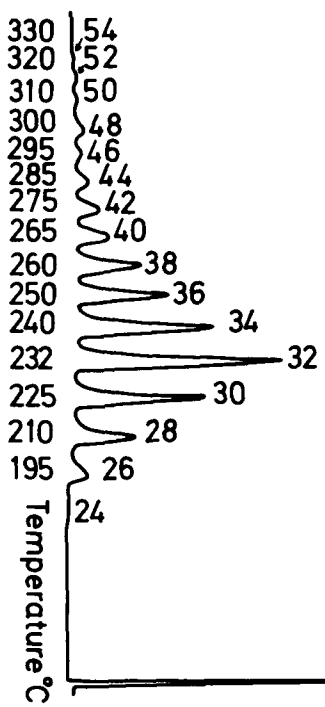

FIG. 1. Gas chromatography of the triglycerides of *Jubea spectabilis* palm oil. The numbers on the peaks refer to the C-no. of the triglycerides.

ACKNOWLEDGMENT

A.-S. Sheikh acknowledges the award of a Senior Fellowship by the Australian Government under the Colombo Plan.

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[Received July 30, 1970]

Volatile Components from Trilinolein Heated in Air

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ABSTRACT

Pure trilinolein and mixtures of trilinolein-tristearin, trilinolein-triolein, and trilinolein-triolein-tristearin were heated to 192 C in air. Volatiles were collected, separated, and identified by gas chromatography-mass spectrometry. Major volatiles observed from each heated sample produced compounds unique to the autoxidation-decomposition of the trilinolein component and included: pentane, acrolein, pentanal, 1-pentanol, hexanal, 2- and/or 3-hexenal, 2-heptenal, 2-octenal, 2,4-decadienal, and 4,5-epoxydec-2-enal. When samples containing both trilinolein and triolein were heated, volatiles were produced that could be ascribed to each triglyceride. However, heated mixtures containing tristearin produced no observable volatiles that could be related to the oxidized saturated triglyceride. Minor volatiles identified from the heated trilinolein and its mixtures included; aliphatic acids, saturated and unsaturated aldehydes, primary and secondary alcohols, gamma lactones, furans, hydrocarbons, and methyl ketones.

INTRODUCTION

Soybean oil, which has linoleic acid as its major constituent (51-55%), is an important source for cooking oils in domestic markets. However, the oil is less important in foreign markets where differences in culture backgrounds result in objections to its use. These objections arise from volatile compounds and resulting unfamiliar odors produced by heated soybean oil which we are currently investigating.

Linoleic acid and its esters have been examined extensively as oxidizable substrates to form hydroperoxides (1-4) and as precursors of volatile decomposition products (5-23). The emphasis on linoleic acid may be attributed to its relatively high susceptibility to oxidation, 10-100 times greater than that of monoene or saturated isologues (1,7,24), and to its greater abundance in edible fats and oils than the more reactive triene isologue (25). In the majority of the volatile decomposition studies, either a single class of compounds was isolated and analyzed or investigations centered on those volatiles (aldehydes and ketones) that formed 2,4-dinitrophenylhydrazine (DNPH) derivatives.

In contrast to prior approaches, excepting that of Thompson et al. (18), our research involves the collection and identification of *all* classes of volatiles that develop when soybean oil is heated to cooking oil temperature (185-200 C). To avoid the complications in results that would arise from a mixture of the unsaturated fatty acids in soybean oil, pure triglycerides of each of the major fatty acids of SBO are used for our heated oil-volatile compound study. Previously, we characterized volatiles from heated tristearin (26), triolein (27), and thermally decomposed methyl oleate hydroperoxides (28). This paper reports our results with trilinolein and various triglyceride mixtures containing trilinolein when heated to 192 C in air.

EXPERIMENTAL PROCEDURES

Trilinolein and triolein were purchased from the Nu-Check-Prep., Inc. (Elysian, MN). Thin layer chromatography (TLC), described below, indicated a slight impurity in the trilinolein but none in the triolein. The trilinolein was purified by liquid chromatography (Silica gel.– hexane solvent), whereupon the purified material had only a single spot on further TLC analysis. Triolein was deodorized at 1 mm pressure for 1.5 hr at 185-220 C prior to use. Tristearin was purchased from Anderson Claton Foods, Jacksonville, IL, purified by three recrystallizations from acetone, and deodorized as above.

Fatty acid compositions [by gas liquid chromatography (GC) of methyl esters prepared from the triglycerides] of each of the three model triglycerides were: purified trilinolein – 99.8% linoleic, 0.03% palmitic, 0.06% oleic, and 0.1% linolenic; triolein – 98.9% oleic, 0.7% stearic, 0.1% palmitic, 0.1% linoleic, and 0.2% linolenic; tristearin – 88.9% stearic and 11.1% palmitic. Neither trilinolein nor triolein had UV absorption at 233 mm (conjugated diene); however, trilinolein had 0.18% conjugated triene, calculated from absorption at 268 nm (29). None of the three model triglycerides contained isolated *trans* double bonds (no infrared isolated *trans* absorption at 962 cm^{-1} from prepared methyl esters), free fatty acids (by titration with NaOH), or mono- or diglycerides (by TLC, Kieselgel 60 F-254 precoated-0.25 mm thick-Silica Gel TLC plates developed in petroleum ether/diethyl ether/acetic acid mixture, 70:25:5).