The Triglyceride Composition of *Butea monosperma* Seed Oil

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ABSTRACT

Fatty acid and triglyceride composition of *Butea monosperma* seed oil have been determined by a combination of the techniques of systematic crystallization at low temperature, pancreatic lipase hydrolysis, and gas chromatography. The percentages of individual fatty acids are: myristic 0.2, palmitic 19.3, stearic 7.4, arachidic 1.8, behenic 14.0, lignoceric 6.2, oleic 21.8, linoleic 27.8, and linolenic 1.7. *B. monosperma* seed oil is constituted of SSS 3.8, SSU 3.9, SUS 40.9, USU 0.9, SUU 40.4 and UUU 10.1%. Chief component glycerides are PLL 5.8, PLB 5.2, POL 4.8, POB 4.2, PLP 4.0, PLO 3.8, BLL 3.6, POP 3.3, PLST 3.2, and POO 3.0%. *B. monosperma* seed oil, on segregation by low temperature crystallization yielded two major fractions, each representing 30% of the total. One of them is richer in the content of SSS and SUS while the other is richer in UUU and SUU. Compositions of these fractions suggest the possibility of utilization of one as an ointment base and the other as a solvent for drugs.

INTRODUCTION

The species *Butea monosperma* (Family, *Leguminosae*) is a medium sized deciduous tree common throughout India upto an altitude of 4000 ft. This species (common name, Palas) flowers at the beginning of the hot season. The pod contains a single seed (1 in. to 3/4 in. long) at its apex. Yield of seeds per tree is about 200 g (1). In India, demand for palas seeds as a commercial source of vegetable oil has increased considerably since 1974. A few hundred tons of palas seeds were collected during 1973-74 to explore their potential utility (2).

The species *B. monosperma* belongs to the subdivision *Papilionatae*. Oils of this subdivision are usually rich in unsaturated acids, chief components being oleic and linoleic (60 to 80%) acids (3). Some of these oils contain 30 to 40% linoleic acid while in others oleic acid is present in greater proportions. Linolenic acid appears as a major component only in a few of these oils.

Fatty acid composition of *B. monosperma* seed oil had been differently reported by two groups of workers (4,5). Neither of these compositions, however, agrees with the general characteristics of the seed oils of this subdivision, *Papilionatae*. According to previous reports, *B. monosperma* seed oil contained 20-22% palmitic acid, 9-10% stearic acid, and 13-16% higher saturated acids. Oleic and linoleic acids together amounted to 50-54%. These deviations from the general features and also from each other are significant enough to warrant further investigations. Moreover, triglyceride composition of *B. monosperma* seed oil has not yet been reported. So in our search for less known indigenous seed oils, specially suitable for the pharmaceutical industry, the seed oil of *B. monosperma* was examined becaue of its reported content of high proportions of palmitic and oleic acids and a low proportion of linoleic acid. The present communication reports the fatty acid and triglyceride composition of *B. monosperma* seed oil determined by the combined techniques of low temperature segregation, pancreatic lipase hydrolysis, and gas liquid chromatography (GLC).

EXPERIMENTAL PROCEDURES

B. monosperma seeds were procured from a local com-

TABLE I

Fatty Acid Composition of the Triglycerides and 2-Monoglycerides of *B. monosperma* Seed Oil and Its Different Fractions (A to I)

Fractions[a]	I.V.[b]	Sample	Fatty acid composition (mol %)								
			$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{20:0}$	$C_{22:0}$	$C_{24:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
Seed oil	69.3	TG[c]	0.2	21.7	7.5	1.5	11.8	4.8	22.2	28.5	1.8
		MG[d]	---	7.8	0.8	---	---	---	40.9	50.5	---
A (3.6)	89.6	TG	13.9	14.7	5.6	---	---	---	31.9	32.3	1.6
		MG	---	7.0	1.3	---	---	---	44.3	47.4	---
B (11.8)	97.7	TG	5.4	19.6	2.9	---	1.2	---	32.7	35.3	2.9
		MG	---	7.0	1.2	---	---	---	41.8	50.0	---
C (8.5)	91.3	TG	2.9	24.1	3.7	0.3	1.7	---	31.8	32.9	2.6
		MG	---	7.4	1.4	---	---	---	34.6	56.6	---
D (10.5)	83.2	TG	2.3	24.7	6.2	1.8	3.2	---	27.7	32.4	1.7
		MG	---	8.0	1.1	---	---	---	42.0	48.9	---
E (12.5)	73.2	TG	---	23.2	7.4	3.0	10.6	---	25.8	29.0	1.0
		MG	---	7.3	1.5	---	---	---	42.8	48.4	---
F (16.9)	68.8	TG	---	24.7	7.6	4.2	10.8	---	24.4	28.3	---
		MG	---	7.5	1.4	---	---	---	42.4	48.7	---
G (4.9)	57.6	TG	---	30.4	7.7	3.0	13.8	---	21.8	23.3	---
		MG	---	8.2	1.4	---	---	---	42.6	47.8	---
H (18.5)	46.1	TG	---	20.7	8.6	3.1	20.5	9.2	17.5	20.4	---
		MG	---	8.3	1.5	---	---	---	42.5	47.7	---
I[e] (12.8)	42.5	TG	---	19.0	11.4	4.0	19.9	11.0	14.0	20.7	---
		MG	---	6.4	1.4	---	---	---	41.2	51.0	---
Computed values (A to I)	68.8	TG	1.6	22.3	7.1	2.5	10.8	3.1	24.1	27.5	1.0
		MG	---	7.5	1.4	---	---	---	41.6	49.5	---

[a]Number in parentheses represents wt %.
[b]Iodine value.
[c]Triglycerides.
[d]2-Monoglycerides.
[e]Insoluble residue at 20 C (see ref. 7).

TABLE II

Triglyceride Compositions (mol %) of *B. monosperma* Seed Oil and Its Fractions (A-1)[a]

Fractions[b]	SSS	SSU	SUS	USU	SUU	UUU
Seed oil	3.8	3.9	40.9	0.9	40.4	10.1
A (3.6)	1.8	4.1	20.4	2.4	45.7	25.6
B (11.8)	1.2	3.9	14.2	3.1	44.0	33.6
C (8.5)	1.8	4.3	18.2	2.7	45.1	27.9
D (10.5)	2.5	4.5	25.5	2.1	45.1	20.3
E (12.5)	3.3	4.1	35.1	1.4	43.0	13.1
F (16.9)	4.0	3.8	40.3	1.1	40.5	10.3
G (4.9)	5.7	3.5	54.3	0.4	31.5	4.6
H (18.5)	7.9	1.9	70.3	---	18.8	1.1
I (12.8)	6.9	0.9	81.6	---	10.3	0.3
Computed value (A to I)	4.3	3.3	43.9	1.3	34.0	13.2

[a]S represents saturated fatty acids, U represents unsaturated. The sequence represents that on the glycerine moiety.
[b]Number in parentheses represents wt %.

mercial supplier. On extraction with petroleum ether (40-60 C) the seeds yielded 15.5% of a light yellow oil which solidified at 5 C. On analysis by standard procedures the native seed oil showed the following characteristics: percent free fatty acids (as oleic), 10.9; saponification equivalent, 303.7; iodine value (Wij's 30 min), 69.3; and unsaponifiables, 2.7 wt%. Mixed fatty acids, isolated by standard techniques, had the saponification equivalent and iodine value 290.8 and 73.2, respectively.

The native oil (125 g) as a 50% solution in n-hexane was then refined (6) with alkali to yield 90.3 g of oil (acid value 0.1). Refined seed oil (61 g) was next segregated into nine fractions (A to I) with varying degrees of unsaturation by stepwise crystallization at low temperature (7), commencing the process at -60 C and raising the temperature by 20 C at the second step and by 10 C at subsequent steps.

These fractions (A to I) and the refined oil were analyzed by GLC for their fatty acid composition. GLC of the methyl esters was carried out in an F and M analytical gas chromatograph (Model 700-R-12) with a flame ionization detector. The column (6 ft x ¼ in.), packed with 10% polyester of diethylene glycol adipate on 60-80 mesh Gas Chrom Z, was operated at 166 C with carrier gas flow of 40 ml/min. Peak areas were determined as the product of peak height and the width at half height.

RESULTS AND DISCUSSION

The oil and its nine fractions were all subjected to hydrolysis by pancreatic lipase (8). The resultant 2-monoglycerides were converted into methyl esters by the semimicro method of Luddy et al. (9) and were analyzed by GLC. Wt% compositions were converted into mol % and are shown in Table I.

Triglyceride compositions of the *B. monosperma* seed oil and of its different fractions (A to I) were calculated from the fatty acid compositions (mol %) of the triglycerides and the corresponding 2-monoglycerides using the assumptions of Vander Wal (10) and Coleman (8). Results are given in Table II.

Present and previous findings (4,5) on the fatty acid composition of *B. monosperma* seed oil are given in Table III. These data are in close agreement so far as the contents of palmitic and stearic acids are concerned. But significant deviations are observed in the case of behenic and individual C_{18} unsaturated acids. According to present findings, the content of behenic acids is 14%, while previous workers reported its content as 6%. Parihar and Datta (4) reported that oleic and linoleic acids were present mostly in equal proportions (25.7 and 27.9%), while Badami et al. (5) found the content of oleic acid as 1.5 times that of linoleic acid (31.3% and 19.2%). Present findings, much in parallel to those of Parihar and Datta (4), indicate that *B. monosperma* seed oil contains more of linoleic acid (27.8%) than oleic acid (21.8%). Moreover this oil also contains 1.7% linolenic acid, not reported earlier. Probably these variations in compositions cannot be accounted for by the influence of environmental factors. Present data based on GLC, however, seem more reliable.

Fatty acid composition of the *B. monosperma* seed oil as determined in the present instance also agrees in general with the characteristics of seed oils of the species of the *Papilionatae* subdivision (11-18) specially in the content of myristic (less than 1.0%), palmitic (15-25%), stearic (2.0-9.0%), arachidic (1.0-4.0%), and lignoceric (1.0-6.0%) acids. All these previous reports (11-18) were based upon GLC or spectrophotometry. But deviation becomes prominent in the case of behenic acid. Except *Erythrina indica* seed fat, which is reported to contain 16.0% behenic acid (14), seed fats of this subdivision generally contain 2.5 to 7.0% behenic acid. Whether this high content of 14% behenic acid in *B. monosperma* seed oil is a genetic characteristic needs further investigations. Moreover, according to previous reports (11-18) seed fats of the subdivision *Papilionatae* are generally rich in the content of C_{18} unsaturated acids (75.0 to 85.0%). Exceptions are the seed fats from the genera *Erythrina* (14), *Lens* (12), *Phaseolus* (12,18), and *Vigna* (12,14), where total content of C_{18} unsaturated acids varies within 55 to 65%. The seed fat of the genus *Butea* seems to belong to this second group. But seed fats of the genera *Lespedeza* (14,15), *Phaseolus* (12,18), *Tephrosia* (14), and *Vigna* (12,14) contain considerable amount of linolenic acid (16 to 35%). On the other hand, *B. monosperma* seed oil, in parallel with the seed oils of the genera *Erythrina* (14), *Lens* (12), and *Pongamia* (14,16), is poor in the content of linolenic acid (below 5.0%). Thus fatty acid composition of *B. monosperma* seed oil as determined in the present instance appears to represent the genetic characteristics of the species.

Present investigations based upon low temperature segregation followed by pancreatic lipase hydrolysis, show the seed oil of *B. monosperma* to be composed of SSS 3.8, SSU 3.9, SUS 40.9, USU 0.9, SUU 40.4, and UUU 10.1%. Chief component glycerides are PLL 5.8, PLB 5.2, POL 4.8, POB 4.2, PLP 4.0, PLO 3.8, BLL 3.6, POP 3.3, PLST 3.2, POO 3.0, PLA 2.8, BOL 2.8, POST 2.6, and OLL 2.6%. Since the triglyceride composition of *B. monosperma* oil had not

TABLE III

Fatty Acid Composition of *B. monosperma* Seed Oil

Sample	Fatty acid compositions (wt %)								
	$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{20:0}$	$C_{22:0}$	$C_{24:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
B. monosperma[a]	1.0	20.3	9.5	3.0	7.5	2.5	31.3	19.2	---
B. monosperma[b]	---	21.2	9.1	6.0	5.7	4.4	25.7	27.9	---
Present work	0.2	19.3	7.4	1.6	14.0	6.2	21.8	27.8	1.7

[a]From ref. 4. Contents (wt %) of $C_{8:0}$ 0.9; $C_{10:0}$ 0.7; $C_{12:0}$ 1.3; and oxygenated acids, 2.8, were reported.
[b]From ref. 5.

been reported earlier, present findings are uncomparable.

By low temperature crystallization technique, *B. monosperma* seed oil could be segregated into two major fractions, one richer in SSS and SUS while the other richer in the content of UUU and SUU. The former was obtained by combining the fractions H and I while the latter came from the fractions B, C, and D. Each of these fractions represented 30% of the total. The fraction rich in saturated glycerides may be useful as a base for ointments while the other shows potentiality as a solvent for drugs.

Results of pancreatic lipase hydrolysis of different fractions of *B. monosperma* seed oil agree farily closely with the theory of Gunstone (19) that the 2-position is preferentially esterified with C_{18} unsaturated acids. 2-Position of the glycerine moiety in *B. monosperma* seed oil however, contains about 8% saturated acids ($C_{16:0}$ and $C_{18:0}$).

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