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Phytochemical characterization of *Butea monosperma* seed oil

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A B S T R A C T

The seed oil of *Butea monosperma (Lam.)* Taub was analyzed to establish its physicochemical properties and fatty acids profile as part of an ongoing screening process for plant constituents of nutritional/neutraceutical significance. Physicochemical characteristics showed that the light yellow oil had a refractive index of 1.454 ± 0.003, The iodine value was 64.86 ± 0.06mg iodine/g, saponification value was 138.50 ± 2.97 mg KOH/g, acid value was 11.76± 0.02 mg KOH/g and peroxide value 1.76 ± 0.05mEq/kg. The seed oil was found to contain high level of unsaturated fatty acids ; oleic acid (633.16 ppm), linoleic acid (53.60 ppm) and a high molecular weight fatty acid; Arachidic acid (2436.11 ppm).

Introduction

Butea monosperma (Lam.) Taub (Syn. *Butea frondosa*; Family *Fabaceae*) popularly known as 'dhak' or 'palas' ,commonly known as 'Flame of forest', *palas , mutthuga, bijasneha, khakara, chichara , Bastard teak* , Bengal *kino* (Kirtikar and Basu, 1935) is very widely distributed in India and is used extensively in the folk medicine. Commonly *Butea monosperma* is used as tonic, astringent, aphrodisiac and diuretics (Nadkarni, 2002). Upon compiling the available literature on research work done mainly on physicochemical characterization of oil from the seed of *Butea monosperma*, the present work is planned to fill the niche areas.

Materials and Methods

The seeds *Butea monosperma L.* were collected from local market of Junagadh. Oil was extracted from seeds by soxhlet extraction with hexane as solvent. The extracted oils were dried under reduced pressure in rotary evaporator to remove the solvent.

Oils were stored at -20 ºC and were used for evaluation of acid value, iodine value, peroxide value saponification values, Refractive index and moisture content.

Chemical analysis of *Butea monosperma L.*

Moisture was determined by oven drying at 105°C for 3 hours. Ash and total fat contents were determined according to AOAC (2005). Physicochemical characteristics of *Butea monosperma L.* The ordinary oil constants, e.g., acid value, iodine, saponification, and peroxide number, and refractive index, were also estimated according to the AOAC (2005). The fatty acids profiles were determined by GC-MS. Fatty acid methyl esters were prepared using BF3 methanolic solution and extracted with hexane (Viorica *et al.*,2012)

GC-MS analyses were performed as per method described by Bajaniya *et al.*(2015) with some modification. GC-MS analyses were performed by Food Testing Laboratories using a Shimdzu model QP2010 quadruple mass spectrometer detector. The GC column was a DB-5, 30m, 0.25µ m capillary. The initial column temperature was 60^{o}C. The temperature program was 12 ºC per minute with one minute hold time upto 150 ºC. The final temperature was 240 ^{o}C per minutes with hold time at five minutes and the mass spectrometer detector analyses. The ion source temp was 230 ºC. Interface temp was 240 ºC and the solvent cut time was 2 minutes. For the identification of the compounds the mass spectra of the samples were compared with those of Mass Spectral Library as well as appropriate standards.

Results and Discussion

Oils and fats and their products are rarely delivered completely dry to customers. The solubility of water in common fats and oils is as high as 0.05–0.30% without physical evidence of its presence (Sonntag, 1982). The result of present study showed that the moisture content was less in the oil of *Butea monosperma (Lam.)* Taub (Table 1). Acid value is an important indicator of vegetable oil quality. Acid value is expressed as the amount of KOH (in milligrams) necessary to neutralize free fatty acids contained in 1 g of oil (ISO, 1983). The increase in acid value should be taken as an indicator of oxidation of oil which may lead to gum and sludge formation besides corrosion. The present study showed that oil of *Butea monosperma* (L.) has less acid value (11.76).

The amount of unsaturation of the constituent fatty acids. has been measured by the iodine value. The iodine value of oils can provide very useful information in other scientific fields. For example, iodine value is used for the determination of oil quality of different plant species for the study of the effects of insecticides on plants, and for the determination of the quality of diesel fuel derived from vegetable oils (Misra *et al.*, 1988; Bergman *et al.*, 1989). Although many methods have been developed, the Wijs method is the most widely used as a standard method.

It is difficult to provide a specific guideline relating peroxide value to rancidity. High peroxide values are a definite indication of a rancid fat, but moderate values may be the result of depletion of peroxides after reaching high concentrations. In highly unsaturated fats, even after extensive oxidation, the amounts of peroxide remain low. This is because the peroxides initially formed from unsaturated fats are themselves highly unsaturated and thus unstable and react quickly to values may also be obtained for any extremely rancid value may also be obtained for any extremely rancid products, again because the peroxides initially formed have all undergone further oxidation reactions (Levmore 2004).

Table.1 Physicochemical properties of the *Butea monosperma* (L.) oil

Sr. No.	Different Oil Parameters	Value
1	Moisture content (%)	0.26± 0.01
2	Acid Value(mgKOH/g)	11.76± 0.02
3	Iodine value (I_2/g)	64.86 ± 0.06
4	Peroxide value (m eq Peroxide/Kg)	1.76 ± 0.05
5	Saponification number (mg KOH/g)	138.50 ± 2.97
6	Refractive index value	1.454

Table.2 Quantitative analysis of free fatty acid content in *Butea monosperma* seed oil

Peak	R.Time	Area	Height	Conc. In ppm	Name
1	10.89	331681	131778	13.80	Lauric acid, methyl ester
2	14.30	3154657	1106738	163.93	Myristic acid, methyl ester
3	17.68	115189	28490	15.75	Palmitic acid, methyl ester
4	18.42	2140826	576819	80.29	Palmitoleic acid, methyl ester
5	-	---	--	N.D.	Stearic acid, methyl ester
6	22.13	15020613	2020165	633.16	Oleic acid, methyl ester
7	22.52	1110663	236115	53.60	Linoleic acid, methyl ester
8	23.67	729562	238724	44.37	Linolenic acid, methyl ester
9	25.12	61552315	8649606	2436.11	Arachidic acid methyl ester
10	28.20	393115	71263	48.61	Behenic acid, methyl ester

Fig.1 Chromatogram of GCMS of Butea monosperma seed oil

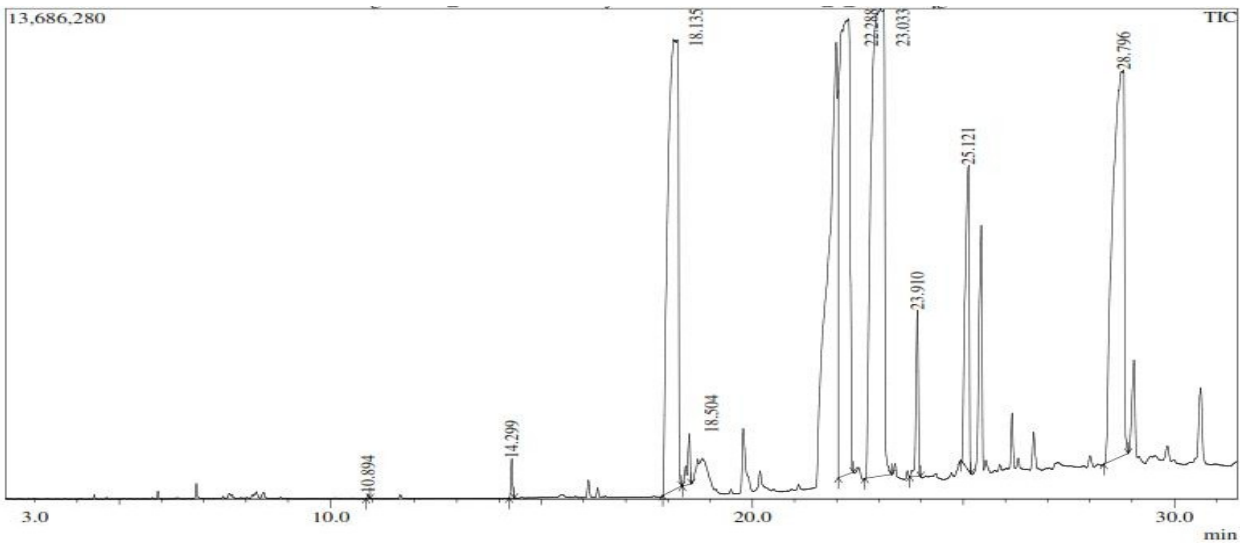

Table.3 Qualitative analysis of free fatty acid content in Butea monosperma seed oil

Sr. No.	Compound Name	SI	Structure	M. W.	R. T.	Area	Height
1.	Dodecanoic acid, methyl ester	94	$C_{13}H_{26}O_2$	214	10.89	272769	123214
2.	Methyl tetradecanoate	95	$C_{15}H_{30}O_2$	242	14.30	3143962	1102605
3.	Pentadecanoic acid, methyl	95	$C_{16}H_{32}O_2$	256	16.12	1576187	488343
4.	5-Octadecenoic acid, methyl	91	$C_{19}H_{36}O_2$	296	16.34	818962	270430
5.	Hexadecanoic acid, methyl ester	96	$C_{17}H_{34}O_2$	270	18.14	212623798	12574981
6.	9-Hexadecenoic acid, methyl	91	$C_{17}H_{32}O_2$	268	18.42	1814930	536156
7.	9-Hexadecenoic acid,methyl	96	$C_{17}H_{32}O_2$	268	18.50	4431012	1408204
8.	9,12-Hexadecadienoic acid, methyl ester	89	$C_{17}H_{30}O_2$	266	19.49	401132	130564
9.	Heptadecanoic acid,methyl ester	95	$C_{18}H_{36}O_2$	284	19.79	10835515	1800477
10.	Cyclopropaneoctanoic acid, 2-hexyl-, methyl ester	93	$C_{18}H_{34}O_2$	282	20.18	1745471	463932
11.	9,12-Octadecadienoic acid, methyl ester	86	$C_{19}H_{34}O_2$	294	21.09	501451	149776
12.	Heptadecanoic acid, 16-methyl-, methyl ester	88	$C_{19}H_{38}O_2$	298	21.99	184209543	12194337
13.	9-Octadecenoic acid (Z)-, methyl ester	93	$C_{19}H_{36}O_2$	296	22.29	225811231	12737909
14.	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	96	$C_{19}H_{34}O_2$	294	23.03	272676512	12862892
15.	14-Pentadecynoic acid, methyl	84	$C_{16}H_{28}O_2$	252	23.38	1050399	328741
16.	10-Nonadecenoic acid, methyl ester	92	$C_{20}H_{38}O_2$	310	23.68	514174	200892
17.	9,12,15- Octadecatrienoic acid, methyl ester	92	$C_{19}H_{32}O_2$	292	23.91	16421815	4536186
18.	Eicosanoic acid, methyl ester	94	$C_{21}H_{42}O_2$	326	25.12	60283689	8605562
19.	11-Eicosenoic acid, methyl ester	93	$C_{21}H_{40}O_2$	324	25.42	34371400	6855543
20.	11,13-Eicosadienoic acid, methyl ester	94	$C_{21}H_{38}O_2$	322	26.16	4818618	1509922
21.	Heneicosanoic acid, methyl	93	$C_{22}H_{44}O_2$	340	26.67	4305074	1047967
22.	Docosanoic acid,methyl ester	93	$C_{23}H_{46}O_2$	354	28.80	203947357	10723240
23.	13-Docosenoic acid, methyl	90	$C_{23}H_{44}O_2$	352	29.04	12869762	2638974
24.	Tricosanoic acid,methyl ester	93	$C_{24}H_{48}O_2$	368	30.62	11847007	2082832

SI-Similarity Index, M. W.-Molecular Weight, R.T.-Retention Time

Saponification of oils is the applied term to the operation in which ethanolic KOH reacts with oil to form glycerol and fatty acids. Glycerol and fatty acids are widely used as raw materials in food, cosmetics, pharmaceutical industries, soap production, synthetic detergents, greases, cosmetics, and several other products. The soap production starting from triglycerides and alkalis is accomplished for more than 2000 years by (Serri *et al.*, 2008; Hermansyah *et al.*, 2006).

The present study showed that oil of *Butea monosperma* (L.) have potential to be used in the cosmetic industries. Most of the physicochemical properties of the studied oils were favorably compared with other conventional seed oils like palm kernel oil, peanut oil, and soyabean oil.

The Fig. 1 and Table 2 representing GC-MS chromatogram and mass spectra, are shown the results obtained for samples of fatty acids from *Butea monosperma* oil and also table 1 have physicochemical characteristics of *Butea monosperma* oil and mass spectrum of lauric acid methyl ester (1), myristic acid methyl ester (2), palmitic acid methyl ester (3), palmitoleic acid methyl ester (4), stearic acid methyl ester (5), oleic acid methyl ester (6), linoleic acid methyl ester (7), linolenic acid methyl ester (8), archidic acid methyl ester (9), and behenic acid methyl ester (10). Predominantly in the composition of saturated fatty acids was Arachidic acid methyl ester (2436.11 ppm) followed by myristic acid, methyl ester (163.93 ppm), also the category of unsaturated fatty acids were oleic acid (633.16 ppm) and linoleic acid observed (53.60 ppm).

A total of 24 components were identified in *Butea monosperma* oil by their retention indices RI, as well as by GC-MS (Table 3). Dodecanoic acid, methyl ester (SI 94%), Methyl tetradecanoate (SI 95%), Pentadecanoic acid, methyl ester (SI 95%), 5-Octadecenoic acid, methyl ester (SI 91%), 5-Octadecenoic acid, methyl ester (SI 96 %), 9-Hexadecenoic acid, methyl ester (SI 91%), 9- Hexadecenoic acid, methyl ester (SI 96%), Heptadecanoic acid, methyl ester (SI 95%), Cyclopropaneoctanoic acid, 2-hexyl-, methyl ester (SI 93%), 9-Octadecenoic acid (Z)-, methyl ester (SI 93%), 9,12-Octadecadienoic acid (Z,Z)-, methyl ester (SI 96%), 10-Nonadecenoic acid, methyl ester(SI 92%), 9,12,15-Octadecatrienoic acid, methyl ester (SI 92%), Eicosanoic acid, methyl ester (SI 94%), 11-Eicosenoic acid, methyl ester (SI 93%), 11,13-Eicosadienoic acid, methyl ester (SI 94%), Heneicosanoic acid, methyl ester (SI 93%), Docosanoic acid, methyl ester (SI 93 %), 13-Docosenoic acid, methyl ester (SI 90%), Tricosanoic acid, methyl ester (SI 93%). According to the World Health Organization, evidence is "convincing" that consumption of palmitic acid (hexadecanoic acid, methyl ester) increases risk of developing cardiovascular diseases, placing it in the same evidence category as trans fatty acids. Retinyl palmitate is an antioxidant and a source of vitamin A added to low fat milk to replace the vitamin content lost through the removal of milk fat. Palmitate is attached to the alcohol form of vitamin A, retinol, to make vitamin A stable in milk. Gondoic acid (11-Eicosenoic acid) is a monounsaturated omega-9 fatty acid found in a variety of plant oils and nuts Miwa,(1971). Over all, seed oil of *Butea monosperma* is a comparable good quality having number of valued fatty acids which is medicinally important.

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