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Article *in* Dhaka University Journal of Pharmaceutical Sciences · March 2012

DOI: 10.3329/dujps.v10i1.10015

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Comprehensive Analysis of the Composition of Seed Cake and its Fatty Oil from *Swietenia mahagoni* Jacq. Growing in Bangladesh

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ABSTRACT: The proximate nutritional compositions of *Swietenia mahagoni* Jacq seed cake and the fatty acids present in the oil were investigated. The proximate nutritional composition of the seed cake were analyzed by the standard methods and it was found to contain moisture (14.37%), minerals (16.36%), fats (19.42%), crude fiber (19.60%), protein (8.76%) and carbohydrate (21.49%). The fatty acid composition of the oil was analyzed by GC-MS and a total of 48 compounds have been identified. The major constituents of the methylated fatty esters were linoleic acid (26.00%), elaidic acid (24.39%), stearic acid (14.32%), palmitic acid (12.97%), 10-methyl-10-nonadecanol (5.24%), ecosanoic acid (2.48%), 3-heptyne-2,5-diol, 6-methyl-5-(1-methylethyl) (2.03%), octadecanoic acid 9,10,12-trimethoxy (1.90%); 1,3-dioxalane, 4 ethyl-4-methyl-2-pentadecyl (1.89%) and 2-furapentanoic acid (1.03%). It is evident from this study that the oil can be considered as a good source of unsaturated fatty acids.

Key words: *Swietenia mahagoni*, Seed cake, Proximate nutritional compositions, Fatty acid analysis

INTRODUCTION

Swietenia mahagoni Jacq locally known as mahagoni belongs to Meliaceae family that grows abundantly in the plain lands and hilly areas of Bangladesh. It is also distributed in India, America and most of the tropical countries.[1] *S. mahagoni* is an important medicinal plant and has various types of medicinal values like antimalarial and antidiarrhoeal effects.[2,3] The plant extracts possess antibacterial and antifungal activities.[4] *S. mahagoni* extract showed agonistic activity to PPAR (gamma) and gave ameliorative effects on diabetic mice.[5] The seed extract of *S. mahagoni* has also been found to inhibit platelet-activating factor (PAF)-induced platelet aggregation.[6] Previous chemical investigations on the *S. mahagoni* led to the isolation of some terpenoids and limonoids.[7] Now a day, the seeds of *S. mahagoni* have been used for the management of diabetes in some areas of Bangladesh. There is no information about the nutritional composition of seed cake although little is known about the fatty acids present in *S. mahagoni* seed oil. Therefore, the objective of the present study was to assess the nutritional composition of *S. mahagoni* seed cake and determine the complete fatty acid composition of the seed oil.

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Dhaka Univ. J. Pharm. Sci. **10**(1): 49-52, 2011 (June)

MATERIALS AND METHODS

The seed of *S. mahagoni* (1.0 kg) was collected from BCSIR Campus, Dhaka during September 2006. The plant was identified by the consultant Botanist of Bangladesh National Herbarium (BNH), where a Voucher specimens (Herbarium no DACB-Accession no 35234) has been deposited.

The seeds were dried in an oven at 40^{o}C and then were ground to get white powder (830 g). The percentage of moisture, ash, total fat, protein and

crude fiber of the seed cake were determined by standard procedures.[8]

The seed powder (400 g) was taken in a thimble and placed in a Soxhlet apparatus and extracted with pet. ether (40-60ºC) for about 6 hours. The pet. ether extract was concentrated by a rotary vacuum evaporator under reduced pressure. The oil thus obtained was taken in ether washed with distilled water and finally dried over anhydrous Na_2SO_4. After removing Na_2SO_4 and ether yellowish colored oil (215.0 g, 53.75%) was obtained. The physico-chemical properties like specific gravity, refractive index[9], acid value, free fatty acids, iodine value (Hanus method), saponification value[10], the quantity of unsaponifiable matter and polenske value[11] of the oil were determined with three replications.

The fatty acid composition of the seed oil was also investigated by GC-MS after conversion of the acids into the corresponding methyl esters[12] by following the boron trifluoride catalyst method. Briefly, the oil (400 mg) was saponified with methanolic sodium hydroxide (40 ml) by refluxing on a boiling water bath for about 1 hr. The solution was dried and then esterified with BF_3-methanol complex (20 ml) by heating the mixture in a boiling water bath for about 45 mins. The methylated esters of the fatty acids were isolated by partitioning with n-hexane and water. The *n*-hexane soluble material was concentrated, dried and analyzed by GC-MS.

GC-MS analysis of methylated fatty acid. Analysis was carried out by GC-MS electron impact ionization (EI) method[13] on GC-17A Gas Chromatograph (Shimadzu, Japan) coupled to a GC-MS-QP 5050A Mass Spectrometer. Fused silica capillary column (temperature range 4º to 250 ºC) port temperature 250 ºC ca at constant pressure (100 Kappa), flow rate 20ml/min, acquisition parameters full scan range 40-450 a.m.u. were used. The compounds were identified by comparison with the NIST 127 and NIST 147 Library data.

RESULTS AND DISCUSSION

The proximate composition of the seed cake was determined by the procedure described by AOAC.[14] Cake was analyzed for moisture, crude fat, crude fiber, protein, carbohydrate and minerals (total ash), which are shown in Table 1. It was found that the moisture, crude fats, crude fibers, proteins, carbohydrates and minerals were found to be 14.37%, 19.42%, 19.60 %, 8.76%, 21.49% and 16.36%, respectively. The proximate analysis showed the seed cake to contain high quantity of valuable nutrients, such as crude fat, crude fiber, protein and minerals content, which signify the presence of high levels of macro- and micro-nutrients. The presence of high nutrients suggests that seed cake may serve as useful alternative feedstuffs for livestock, if properly processed. However, the presence of bitter substance mahagonin[1] and other alkaloids as well as some toxicants have limited the use of seed for feeding purposes for human or animals.

Table 1. The nutritional composition of the seed cake of *S. mahagoni*

Parameters	Results
Moisture	14.37%
Fats	19.42%
Crude fibers	19.60%
Proteins	8.76%
Carbohydrates	21.49%
Minerals	16.36%

Table 2. The physico-chemical characteristics of *S. mahagoni* seed oil

Parameters	Results
Colour	Brown
Moisture	24.60 %
Specific gravity at 30 ^{0}C	0.9334
Acid value	10.92
Free fatty acid (FFA)	5.49 % (as oleic acid)
Saponification value	191.27
Iodine value	94.4
Unsaponifiable matter	1.49 %
Oil (dry basis)	53.75 %
Polenske value	0.35

The percentage of oil in the seed powder was found to be 53.75% which was similar to the reported value from India.[1] The physico-chemical characteristics of the isolated oil as well as chemical composition were determined and the results are given in Table 2 & 3. The specific gravity of the oil

Table 3. Composition of methylated fatty acid of *Swietenia mahagoni* seeds oil

Serial No.	Name of compounds	M.W	M.F	%
1	Myristic acid, methyl ester	242	$C_{15}H_{30}O_2$	0.10
2	Methyl pentadecanoate	252	$C_{16}H_{32}O_2$	0.02
3	Palmitoleic acid, methyl ester	268	$C_{17}H_{32}O_2$	0.22
4	Hexadecanoic acid, 14-methyl-, methyl ester	284	$C_{18}H_{36}O_2$	0.03
5	Palmitic acid, methyl ester	270	$C_{17}H_{54}O_2$	12.97
6	Heptadecanoic acid, methyl ester	284	$C_{18}H_{36}O_2$	0.13
7	Linoleic acid, methyl ester	294	$C_{19}H_{34}O_2$	26.00
8	7,10-Octadecenoic acid, methyl ester	294	$C_{19}H_{34}O_2$	0.04
9	Elaidic acid, methyl ester	296	$C_{19}H_{36}O_2$	24.39
10	Stearic acid, methyl ester	298	$C_{19}H_{38}O_2$	14.32
11	Oleic acid, methyl ester	282	$C_{18}H_{34}O_2$	0.79
12	Heptadecanoic acid, 15-methyl-, methyl ester	298	$C_{19}H_{38}O_2$	0.23
13	Naphthalene, 2-butyldecahydro	294	$C_{14}H_{26}$	0.21
14	9,12,15-octadecatrienal,dimethylacetal	308	$C_{20}H_{36}O_2$	0.15
15	3-Heptyne-2,5-diol-6-methyl 5-(1-methylethyl)	284	$C_{11}H_{20}O_2$	2.03
16	2-Furapentanoic acid, tetrahydro-5-nonyl, methyl ester	312	$C_{19}H_{36}O_3$	1.03
17	Tetrahydrofuran, 2-ethyl-5-butyl	156	$C_{10}H_{20}O$	0.18
18	Cyclohexanol, n-butyl	156	$C_{10}H_{20}O$	0.08
19	4-Pentenoic acid, 3-methyl -2-(phenyl-formyl), methyl ester	233	$C_{14}H_{17}O_3$	0.09
20	Octadecanoic acid,9,10,12-trimethoxy, methyl ester	388	$C_{22}H_{44}O_5$	1.90
21	1,3-Dioxalane, 4 ethyl-4-methyl -2-pentadecyl	326	$C_{21}H_{42}O_2$	1.89
22	8,11-Octadecadienoic acid, methyl ester	294	$C_{19}H_{34}O_2$	0.93
23	10-Methyl-10-nonadecanol	298	$C_{20}H_{42}O$	5.24
24	2-Oxazolidinone, 3-methyl	101	$C_4H_7NO_2$	0.14
25	2-Octan-1-ol,7-ethoxy-3,7-dimethyl	200	$C_{12}H_{24}O_2$	0.17
26	Cyclopropane-undecanol, 2-nonyl	336	$C_{23}H_{44}O$	0.16
27	Z,Z-8,10-Hexadecadien-1-ol	238	$C_{16}H_{30}O$	0.13
28	4-Hexadecanol	242	$C_{16}H_{34}O$	0.18
29	11-Eicosenoic acid, methyl ester	324	$C_{21}H_{40}O_2$	0.48
30	1-Oxaspiro[2.5]octan-4-one, 2,2,6-trimethyl-trans	168	$C_{10}H_{16}O_2$	0.08
31	Pentanoic acid, 2-octyl ester	214	$C_{13}H_{26}O_2$	0.08
32	Octadecanoic acid, 9,10-dihydroxy-, methyl ester	330	$C_{19}H_{38}O_4$	0.44
33	Eicosanoic acid, methyl ester	326	$C_{21}H_{42}O_2$	2.48
34	Bicyclo[2.2.1]heptan-2-one,5-hydroxy-4,7,7-trimethyl-endo	168	$C_{10}H_{16}O_2$	0.07
35	7-Hydroxy-6-methyl-oct-3-enoicacid	172	$C_9H_{16}O_3$	0.04
36	Alpha-D-xylofuranose,1,2:3,5-bis -*o*-(1-methylethylidene)	230	$C_{11}H_{18}O_5$	0.12
37	1,6-Octadiene,3-ethoxy-3,7-dimethyl	182	$C_{12}H_{22}O$	0.20
38	Octadecanoic acid,10-dihydroxy methyl ester	314	$C_{19}H_{38}O_3$	0.07
39	Cyclohexanol, 5-methyl-2-(1-methylethyl)	156	$C_{10}H_{20}O$	0.08
40	Cyclobutanecarboxylic acid, Undec-10-enyl ester	252	$C_{16}H_{28}O_2$	0.04
41	Myrothecic acid, hexahydro-dimethyl ester	316	$C_{16}H_{28}O_6$	0.03
42	2,4-Dodecadienoic acid,11-methoxy-3,7,11-trimethyl, methylester	282	$C_{17}H_{30}O_3$	0.06
43	Tridecanedial	212	$C_{13}H_{24}O_2$	0.06
44	Tetradecanoic acid, tetradecyl ester	424	$C_{28}H_{56}O_2$	0.02
45	Heptadecanoic acid, 16-methyl-, methyl ester	298	$C_{19}H_{38}O_2$	0.81
46	Acetic acid, 2-(5,9-dimethyl-1-oxacycloundeca-5,9-dien-2-ylidene)	250	$C_{15}H_{22}O_3$	0.65
47	Tetradecanoic acid, 12-methyl- , methyl ester	256	$C_{16}H_{32}O_2$	0.04
48	16-Octadecenoic acid, methyl ester	296	$C_{19}H_{36}O_2$	0.05
	Total			=100.00

M.W. = Molecular weight; M.F.= Molecular formula.

was found to be 0.9334 at 30 ^{o}C which was close to that of Neem seed oil (0.9109) and Bohera seed oil (0.9111). The iodine value (degree of unsaturation) of the *S. mahagoni* seed oil was also found to be 94.46, which was almost similar to that of castor oil (90.08). The saponification value of the oil was found as 191.27, which was almost similar to that of castor oil (175.0 - 183.0). The higher saponification and iodine values indicated that the oil contain larger portion of unsaturated fatty acids. The Polenske value of the oil was found as 0.35, which was quite similar to the value reported for the same oil in India. The acid value and percentage of free fatty acid (as oleic) of the oil were found 10.92 and 5.49%, which were much higher than that of the other edible oils. The high acid value and free fatty acid at such level indicated that the oil is not suitable for edible purpose.[15] It may be used for edible purpose through proper refining.

The fatty oil of *S. mahagoni* seed was converted to their corresponding methyl esters by boron trifluoride catalyst method. GC-MS analysis of the methyl ester of the fatty acids showed that the oil contained 48 compounds. The major constituents of the methylated fatty esters as detected were linoleic acid (26.00%), elaidic acid (24.39%), stearic acid (14.32%), palmitic acid (12.97%), 10-methyl-10-nonadecanol (5.24%); ecosanoic acid (2.48%), 3-heptyne-2,5-diol-6-methyl-5-(1-methylethyl)(2.03%), Octadecanoic acid, 9,10,12-trimethoxy (1.90%) and 2-2-Furapentanoic acid, tetrahydro-5-nonyl (1.03%). The amount of unsaturated fatty acids like, linoleic acid (26.00%), elaidic acid (24.39%) etc. were much higher than the saturated fatty acids, mainly palmitic acid (12.97%) and stearic acid (14.32%) of oil. The percentage of linoleic acid and palmitic acid were found to be higher but the oleic acid and stearic acid were much lower than the reported values.[1] The present study revealed that the oil content in the seed is high. Hence the oil is bitter in taste and considered as a moderate drying oil, which can be useful in different chemical industries for soap and dying.

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