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Full Length Research Paper

Extraction and characterization of oils from *sapindus trifoliatus* linn seed of different origin of Bangladesh

Md. Aunik Mahmood[1], Iqbal Mahmud Asif[1], Mohammad Sayed Alam[1], Muhammad Saiful Islam[2]*, Shamima Akther Eti[2], Farzana Hossain[2], Md. Moniruzzaman[2] and Mala Khan[2]

[1]Department of Chemistry, Jagannath University, Dhaka-1100, Bangladesh.
[2]Designated Reference Institute for Chemical Measurements, Bangladesh Council of Scientific and Industrial Research, Dhaka-1205, Bangladesh.

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Three varieties *Sapindus trifoliatus* Linn seed of Bangladesh were collected from local market like Gaibandha, Rajshahi and Dinajpur for comparative study. The proximate analysis of the collected seeds, physico-chemical characteristics and compositional analysis of the essential oils as well as the fatty oils were investigated. Essential oils were extracted by hydro distillation and fatty oils by solvent extraction, using 40-60 ^{0}C petroleum ether as solvent. On the dry sample basis Sapindus found to be containing essential oil is 0.025% in seeds of Gaibandha and Rajshahi, other sample contain 0.024% of the same. The fatty oil content was found to be 8.925%, 8.655%, 8.717% w/w in the seeds of Gaibandha, Rajshahi and Dinajpur respectively. Physical and chemical characteristics of the oils were determined by the usual standard procedures. The chemical composition of the essential oils and fatty oils were determined by Fourier Transform Infrared (FTIR) spectroscopy and Gas Chromatography-Mass Spectroscopy (GC-MS). The elemental nutrients in the seed cakes were determined by Energy Dispersive-X-ray Fluorescence (ED-XRF) instrument.

Keywords: Sapindus, extraction, essential oil, fatty oil, characterization, composition.

INTRODUCTION

Sapindus is a genus of about five to twelve species of shrubs and small trees in the Lychee family. It is native to warm temperate to tropical regions (Austin, 2004 and Stoffels, 2008). The genus includes both deciduous and evergreen species. Members of the genus are commonly known as soapberries or soapnuts because the fruit pulp is used to make soap (Marcus, 2007 and Quattrocchi, 2000). The leaves are alternate, 15–40 cm long, pinnate, with 14-30 leaflets. The flowers form in large panicles, each flower small, creamy white. The fruit is a small leathery-skinned drupe 1–2 cm in diameter, yellow ripening blackish, containing one to three seeds (Maiti *et al.* 1968). The Sapindus contains saponins which are a natural surfactant. They have been used for washing for thousands of years by native peoples in asia as well as native Americans. Sapindus are being considered (Arulmozhi *et al.* 2004) and used (Setty, *et al.* 2007) for commercial use in cosmetics and detergents as well as many other products. (Allen, 1998) Summarized the fatty acid composition of some naturally occurring oils and fats in Sapindus. (Ojha *et. al.* 2003) found that the Sapindus oil contained about 30.02% and 60.012% of Ca and K in total minerals. (Abhijeet *et. al.* 2005) Complete ^{1}H and ^{13}C NMR of six saponins from *Sapindus trifoliatus*. (Fairhall, 2009) Found that the Zn naturally occurring in

*Corresponding Author E-mail: saifulacctdu@yahoo.com

sapindus was 0.202% varying from 0.29% to 1.3 %. (Gubitz, 2002) Worked about the fatty acid of *sapindus trifoliatus* linn and established that oleic acid was the most common fatty acid (52.63%). (Zahra, 2007) Investigated the oil composition of *Sapindus trifoliatus* L. by IR, TLC, GC and ^{13}C NMR. Oleic acid represented by far the major compound (58.2%), but unusual content of arachidic acid (15.9%) was found together with smaller amount of 11-eicosenoic acid (8.6%). (Parry, 2009) determined the refractive index of sapindus essential oil by refractiometer. (Rao, 1992) Determined the fatty acid composition of Sapindus trifoliatus seed oil by spectrophotometry, urea complexation, and gas liquid chromatography (GLC).

Experimental

Collection of sapindus

Three varieties of sapindus were collected from the mostly grown area of Bangladesh, such as, Gaibandha, Rajshahi and Dinajpur.

Cleaning, drying and chipping

The collected samples were washed clearly by deionized water to remove dust materials. Then they were dried. The dried Sapindus seeds were crushed and powdered finely.

Proximate analysis of *sapindus trifoliatus* seed

The proximate analysis like moisture, dry matter, ash, crude fiber, protein, carbohydrates, food energy index of *Sapindus trifoliatus* fruit of different origin of Bangladesh were determined by the usual conventional methods.

Extraction of essential oils

Hydro-distillation method was used to extract the essential oil from Sapindus samples. In this regard a cleavenger apparatus was used. The distillation process was carried out for 6 hrs to ensure the maximum yield. The essential oil was the collected with the help of acetone rinsing and dried with sodium sulphate. The cleaned and dried sample was then stored in a 5^0C refrigerator until further analysis.

Soxhlet extraction of fatty oils

The moisture and essential oil free sample in thimble was placed in the soxhlet apparatus unit and extraction was carried out with 40- 60° C petroleum ether as a solvent for 30 hrs in a water bath at 80°C-90°C.

Purification of fatty oil

The fatty oil in the solvent obtained from the soxhlet unit was filtered to remove any coarse particles. The solvent was removed from the oil by rotary vacuum evaporator and dried in an oven at 110°C. The purified fatty oil thus obtained was stored in a 5^oC refrigerator for further characterization.

Physico chemical properties of essential and fatty oil

The physico-chemical characteristics of the derived essential oils and fatty oils such as moisture, ash, iodine value, acid value, saponification value etc. were determined by standard methods of AOAC (Association of Analytical Chemists) and AOCS (American Oil Chemists' Society).

Chemical composition by FTIR, GC-MS

The chemical constituents of the oils were determined by Shimadzu IR Prestige-21 FTIR and Agilent inert XL Electron Impact Ionization (EI) GC-MSD. The fatty oils were esterified with BF_3/MeOH mixture prior to GC-MS analysis.

Elemental composition by ED-XRF

The elemental compositions of the seed cake or residue of the extraction process were investigated by the Thermo Scientific ED-XRF from which the weight percent of an element in the total amount is measured.

RESULTS AND DISCUSSIONS

The experimental results of proximate analysis of the collected sapindus samples are tabulated in Table I with comparative studies. The analysis showed some variations in observed data. These variations may be due to the factors such as genetic variety, maturity, collection time, climatic condition of geographical location, composition of the soil, water and fertilizer used.

Yield of essential oils and fatty oils

The Table 2 depicted the percent yield of essential oil and fatty oil from the collected sapindus samples. The

Table 1. Comparative study on the proximate analysis of Sapindus samples

Parameters of proximate analysis (g/l00g)	Sapindus collected from		
	Gaibandha	Rajshahi	Dinajpur
Maturity	Mature	Mature	Mature
Moisture	24.416	16.502	16.485
Dry Matter	75.584	83.478	83.516
Total ash	6.635	7.109	6.049
Acid soluble ash	84.493	84.242	84.876
Acid insoluble ash	15.507	15.75	15.124
Water soluble ash	36.282	36.50	36.012
Water insoluble ash	63.718	63.50	63.988
Organic matter	93.365	92.891	93.951
Crude fiber	1.45	1.13	1.26
Nitrogen	1.384	1.319	1.306
Protein	8.624	8.219	8.175
Carbohydrates	56.928	65.06	66.051
Food energy,(cal/gm)	279.713	310.936	314.724

Table 2. Percent yield of essential oil and fatty oil

Oil Type	Sample Origin	Percent yield
Essential oil	Gaibandha	0.025
	Rajshahi	0.025
	Dinajpur	0.024
Fatty oil	Gaibandha	8.925
	Rajshahi	8.655
	Dinajpur	8.717

Table 3. Physico-chemical characteristics of essential oil and fatty oil of Sapindus

Properties	Oil Type	Sample origin	Results
Sp. Gravity	Essential oil	Gaibandha	0.901
		Rajshahi	0.918
		Dinajpur	0.892
	Fatty oil	Gaibandha	0.935
		Rajshahi	0.916
		Dinajpur	0.922
Refractive index	Essential oil	Gaibandha	1.139
		Rajshahi	1.140
		Dinajpur	1.138
	Fatty oil	Gaibandha	1.462
		Rajshahi	1.461
		Dinajpur	1.463
Color	Essential oil	Gaibandha	Golden yellow
		Rajshahi	Golden yellow
		Dinajpur	Golden yellow
	Fatty oil	Gaibandha	Light yellow
		Rajshahi	Light yellow
		Dinajpur	Light yellow
Odor	Essential oil	Gaibandha	Strong spicy odor
		Rajshahi	Strong spicy odor
		Dinajpur	Strong spicy odor

Table 3. Continue

		Gaibandha	Light spicy odor
	Fatty oil	Rajshahi	Light spicy odor
		Dinajpur	Light spicy odor
Acid value, mg KOH/g oil		Gaibandha	43.713
	Fatty oil	Rajshahi	43.127
		Dinajpur	43.210
Iodine value		Gaibandha	101.479
	Fatty oil	Rajshahi	100.805
		Dinajpur	100.342
Saponification value		Gaibandha	141.203
	Fatty oil	Rajshahi	144.197
		Dinajpur	137.889
Unsaponifiable matter		Gaibandha	30.682
	Fatty oil	Rajshahi	32.053
		Dinajpur	31.273

Table 4. Chemical composition of the essential oil of Sapindus

Origin of samples	Major compounds	Molecular formula	% Total
Gaibandha	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate	C12H20O2	24.4
	1,2-Benzenedicarboxylic acid, di isooctyl ester	C24H38O4	46.5
Rajshahi	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate	C12H20O2	28.9
	1,2-Benzenedicarboxylic acid, di isooctyl ester	C24H38O4	45.4
	3,7-dimethyl-1,6-Octadien-3-ol	C10H18O	10.44
Dinajpur	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate	C12H20O2	22.6
	3,7-dimethyl-1,6-Octadien-3-ol	C10H18O	7.65
	1,2-Benzenedicarboxylic acid, di isooctyl ester	C24H38O4	48.7

variations in oil yield of the studied samples are insignificant.

Physico-chemical properties of oil

The results of physico-chemical analysis are given in (Table 3) for essential oil and fatty oil of different origin of Bangladesh with comparative studies.

Chemical compositions of the oils

The extracted essential oils and fatty oils were investigated for chemical composition using FTIR spectroscopy and GC-MS instrument. The NIST library searching of the GC-MS as well as the functional group analysis of FTIR revealed the constituents of essential oils and fatty oils. Table 4 and 5 gives the overall picture of the composition of the derived essential oils and fatty oils.

Mineral contents of sapindus seed cake

Mineral content such as K, Ca, Fe, Cl, Si, Sx, Rb, Zn, U, Ti, Cu, Pb, Cr etc. were determined in the cake residue from extraction process. The element analyses were performed by ED-XRF instrument. The major minerals content of Sapindus seed cakes appeared as elemental basis in Table 6.

Table 5. Chemical composition of the fatty oil of Sapindus

Origin of samples	Major compounds	Molecular formula	% Total
Gaibandha	Hexadecanoik acid, methyl ester	C17H34O2	14.4
	9-Octadecenoic acid(Z)-,methyl ester.	C19H36O2	38.3
	Octadecanoic acid, methyl ester.	C19H38O2	12.8
	Octanedioic acid, 4-isopropyl-,dimethyl ester	C13H24O4	7.63
	Cis-11-Eicosenoic acid, methyl ester.	C21H40O2	16.6
	Eicosanoic acid, methyl ester	C21H42O2	1.9
	Docosanoic acid, methyl ester.	C23 H46O2	2.3
Rajshahi	9-Octadecenoic acid(Z)-, methyl ester.	C19H36O2	11.1
	Octadecanoic acid, methyl ester.	C19H38O2	39.3
	Cis-11-Eicosenoic acid, methyl ester.	C21H40O2	8.0
	Eicosanoic acid, methyl ester.	C21H42O2	4.2
	Docosanoic acid, methyl ester.	C23H46O2	17.1
	Hexadecanoic acid, methyl ester.	C17H34O2	7.3
Dinajpur	9-Octadecenoic acid(Z)-, methyl ester.	C19H36O2	12.1
	Octadecanoic acid, methyl ester.	C19H38O2	37.3
	Cis-11-Eicosenoic acid, methyl ester.	C21H40O2	8.0
	Eicosanoic acid, methyl ester.	C21H42O2	14.2
	Docosanoic acid, methyl ester.	C23H46O2	12.5
	Hexadecanoic acid, methyl ester.	C17H34O2	7.3

Table 6. Elemental analysis results of Sapindus seed cakes in total elemental composition

SL. No.	Component as Element	Name of the region		
		Gaibandha	Rajshahi	Dinajpur
1	K	68.05%	67.62 %	56.46%
2	Ca	27.70 %	28.36 %	20.51%
3	Fe	1.63 %	1.36 %	11.78%
4	Cl	1.10 %	1.41 %	3.52%
5	Zn	0.132%	0.304%	0.202%
6	Ti	0.096%	0.086%	0.454%

CONCLUSION

It is estimated that about 80% of the world population relies on botanical preparations for medicines to meet their health needs. Sapindus is mostly used for the purpose of manufacturing various types of medicine and cleaning agents. It is a powerful anti-inflammatory for human body. It has also been indicated for arthritis, fevers, headaches, toothaches, coughs, bronchitis, osteoarthritis, rheumatoid arthritis, to ease tendonitis, lower cholesterol and blood-pressure and aid in preventing internal blood clots worldwide. The vast application area of this plant makes it an important plant to the researcher and manufacturer. In Bangladesh, it grows in the northern area and is not very well known. Our study is to fill up this gape and to explore the valuable information about this plant. The major essential and fatty oil constituents that are found from this study might be further investigated to be used as antioxidant,

anti inflammatory drug, anti microbial agent as well as in food and pharmaceutical industries. The fatty oil could be used as surfactant in soup industry. The strong odor of the derived essential oil makes it a potential fragrance in cosmetics preparation. The elemental composition of the seed cake revealed that it might be an important source of potassium, calcium and iron for food formulae.

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