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PHYSICAL PROPERTIES AND GC-MS ANALYSES OF ESSENTIAL OIL OF *SAPINDUS TRIFOLIATUS*

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Abstract

The fruit of *Sapindus trifoliatus* is locally known as Ritha (soapnuts) in Bangladesh. Essential oils were extracted by steam distillation from the three varieties of Ritha collected from Gybandha, Rajshahi and Dinajpur and investigated for their chemical composition by GC-MS. The gas chromatography and mass spectrometry (GC-MS) analysis shows that essential oil of soapnuts collected from three different district of Bangladesh contain compounds 1,2-Benzenedicarboxylic acid, diisooctyl ester (46.5%) and 2,6-Octadiene-1-ol, 3,7-dimethylacetate (24.4) with equal composition and their retention time was 914 and 928, respectively. Comparative studies on physical properties of essential oil extracted from three different varieties of soapnuts and found almost similar properties.

Key words: *Sapindus trifoliatus, physical properties, essential oil*

1. Introduction

Sapindus trifoliatus (ST) is a medium sized tree that belongs to the Sapindaceae family and widely found in warm to tropical regions in both the Afro-Eurasia and Western hemisphere. The Sapindus genus includes both deciduous and evergreen species. Members of this genus are commonly known as soapberries (Reetha) or soap nuts because the fruit pulp is used to make soap. The plant has been reported for its high content of saponins and sugars. The saponin moiety is characterized as the hederagenin group of glycosides. The drupes (soapnuts) which contain saponins are usually use as natural surfactant. The generic name is derived from the Latin words *saponis*, meaning "soap", and *indicus*, meaning "of India" (Quattrocchi, 2000). They have been used for washing for thousands of years by native peoples in Asia as well as native Americans (Austin and Honychurch, 2004). Soapnuts are being considered and used for major commercial ingredient in cosmetics and detergents as well as many other products. The various parts of *Sapindus trifoliatus* are well known for their medicinal values (Ojha *et al*. 2003; Arulmozhi *et al*, 2004 and 2005; Peleigrini *et al*., 2008; Arulmozhi *et al*, 2009). The phytochemical investigation on *S. trifoliatus* were carried out by the many research groups and 1,12-bis-O-β-D-xylopyranosyl(1→3)-[α-L-rhamnopyranosyl(1→2)]-β-D-

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glucopyranoside, 15-hydroxyfarnesol, 15-O-β-xylopyranosyl(1→3)-[α-rhamnopyranosyl (1→2)]-β-glucopyrano- sidefarnesol, 15-O-β-xylopyranosyl(1→3)-[α-rhamnopyranosyl (1→2)]-β-glucopyranoside-15-hydroxyfarnesol and sesquiterpene ologoglycoside isolated from the pericraps of this plant (Sharma *et al*. 2011; Morikawa *et al*. 2009, Kasai *et al*. 1988). In the present study, we have isolated essential oils from the soapnuts (Ritha), collected from three different region of Bangladesh, *e.g*. Gybandha, Rajshahi and Dinajpur and carried the comparative studies of chemical composition using GC-MS analyses. Finally, we also studied and compared the physical properties of essential oils extracted from aforesaid three different varieties.

2. Materials and Method

The three varieties of soapnuts (Ritha), e.g. Gybandha, Rajshahi and Dinajpur Ritha, were collected from the local markets of Dhaka city (chalkbazar). The raw samples were washed with water to remove dust materials and kept for air dry for 2 weeks. Finally, the dried Ritha were crushed by Fritsch mortar grinder (Germany) for one hour and powder was sieved and collected with particle size 0.25 and 0.50 mm prior to the extraction process.

Extraction of essential oil

There are a number of methods employed for the extraction of essential oil or volatile oil from the plants. In the present study, we have used steam distillation method to extract essential oil from the plant materials. Briefly, the mixture of dirt free soapnuts powder (200 gm) and 600 mL distilled water were taken in a distillation flask (Clevenger's apparatus, JAOAC) and refluxed by electric heating mantle for four hours. The mixture of water vapor and essential oil of soapnuts were condensed by water condenser and collected in a round bottom flask. The steam distilled essential oil make a layer over water which was extracted and washed with analytical grade ether. The ether-essential oil layer was dried over anhydrous Na_2SO_4 and then filtered. The ether was removed *in vacuo* and the remaining essential oil was kept in a dry vial.
The yield of percentage of essential oil was determined using the following formula described by Rao *et al*. (2005).

$$\text{Yield (\%)} = \frac{\text{Amount of essential oil recovered (g)}}{\text{Amount of plant material used (g)}} \times 100$$

Preparation of samples and GC-MS analysis

Essential oil was diluted to 7% by chloroform (w/v) and analyzed by Electron Impact Ionization (EI) method on GC-17A gas chromatograph, coupled to a GC-MS 2010 plus mass spectrometer. The operating condition were as follows: fused silica capillary

column (RTS-5MS) wtih diameter 30 cm and length 0.25mm, column-initial temperature 40^0C, injector temperature-220^0C, holding 5 min, column packing was done with 10% diethylene glycol succinate on 100-120 mesh diatomic CAW, samples were injected by splitting with the spilt ratio 10, helium carrier gas at constant pressure 90 KPa, range of linear temperature increase-10^0C per min .

The GC-MS analysis of samples was carried out as follows: the flow rate of the carrier gas was adjusted to ensure reproducible retention time and to minimize the dirt of detector. After that the sample was injected by a micro syringe through a heated injection part which was vaporized and passed into the column. The long tube of the column was tightly packed with solid particles. The solid support was uniformly covered with a thin film of a high boiling liquid (the stationary phase). The mobile and stationary phases were then partitioned by the samples and it was separated into the individual components. The carrier gas and sample component was then emerging from the column and passed through a detector. The amount of each component as concentration by the device and generates a signal which was registered electrically. The signal was passed to a detector.

Identification of the components

Interpretation of mass spectroscopy (GC-MS) was conducted using data base of National Institute Standard and Technology (NIST) having more than 6200 patterns. The spectrum of the unknown component was compared with the spectrum of the known component stored in the NIST library. The retention time, molecular weight, molecular formula and composition percentage of the sample material was recorded.

3. Results and Discussion

S. trifoliatus (ST) is medium sized deciduous tree which is locally known as soapnut (Ritha) tree. The plant has been reported for its high content of saponins and sugars and the various parts of this plant used as folk medicine for the treatment of stomachic, spermicidal, hemicarnia and also used as tonic etc. The present study reports the isolation of essential oils from the soapnuts (Ritha), extracted from three different region of Bangladesh, *e.g*. Gybandha, Rajshahi and Dinajpur and comparative studies of chemical composition using GC-MS analyses. To ends, we compared the physical properties of essential oils extracted from aforesaid three different varieties.

GC-MS analyzed results which include the active principles with their retention time, molecular formula, molecular weight and composition of the essential oil of *S. trifoliatus* (Ritha) extracted from three varieties are presented in Table 1. Essential oil constituents were identified by comparing retention times of the chromatogram peaks with those of reference compounds run under identical conditions, by comparison of retention indices and comparison of mass spectra of the peaks with those of standard compounds using data base of National Institute Standard and Technology (NIST) having more than 6200 patterns. Peak areas and retention times were measured by the electronic integrator. The

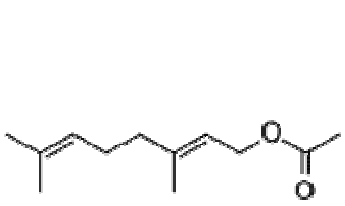
relative amounts of individual constituents were computed from peak areas without FID response factor correction.

Table 1. Chemical constituents of the essential oil of Ritha from Gybandha, Rajshahi and Dinajpur

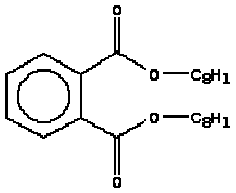
No.	RT[a]	Name of the compound	MW[b]	MF[c]	Composition (%)		
					Sample 1[d]	Sample 2[e]	Sample 3[f]
1	928	2,6-Octadiene-1-ol, 3,7-dimethyl acetate	196	$C_{12}H_{20}O_2$	24.4	24.4	24.4
2	914	1,2 Benzenedicarboxylic acid, di-isooctyl ester	390	$C_{24}H_{38}O_4$	46.5	46.5	46.5

[a]Retention time; [b]Molecular weight; [c]Molecular formula; [d]Essential oli extracted from Gybandha's soapnuts; [d]Essential oli extracted from Rajshahi's soapnuts; [d]Essential oli extracted from Dinajpur's soapnuts.

As presented in Table 1, the chemical composition of essential oil extracted in the present study were found same in the case of all soapnut samples collected from Gybandha, Rajshahi and Dinajpur district. In the case of all three samples following two compounds are common, *e.g.* 2,6-Octadiene-1-ol, 3,7-dimethyl-acetate (24.4) and 1,2-Benzenedicarboxylic acid, diisooctyl ester (46.5%).



2,6-Octadiene-1-ol, 3,7-dimethyl acetate



1,2 Benzenedicarboxylic acid, di-isooctyl ester

Figure 1. Structure of identified compounds using GC-MS

The results of comparative studies of physical properties of essential oil of *S. trifoliatus* are presented in Table 2. Physico-chemical analysis was performed according to the procedure described by (Atti-Santos *et al*., 2005) by using five parameters: specific gravity (SG), refractive index (RI), solubility in ethanol (SE), and residue on evaporation (RE). The results shows slight variation in specific gravity and refractive index of the essential oil which might be depend on several factors such genotype, stage of maturity, cultivation peculiarities, soil composition and climate differences in various geographical locations. The solubility properties of all essential oil samples in different solvent compositions are same.

4. Conclusion

Sapindus trifoliatus is locally known as soapnut tree (Ritha) in Bangladesh. They are a popular ingredient in Ayurvedic shampoos and cleansers. The different part of *S. trifoliatus* are used in Ayurvedic medicine as a treatment for eczema, psoriasis, and for removing freckles. Soap nuts contain saponins, a natural surfactant and have been used as detergent. In the present study, essential oil were extracted by steam distillation from the three varieties of Ritha collected from Gybandha, Rajshahi and Dinajpur and investigated for their chemical composition by GC-MS. The gas chromatography-mass spectrometry (GC-MS) analysis shows that essential oil of soapnuts collected from three different district of Bangladesh contain following two compounds, *e.g*. 2,6-Octadiene-1-ol, 3,7-dimethylacetate (24.4) and 1,2-Benzenedicarboxylic acid, diisooctyl ester (46.5%) with equal composition and their retention time was 914 and 928, respectively. The comparative studies on physical properties of essential oil show almost similar properties. The result obtained in the present study could be use as reference for further studies.

Table 2: Comparative studies on physical properties of essential oils of soapnuts (Ritha)

Physical properties		Sample 1[a]	Sample 2[b]	Sample 3[c]
Oil yield (%)		0.025	0.025	0.024
Organol-Eptic	Taste	Bitter taste	Bitter taste	Bitter taste
	Odor	Spicy	Spicy	Spicy
	Color	Golden yellow	Golden yellow	Golden yellow
	Appearance at rt (25^0c)	Homogeneous, transparent liquid, lighter than water		
Specific gravity at 30^0c		0.901	0.918	0.892
Refractive index[$\acute{\eta}^{t\,c}$]		1.139	1.140	1.138
Solubility	60% alcohol	Not soluble		
	70% alcohol	Cloudy up to 9.8 volume		
	80% alcohol	Soluble in 5.0 volume		
	90% alcohol	Soluble in 0.1 volume		
	95% alcohol	Soluble in0.08 volume		
	100% alcohol	Soluble at any volume		
	Distilled water	Not Soluble		
	Chlorofrom	Soluble at any Volume		
	$CC1_4$	Soluble at any Volume		
	Petroleum ether	Soluble at any Volume		
	Diethylether	Soluble at any Volume		
	n-hexane	Soluble at any Volume		

[a]Essential oli extracted from Gybandha's soapnuts; [b]Essential oli extracted from Rajshahi's soapnuts; [c]Essential oli extracted from Dinajpur's soapnuts.

References

Arulmozhi D. K., Veeranjaneyulu A., Bodhankar S. L., Arora S. K. **2004**. Pharmacological studies of the aqueous extract of *Sapindus trifoliatus* on central nervous system: possible antimigraine mechanisms, *Journal of Ethnopharmacology*, *97* (3), pp. 491–496.

Arulmozhi D. K., Veeranjaneyulu A., Bodhankar S. L., Arora S. K. **2009**. Effect of *Sapindus trifoliatus* on hyperalgesic *in vivo* migraine models, *Brazilian Journal of Medical and Biological Research*, *38* (3). pp. 469–475.

Arulmozhi D. K., Veeranjaneyulu A., Bodhankar S. L., Arora S. K. **2005**. Pharmacological investigations of *Sapindus trifoliatus* in various *in vitro* and *in vivo* models of inflammation, *Indian J Pharmacol*, *37*(2), pp. 96-102.

Atti-Santos, A. C., Rossatol M., Pauletti G. F., Rotal L. D., Rech J. C., Panseral M. R., Agostini F., Serafini L. A., and Moyna P. **2005**. Physico-chemical evaluation of *Rosmarinus officinalis* L. essential oils, *Brazilian Archives of Biology and Technology*, *48*, pp. 1035-1039.

Austin, D. F. and Honychurch P. N. **2004**. *Florida Ethnobotany*, CRC Press, London, pp. 601–603.

Kasai R., Nishi M. Mizutani K., Miyahara I., Moriya T., Miyahara K. and Tanaka O. **1988**. Trifolioside II an sesquiterpene oligoglycoside from pericraps *S. trifoliatus*, Phytochemistry, 27, pp. 2209-2211.

Morikawa T., Xie Y., Asao Y., Okamoto M., Yamashita C., Muraoka O., Matsuda H., Pongpriyadacha Y. Yuan D. and Yoshikawa M. **2009**. Oleanane type tritrepene oligoglycosides with pancreatic lipase inhibitory activity from the pericraps of *S. rarak*, Phytochemistry, *70*, pp. 1166-1172.

Ojha P., Maikhuri J. P. and Gupta G. **2003**. Effect of spermicides on *Lactobacillus acidophilus* in vitro - nonoxynol-9 vs. *Sapindus* saponins, *Contraception*, *68* (2), pp. 135–138.

Peleigrini D. D., Tsuzuki J. K., Amado C. A. B., Cortez D. A. G. and Ferreira I. C. P. **2008**. Biological activity and Isolated compounds in S. saponaria L. and other plants in genus Sapindus, Lat. Am. J. Pharm., 27, pp. 922-932.

Quattrocchi U. **2000**. CRC World Dictionary of Plant Names: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. IV R-Z. Taylor & Francis. p. 2381.

Rao B. R. R., Kaul P. N., Syamasundar K.V. and Ramesh S. **2005**. Chemical profiles of primary and secondary essential oils of palmarosa (*Cymbopogon martinii* (Roxb.) Wats var. *motia* Burk.), *Industrial Crops and Products*, *21*, pp. 121-127.

Sharma A., Sati S. C., Sati O. P., Sati D. M. and Kothiyal S. K. **2011**. Chemical constituents and bio activities of genus sapindus, International Journal of Research in Ayurveda and Pharmacy, *2*(2), pp. 403-409.