

Original Research Article
Volatile constituents from the leaves of *Pachira*
***aquatica* Aubl grown in Nigeria**

ABSTRACT

The hydrodistilled essential oil obtained from the leaves of *Pachira aquatica* Aubl., growing in Nigeria was analyzed by gas chromatography-flame ionization detector (GC-FID) and gas chromatography coupled with mass spectrometry (GC/MS). Six constituents representing 99.8% of the oil were identified from the GC/MS spectra. The major components of the oil were 9-octadecenamide (35.1%), phytol (31.2%) and methyl palmilate (19.1%). This is the first report on the chemical composition of essential oil of *P. aquatica* growing in Nigeria.

Aims: The aim of the research is to investigate the volatile constituents from *P. aquatica* harvested in Surulere area, Lagos, Nigeria

Study design: The design includes the extraction of essential oil the air-dried leaves samples of *P. aquatica* and the determination and identification of the chemical constituents of the oil.

Place and Duration of Study: Mature leaves of *P. aquatica* were collected in Surulere Local Government Area, Lagos State, in December 2014.

Methodology: Air-dried and pulverized leaves were hydrodistilled in a Clevenger-type apparatus to obtained colourless volatile oil whose chemical constituents was analyzed by GC and GC/MS.

Results: A total of six compounds accounting 98.8% of the oil were identified from the GC/MS and the major constituents were found to be 9-octadecenamide (35.1%), phytol (31.2%) and methyl palmilate (19.1%).

Conclusion: The present oil compositions were found to be different from the results previously reported from other part of the world.

Keywords: *Pachira aquatica*; **Bombacaceae**; essential oil composition; 9-octadecenamide; phytol

1. INTRODUCTION

In continuation of an extensive research into the volatile constituents of poorly studied species of Nigerian flora [1-3], we report herein the chemical constituents of essential oil of *Pachira aquatica* aubl. The genus *Pachira* has 24 species, three of which have located in Nigeria namely *Pachira glabra*, *Pachira aquatica* and *Pachira insignis*. *Pachira aquatica* of the Bombacaceae family is a plant whose seed is used for the production of local condiments. The plant is known to possess hypoglycaemic effect [4] and used to ameliorate stomach ache, ulcers, diabetes, bacterial infections, skin rashes and sores and used as blood purifier [5]. An ethanol extract of *P. aquatica* displayed fungicide activity [6]. *P. aquatica* seeds have tryptophan, threonine and phenylalanine and tyrosine contents higher than those reported for human milk, chicken egg and cow's milk [7].

Previous chemical analyses on *P. aquatica* led to the isolation and identification of antifungal fungitoxin known as isohemigossypolone [7,8], aquatidial, bis-norsesquiterpenoid, triacontyl p-coumarate and lupeol [8], 11-hydroxy-2-O-methylhibiscolactone A and O-methylhibiscone D, together with 18 known compounds, including 5-hydroxyauranetin, kaempferol-3,7,4'-trimethyl ether, santi-7-methyl ether, 3,5,6,7,8,3',4'-heptamethoxyflavone, calycopterin,

retusin, 5,4'-dihydroxy-3,7-dimethoxyflavone, isohemigossylic acid lactone-7-methyl ether, hibiscolactone A, hibiscone C, hibiscone D, 2-O-methylisohemigossypolone, scopoletin, benzophenone, 2 α ,3 β -dihydroxylupene, lupenone, 24-methylenecycloartenol and (23*E*)-cycloart-23-ene-3 β ,25-diol [9]. Both 5-hydroxyauranetin and isohemigossylic acid lactone-7-methyl ether exhibited potent inhibition against *N*-formyl-L-methionyl-L-leucyl-L-phenylalanine-induced superoxide production with IC₅₀ values of 28.84 $\pm$ 2.26 and 12.77 $\pm$ 2.48 μ M, respectively [10]. In addition, cyanidin-3-glucoside and cyanidin-3-rutinoside [11], palmitic acid [12], heptadecanoic acid, stearic acid, linoleic acid, arachidic acid [13] and sterculic acid [14] were isolated previously from the plant. Fatty acids such as malvalic acid, sterculic acid and α -hydroxy-sterculic acid and palmitic acid were previously described from the plant [15,16]. The main volatile compounds of the flower oil of *P. aquatica* from Brazil [17] were (*E*, *E*)- α -farnesene (19.2%), β -caryophyllene (11.5%), *trans*-linalool oxide (pyranoid) (7.2%), elemol (5.6%), phenylacetaldehyde (5.3%), *cis*- and *trans*-linalool oxide (furanoids) (5.2% and 4.2%), and palmitic acid (4.3%).

In Nigeria, *P. aquatica* is cultivated and grown as an ornamental plant. However, to the best of our knowledge, there are no reports on the volatile and non-volatile constituents and biological activities of this *Pachira* species growing in Nigeria. In this paper we report for the first time the chemical composition of essential oil of *P. aquatica* growing in South-western Nigeria.

2. MATERIAL AND METHODS

2.1 Plant material

Mature and fresh leaves sample of *P. aquatica* were collected from plants growing at a private garden in Surulere Government Area of Lagos State, Nigeria (6.58 N, 3.75 E), in October 2014. Identification of the plant material was carried out by Mr. O.O. Oyebamiji of the herbarium, Department of Botany, University of Lagos. Voucher specimen (LUH 5742A) was deposited at the University Herbarium.

2.2 Oil isolation

The air-dried and pulverized leaves of *P. aquatica* (300g) were subjected to hydrodistillation in a Clevenger-type glass apparatus for 3 h in accordance with the British Pharmacopoeia specification [18] to afford a colourless oil in a yield of 0.13% (v/w), calculated on a dry weight basis. The distilled oil was preserved in a sealed sample tube and stored under refrigeration until analysis.

2.3 Gas chromatography (GC) analysis

GC analysis of the oil was carried out on a Hewlett Packard HP 6820 Gas Chromatograph equipped with a FID detector and DB-5 column (60 m x 0.25 mm id), film thickness was 0.25 μ m and the split ratio was 1:25. The oven temperature was programmed from 50 $^{\circ}$ C (after 2 min) to 240 $^{\circ}$ C at 5 $^{\circ}$ C/min and the final temperature was held for 10 min. Injection and detector temperatures were 200 $^{\circ}$ C and 240 $^{\circ}$ C, respectively. Hydrogen was the carrier gas. An aliquot (0.5 μ L of the diluted oil) was injected into the GC. Peaks were measured by electronic integration. A homologous series of *n*-alkanes were run under the same conditions for determination of retention indices.

2.4 Gas chromatography-Mass spectrometry (GC/MS) analysis

GC-MS analysis of the oil was performed on a Hewlett Packard Gas Chromatography HP 6890 interfaced with Hewlett Packard 5973 mass spectrometer system equipped with a HP 5-MS capillary column (30m x 0.25 mm id, film thickness 0.25 µm). The oven temperature was programmed from 70- 240 °C at the rate of 5 °C/min. The ion source was set at 240 °C and electron ionization at 70eV. Helium was used as the carrier gas at a flow rate of 1 ml/min. Scanning range was 35 to 425 amu. Diluted oil in *n*-hexane (1.0 µL) was injected into the GC/MS.

2.5 Identification of compounds

The components of the oil were identified based on the comparison of their retention indices and mass spectra with those standards [19] and published data [20, 21].

3. RESULTS AND DISCUSSION

The identities of the compounds present in *P. aquatica* as well as their percentage composition could be seen in Table 1. Fewer components were identified in the oil sample when compared with other *Pachira* oil compositions [3, 17]. Six constituents accounting for 98.8% of the total oil contents were identified from the GC/MS spectra. The major components of the oil were 9-octadecenamide (35.1%), phytol (31.2%) and methyl palmitate (19.1%). These components belong to different chemical classes of organic compounds. It was noted that the main compounds present in a previous investigated flower sample from Brazil namely (*E, E*)- α -farnesene, β -caryophyllene, *trans*-linalool oxide (pyranoid), elemol and phenylacetaldehyde were conspicuously absent in the present study. This may be attributed to the fact that different parts of a plant normally stored different chemical compounds [2].

Literature information is scanty on the oil composition of *Pachira* species. This result showed some difference in composition with respect to data in the literature on the essential oils of *Pachira* plants. Palmitic acid, the main compound of Brazilian grown *P. glabra* [22] as well as limonene, β -caryophyllene and β -bisabolene that were present in Nigerian grown *P. glabra* [3] were not identified in *P. aquatica*. Although phytol was identified in the Nigerian grown *P. glabra* at a much lower quantity than in the essential oil of *P. aquatica*. In addition, several compounds such as (*Z*)-2-hexenol, octanone, hexenyl butanoate, allo-ocimene, verbenene, cadin-1(10),6-diene, *epi*- α -muurolol, *trans*-linalool-oxide, mentha-1-7(8)-diene and *p*-cymenene, that were identified in *P. dolichocalyx* [23] were not identified in the Nigerian grown *P. aquatica*.

It is well known that the constituents of essential oil of *P. aquatica* perform several biological activities [24-26]. However, some biochemical origin or reactions may affect the concentrations of these constituents of *P. aquatica*. Phytol was obtained by hydrolysis (decomposition by water) of chlorophyll and the rate of hydrolysis may affect its concentration [24]. Methyl palmitate is a fatty acid ester essential oil that naturally occurs in many plant species. Methyl palmitate concentrations in cells are known to be modulated by methanol, but insoluble in water [25]. Methyl salicylate is a water-soluble liquid and may be converted to salicylic acid [26]. Further research works are on to determine the biological potential of the essential oil and the effect of constituents present in the oil.

Table 1. Chemical composition of essential oil of *Pachira aquatica*

Compounds ^a	RI (Cal.)	RI (Lit.)	% Composition
Camphor	1143	1145	3.6
Methyl salicylate	1191	1197	2.0

131	Methyl palmitate	1922	1920	19.1
132	Phytol	2116	2118	31.2
133	Methyl octadecanoate	2128	2128	8.8
134	9-Octadecenamide	2327	2330	35.1
135	Total			99.8
136	Oxygenated monoterpene			5.6
137	Diterpene			31.2
138	Fatty acids			27.9
139	Fatty acid amide			35.1

^aElution order on DB-5 column; RI (Lit.) = Literature retention indices;
RI (Cal.) = Retention indices relative to C₉-C₂₄ *n*-alkanes on the DB-5 column.

4. CONCLUSION

The chemical compositions of essential oil from the leaves of *P. aquatica* grown in Nigeria were being reported for the first time. It was found that the compositional pattern was different from previous studies on the essential oils from this species and from other member of the genus. This may be attributed to the fact that different parts of the same plant contained different phytochemicals. In addition, factors such as the ecological and climatic conditions as well as nature and age of the plant, period of collection etc may contribute to the different nature of the compounds obtained from the essential oil.

REFERENCES

1. Lawal OA, Ogunwande IA, Opoku RA. Chemical composition of essential oils of *Plumeria rubra* L. grown in Nigeria. *Eur J Med Pl.* 2015; 6(1): 55-61.
2. Lawal OA, Ogunwande IA, Opoku RA. Phytoconstituents and insecticidal activity of different leaf solvent extracts of *Chromolaena odorata* against *Sitophilus zeamais*. *Eur J Med Pl.* 2014; 5(3): 237-247.
3. Lawal OA, Ogunwande IA, Salvador AF, Sanni AA, Opoku RA. *Pachira glabra* Pasq. Essential oil: Chemical constituents, antimicrobial and insecticidal activities. *J Oleo Sci.* 2014; 63(6): 629-635.
4. Andrade-Cetto A, Heinrich M. Mexican plants with hypoglycaemic effect used in the treatment of diabetes. *J Ethnopharm.* 2005; 99(3): 325-348.
5. Pietsch J, Koch I, Hermanns-Clausen M, Hüller G, Wagner R, Dressler J. Pediatric plant exposures in Germany, 1998–2004. *Clin Toxicol.* 2008; 46(7): 686-691.
6. Souza DK, Lima RA, Domingues CA, Pedrosa LA, Facundo VA, Gama FC, Alves MR. The potential of the ethanolic extract of fungicide seed *Pachira aquatica* on *Fusarium* sp. *J Center Nat Exact Sci UFSM.* 2014; 36(2): 114-119.
7. Oliveira JTA, Vasconcelos IM, Bezeira LCM, Silveira SB, Monteiro ACA, Moreira RA. Composition and nutritional properties of seeds from *Pachira aquatica* Aubl., *Sterculia striata* St. Hillebrand and *Terminalia catappa* Linn. *Food Chem.* 2000; 70(2): 185-191.
8. Shibata M, Yasuyuki H, Satoshi T. A Major fungitoxin from *Pachira aquatica* and its accumulation in outer bark. *J Chem Ecol.* 1999; 25(2): 347-353.
9. Vanderlucia PF, Marcelo RE, de Barbosa LCA, Howarth OW. Aquatidial, a new bis-norsesquiterpenoid from *Pachira aquatica* Aubl. *J Braz Chem Soc.* 2006; 17(7): 1443-1446.

- 180 10. Chen J, Cheng L, Liao C, Chung M. New sesquiterpene derivatives and anti-
181 inflammatory constituents from *Pachira aquatica*. *Planta Med.* 2011; 77(12): 58-59.
182 11. Scogin R. Reproductive phytochemistry of Bombacaceae: Floral anthocyanins and
183 nectar constituents. *Aliso.* 1986; 11(4): 377-385.
184 12. Rizk AM, Al-Nowaihi AS. *The Phytochemistry of the Horticultural Plants of Qatar.*
185 Oxford:Alden Press, p. 29. 1989.
186 13. Bohannon MB, Kleiman R. Cyclopropene fatty acids of selected seed oils from
187 Bombacaceae, Malvaceae, and Sterculiaceae. *Lipids.* 1978; 13(4): 270-273.
188 14. Gibbs RD. *Chemotaxonomy of Flowering Plants.* Montreal:McGill-Queens University
189 Press, V.1, p. 516; V.2, p. 1450, 1974.
190 15. Spitzer V. GC-MS characterization (Chemical Ionization and electron impact modes)
191 of the methyl esters and oxazoline derivatives of cyclopropenoid fatty acids 1. *J Amer*
192 *Oil Chem Soc.* 1991; 68(12): 963-969.
193 16. De Bruin A, Heesterman JE, Mills MR. A preliminary examination of the fat from
194 *Pachira aquatica*. *J Sci Food Agric.* 1963; 14(10): 758-760.
195 17. das Gracas BZM, Andrade EHA, Maia JGS. Volatiles from flowers of *Pachira*
196 *aquatica* Aubl. *J Essent Oil Bear Pl.* 2003; 6(2):116-119.
197 18. British Pharmacopoeia Specification. Vol II, H.M. Stationary Office. 1980.
198 19. National Institute of Standards and Technology. Chemistry web book. Data from
199 NIST Standard Reference, Database 69, 2011. (<http://www.nist.gov/>).
200 20. Adams RP. Identification of Essential Oil Components by ion trap mass
201 spectroscopy. Academic Press, New York, 2007.
202 21. Joulain D, Koenig WA. The Atlas of Spectral Data of Sesquiterpene Hydrocarbons.
203 E. B. Verlag, Hamburg, Germany, 1998.
204 22. Chaves MH, Araujo FDS, Moura CVR, Tozeto LJ, Aued-Pimentel S, Caruso MSF.
205 Chemical characterization and stability of the *Bombacopsis glabra* nut oil. *Food Pub*
206 *Health.* 2012; 2(4): 104-109.
207 23. Courtois EA, Paine CE, Blandinieres PA, Stien D, Bessiere JM, Houel E, Baraloto C,
208 Chave J. Diversity of the volatile organic compounds emitted by 55 species of
209 tropical trees: A survey in French Guiana. *J Chem Ecol.* 2009; 35(11): 1349-1362.
210 24. Pejcin B, Savic A, Sokovic M, Glamoclija J, Ciric A, Nikolic M. et al. Further in vitro
211 evaluation of antiradical and antimicrobial activities of phytol. *Nat Prod res.* 2014;
212 28(6): 372-376.
213 25. Wang YN, Shi GL, Ren JJ, Zhao L, Du J, Liu YB, Zhao LL. Acaricidal Activity of
214 Methyl Palmitate to *T. cinnabarinus*. In proceeding. 3rd International Conference on
215 Bioinformatics and Biomedical Engineering (ICBBE), 2009; 1-4.
216 26. Vladimir S, Silverman P, Raskin I. Airborne signalling by methyl salicylate in plant
217 pathogen resistance. *Nature.* 1997; 385(8): 718-721.

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