African Journal of Pharmacy and Pharmacology

Volume 11 Number 7, 22 February, 2017
ISSN 1996-0816

Academic Journals

ABOUT AJPP

The **African Journal of Pharmacy and Pharmacology (AJPP)** is published weekly (one volume per year) by Academic Journals.

African Journal of Pharmacy and Pharmacology (AJPP) is an open access journal that provides rapid publication (weekly) of articles in all areas of Pharmaceutical Science such as Pharmaceutical Microbiology, Pharmaceutical Raw Material Science, Formulations, Molecular modeling, Health sector Reforms, Drug Delivery, Pharmacokinetics and Pharmacodynamics, Pharmacognosy, Social and Administrative Pharmacy, Pharmaceutics and Pharmaceutical Microbiology, Herbal Medicines research, Pharmaceutical Raw Materials development/utilization, Novel drug delivery systems, Polymer/Cosmetic Science, Food/Drug Interaction, Herbal drugs evaluation, Physical Pharmaceutics, Medication management, Cosmetic Science, pharmaceuticals, pharmacology, pharmaceutical research etc. The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in AJPP are peer-reviewed.

Contact Us

Editorial Office: ajpp@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/AJPP

Submit manuscript online http://ms.academicjournals.me/

Editorial Board

African Journal of Pharmacy and Pharmacology

Table of Contents: Volume 11 Number 7 22 February, 2017

ARTICLE

academicJournals

Vol. 11(7), pp. 108-119, 22 February, 2017
DOI: 10.5897/AJPP2016.4721
Article Number: 2FD663163210
ISSN 1996-0816

http://www.academicjournals.org/AJPP

African Journal of Pharmacy and Pharmacology

Full Length Research Paper

Essential oil compositions of leaf, stem-bark, stem, root, flower, and fruit with seed of *Blighia unijugata* Baker (Sapindaceae)

Dorcas Olufunke Moronkola[1]*, Usman Zaki Faruq[2], Oludoyin Adeseun Adigun[1] and Clement Odunayo Ajiboye[1]

[1]Department of Chemistry, University of Ibadan, Ibadan, Oyo State, Nigeria.
[2]Department of Pure and Applied Chemistry, Usmanu Danfodiyo University, Sokoto State,, Nigeria.

Received 21 December, 2016: Accepted 27 January, 2017

Essential oils from six different parts of *Blighia unijugata* Bak., were obtained using Clevenger-type apparatus; they gave yields between 0.061 and 0.824%. Chemical constituents of the oils were determined using gas chromatography coupled with mass spectrometry (GC-MS). The GC-MS analysis show forty-seven compounds are present in the leaf oil, twenty-one compounds are in stem-bark, twenty-four in stem oil, sixteen in root oil, twenty-five in flower and twenty-nine in fruit with seed oils. Leaf oil was dominated by methyl salicylate (40.68%), oleic acid (8.74%) and 2-morpholinophenazine (5.20%); stem-bark oil has its most abundant compounds as octadec-9-enoic acid (25.63%), 2-[(tert-butyldimethylsily)oxy]-1-isopropyl-dimethyl-benzene (14.83%) and octadecanoic acid (10.12%). Stem oil contain mostly oleic acid (23.01%), 1,3-dibromo-4,5-dimethylbenzene (15.91%) and 3,7-dimethyl-8-oxo-5-dioxa-spiro[5,5]-3-methyl-undecanoate (8.00%). Principal compounds in root oil are oleic acid (25.53%), 1,2-bis-(trimethylsilyl)benzene (17.97%) and octadecanoic acid (9.60%). Twenty-four compounds were identified in flower oil, which account for 99.28% of it, with its most abundant compounds being oleic acid (25.34%), decamethyl-tracylosane (12.73%) and 2,2-diphenyl-2h-1-benzopyran (9.57%); while the fruit with seed oil is dominated by 2-penten-1-ol (30.68%), 3-methyl-pentane (14.75%) and methyl-cyclopentane (11.71%). Esters dominate leaf oil (47.35%), carboxylic acids were prominent in stem bark, stem, flower and root oils (48.34, 34.36, 35.56 and 50.02%, respectively). Monoterpenes (2.25%), indoles (1.06%) and quinones (1.59%) were abundant in leaf oil while sesquiterpenoids were only in leaf and stem bark oils (0.52 and 0.49%, respectively). This paper report the varied compositions of the six essential oils obtained from different parts of the ethno-medicinally applied *Blighia unijugata*, which have not been reported earlier in literature.

Key words: *Blighia unijugata,* essential oil, esters, carboxylic acids, monoterpenes, sesquiterpenoids, gas chromatography-mass spectrometry, Sapindaceae.

INTRODUCTION

Blighia unijugata Bak belongs to the family Sapindaceae also known as soapberry. This family contains approximately 1900 species in 140 genera, which can be classified into 4 sub-families (Acevedo-Rodriguez et al., 2011). The three species of *Blighia* are *Blighia sapida* (Ackee), *B. unijugata* and *B. welwitschii. B. unijugata* is a

forest species widespread in tropical Africa, from Sierra Leone to Cameroon. The plant is found in Cote d'voire during secondary formations as reforestation (Davies and Verdcourt, 1998; Burkill, 2000). It is also found in South Africa, Ghana, Nigeria and Uganda (Burkill, 2000).

B. unijugata is a shrub 6 to 9 m tall, but grows sometimes up to 30 m, usually straight, up to 180 cm in diameter, slightly fluted at the base and with a dense crown. The bark is gray or brown, smooth, and fine, sometimes with warts. Leaves of this are reddish when young and become shiny green when matured (Acevedo-Rodriguez et al., 2011; Hyde et al., 2016) with attractive appearance, having red or pinkish-yellow fruits.

Generally, *B. unijugata* a fast growing tree is planted for shade in Nigeria. In Kenya and Ethiopia, the trees are often left after land clearance, or sometimes planted to provide shade in coffee plantations. Its other social applications are in soap making, constructions, flooring, interior trim, joinery, furniture, toys, agricultural implements, musical instruments, boxes, crates, and carving. The wood is good source of fuel, suitable for shipbuilding, veneer, plywood and pulpwood, also as firewood and charcoal production (Aquaisua et al., 2011; Burkill, 2000), which is occasionally traded with in international market (Hyde et al., 2016).

Various parts of *B. unijugata* are ethno-medicinally applied. It is recognized for its sedative with energetic properties in the prevention of vomiting (Mshana et al., 2000), treatment of rheumatism (Burkill, 2000), kidney pain, stiffness and they are reported to have oxytocic action in childbirth (Burkill, 2000). In Central Africa Republic, the soapberry seed oil is used in medicinal ointments and in Sierra Leone, seeds are reported to be edible (Aquaisua et al., 2011; Burkill, 2000).

The bark decoction is taken to treat fever and as purgative while bark pulp is applied as an enema. In Cote d'Ivoire, leaf pulp is administered as an embrocation, rejuvenator and relaxant. In Congo, leaves are used as tonic, and vapour baths for the treatment of fever in children. In Nigeria, leaves are eaten as vegetable and its decoction to treat fatigue and vertigo (Aquaisua et al., 2011; Burkill, 2000). Fruits have also been used in Nigeria for the treatment of nausea and vomiting. In South Africa, flowers are sometimes soaked in water to make a fragrant cosmetic lotion. The roots are used to treat postpartum bleeding (haemorrhage) and boils (Mshana et al., 2000).

Scientific report on ethanol extracts of roots, bark and leaves of *B. unijugata* indicates it has antibacterial activity, which is pronounced against *Staphylococcus aureus* (Oderinde et al., 2008). Phytochemical analysis showed presence of steroids, saponins and tannins in its root, bark and leaf extracts (Oderinde et al., 2009). The butanol fractions of its leaves also show presence of polyphenols, tannins, flavonoids, saponins, alkanoids, sterols, polyterpenes, reduced sugar, coumarins, quinones and cardiotonic glycosides (Longanga et al., 2000). Studies on oils extracted from seeds and aril of *B. unijugata* revealed no clinical toxicity (Oderinde et al., 2009).

This study presents essential oils compounds from six parts of *B. unijugata* (leaf, stem-bark, stem, root, flower and fruit with seed), which have not been reported previously.

MATERIALS AND METHODS

Plant collection, separation and essential oils extraction

Samples of *B. unijugata* were collected from University of Ibadan (Nigeria) and separated to leaf (4.80 Kg), stem bark (3.05 Kg), stem (3.50 Kg), root (4.10 Kg), flower (0.50 Kg) and fruit with seed (0.22 Kg) parts. *B. unijugata* was authenticated and voucher specimen was deposited at the Herbarium (UIH-22344), Department of Botany, University of Ibadan, Ibadan (Nigeria).

Each sample was crushed separately and hydro-distilled for 2.5 to 3.0 h in an all glass Clevenger-type apparatus designed to British Pharmacopeia specifications. Oils were collected under iced condition with about 0.5 ml distilled n-hexane, which was removed, and the oils refrigerated.

Gas chromatography-mass spectrometry

The six volatile oils obtained were subjected to GC-MS analyses using Agilent Gas Chromatographic Instrument (model 6890) coupled to mass selective detector (MSD 5973N). The GC column used was Agilent 122-5532 of 30 m nominal length, 0.25 mm (250 μm) diameter with 0.25 μm film thickness. The injection port (inlet) was set on split mode with split ratio of 50:1, at 250°C and helium gas pressure of 3.53 psi to achieve a total flow rate of 52.5 mL/min. The oven was set at initial temperature of 75°C to hold for 5 min then to rise at the rate of 4°C/min to a final temperature of 250°C and to hold for 10 min giving a total running time of 58.75 min. Exactly 1 μL of the sample diluted with n-hexane was introduced into the injection port of the GC using auto-injection device and allowed to run using the set programme. The analysis of the chromatogram was done with the ChemStation software. For the MS, the interface was set 250°C; ion-source at 200°C; quadruple at 150°C; filament energy 70 eV; threshold 3000; scan acquisition mode; scan speed 1428; with a mass range of m/z 40 to 700. Finally ChemStation software was employed for the data analysis.

Identification of components

Essential oil compounds were identified based on their retention indices (determined with reference to a homologous series of *n*-alkanes), and by comparison of their mass spectral fragmentation patterns with in-built computer data and commercial systems, such

*Corresponding author. E-mail: funkemoronkola@yahoo.com. Tel: +2348023416336.

Table 1. Yields of essential oil procured from leaf, stem-bark, stem, root, flower and fruit with seed.

S/N	Plant's parts	Weight of sample (g)	Weight of volatile oil (g)	% Yield of oil	Physical examination	
					Colour	Odour
1	Leaf	4800.00	3.894	0.081	Cream oil	Choking
2	Stem-Bark	3050.00	2.578	0.085	Light yellow	Herbal peppery
3	Stem	3500.00	2.124	0.061	Light yellow	Herbal
4	Root	4100.00	3.227	0.079	Colourless	Woody
5	Flower	500.00	1.848	0.370	Yellow	Sweet
6	Fruit with seed	216.53	1.785	0.824	Deep yellow	Sweet

as the National Institute for Standards and Technology (NIST) 2005database/Chemstation data system. Wiley GC-MS Library, Adams Library (Adams, 2007), Mass Finder 3.1 Library (Joulain and Koenig, 1998), and in-house "Baser Library of Essential Oil Constituents" built up from genuine compounds and components of known oils.

RESULTS AND DISCUSSION

Essential oils obtained from the six parts of *B. unijugata* as shown in Table 1 gave some characteristic colours and odours (leaf was cream and choking, stem-bark is light yellow and herbal peppery, stem was light yellow and herbal peppery; root was colourless and woody; flower was yellow and sweet and fruit with seed was deep yellow and sweet). Essential oils were all obtained in good yields ranging from 0.061 to 0.824%. Highest yield was obtained from fruit with seed oil (0.824%) while the lowest yield was from the stem oil (0.061%), which may be as a result of high fiber content in stem than other parts.

Gas chromatograms of leaf (Figure 1), stem-bark, (Figure 2) stem (Figure 3), root (Figure 4), flower (Figure 5) and fruit with seed (Figure 6) revealed presence of forty-seven compounds in the leaf oil; twenty-one compounds in stem-bark; twenty-four in stem oil; sixteen in root oil; twenty-five in flower, and twenty-nine in fruit with seed oils. One hundred and twenty five (125) compounds have been identified in all the six essential oils (Table 2).

Leaf oil was dominated by methyl salicylate (40.68%), oleic acid (8.74%) and 2-morpholinophenazine (5.20%); stem-bark oil has its most abundant compounds as oleic acid (25.63%), 2-[(tert-butyldimethylsily)oxy]-1-isopropyl-dimethyl-benzene (14.83%) and octadecanoic acid (10.12%). Stem oil contain mostly oleic acid (23.01%), 1,3-dibromo-4, 5-dimethylbenzene (15.91%) and 3,7-dimethyl-8-oxo-5-dioxa-spiro[5,5]- 3- methyl-undecanoate (8.00%). Dominant compounds in root oil were oleic acid (25.53%), 1,2-bis-(trimethylsilyl)benzene (17.97%) and octadecanoic acid (9.60%). Twenty-four compounds were identified in flower oil, which account for 99.28% of it, with its most abundant compounds being oleic acid (25.34%), decamethyl-tracylosane (12.73%) and 2,2-diphenyl-2h-1-benzopyran (9.57%); while the fruit with seed oil was dominated by 2-penten-1-ol (30.68%), 3-methyl-pentane (14.75%) and methyl-cyclopentane (11.71%). This paper report other constituents in each of the six essential oils studied (Table 2).

Monoterpenes (2.25%), indoles (1.06%), quinones (1.59%) and azulene (1.27%) were peculiar to leaf oil. Sesquiterpenoids are in the leaf and stem oils (0.52 and 0.49% respectively), while aldehyde and alcohols were prominent in oils of leaf and fruit with seed. N-substituted aromatics were present in leaf (5.20%) and stem bark oils (0.65%). The six oils contain ester, saturated and unsaturated hydrocarbons, carboxylic acids and ketones as the major classes of compounds (Table 3). Monoterpenes are known to inhibit accumulation of toxins in biological system while sesquiterpenes delete bad information in cellular memory and is often used as fixatives in perfumery industries (Solo Build It, 2017). The two terpenes are present in appreciable amount in leaf and stem-bark essential oils. Esters dominate leaf oil (47.35%); they are important constituent of perfumes, cosmetics, food flavours, and surfactants e.g. in soap and detergents. Methyl salicylate which is abundant in leaf oil (40.68%) is biologically attributed to cause temporary relief of minor pains, hence act as analgesic, also a known fragrance in foods and beverages (Oloyede, 2011; Mason et al., 2004).

Carboxylic acids are prominent in stem bark, stem, flower and root oils (48.34, 34.36, 35.56 and 50.02%, respectively). Oleic acid (Octadec-9-enoic acid), a principal compound in the oils is known to reduce blood pressure, as well as increase fat burning which aids weight loss, protects cells from free radical damage, prevents ulcerative colitis and generates brain myelin (de Silva et al., 2014; Sales-Campos et al., 2013; Cunnane et al., 2012; Teres et al., 2008).

The chemical compositions of the six essential oils reported in this study are unique and supports the vast ethno-medicinal applications of *B. unijugata.*

Conclusions

One hundred and twenty five (125) compounds were

Table 2. Chemical composition of essential oil from leaf, stem-bark, stem, root, flower and fruit with seed of *Blighia unijugata.*

S/N	Identified compound [a]	RI[b]	Class of organic compounds	Leaf % TIC[c]	Stem-bark% TIC[c]	Stem% TIC[c]	Root% TIC[c]	Flower% TIC[c]	Fruit with seed% TIC[c]
1	2-methyl-pentane	260	Saturated Hydrocarbon	-	-	-	-	-	5.77
2	3-methyl-pentane	300	Saturated Hydrocarbon	-	-	-	-	-	14.75
3	2-penten-1-ol	324	Alcohol	-	-	-	-	-	30.68
4	3-methyl-heptane	350	Saturated Hydrocarbon	-	-	-	-	-	0.35
5	Methyl-cyclopentane	365	Cyclic Hydrocarbon	-	-	-	-	-	11.71
6	Cyclohexane	468	Cyclic Hydrocarbon	-	-	-	-	-	6.18
7	3-methyl Hexane	477	Saturated Hydrocarbon	-	0.53	-	0.89	5.63	-
8	2,2,6,6-Tetramethylcyclohexanone	480	Ketone	-	-	-	-	1.26	-
9	1,3-dimethyl-,cis-cyclopentane	491	Cyclic Hydrocarbon	-	-	-	-	1.05	-
10	9-methyl-(z)-3-undecene	495	Unsaturated Hydrocarbon	-	-	-	-	0.41	-
11	1,2-dimethyl-cyclopentane	498	Cyclic Hydrocarbon	-	-	-	-	0.58	-
12	3,3,5-trimethyl-heptane	506	Saturated hydrocarbon	-	-	0.61	-	0.72	-
13	3,3,4-trimethyl-hexane	506	Saturated HC	-	-	-	0.79	-	-
14	2-methyl 2-methylpropanoate	506	Ester	-	0.57	-	-	-	-
15	2-ethyl furan	507	Ether	1.01	-	-	-	-	-
16	Toluene	739	Cyclic Hydrocarbon	-	-	-	-	0.37	-
17	1,3,5-heptatriene	739	Unsaturated Hydrocarbon	0.5	-	-	-	-	-
18	1,3-dimethylcyclopentane	753	Cyclic Hydrocarbon	-	0.36	-	-	-	-
19	2-methyl-1,4-pentadiene	799	Unsaturated Hydrocarbon	-	0.47	-	-	-	-
20	2-methylpenta1,3-diene-5-ol	803	Alcohol	3.25	-	-	-	-	-
21	E-2-hexen-1-ol/ cyclohexanol	1061	Alcohol	0.59	-	-	-	-	-
22	Methylcyclopentane	1063	Cyclic Saturated Hydrocarbon	0.41	-	-	-	-	-
23	O/P-xylene	1067	Aromatic Hydrocarbon	0.71	-	-	-	-	-
24	Bicyclo[4.2.0]octa-1,3,5-triene	1080	Bicyclic unsaturated Hydrocarbon	0.53	-	-	-	-	-
25	Octanal	1103	Aldehyde	-	-	-	-	-	0.68
26	Benzaldehyde	1118	Aromatic aldehyde	0.8	-	-	-	-	-
27	2-(1-pentenyl)-E-furan	1133	Ether	1.34	-	-	-	-	-
28	4-ethyl-1,2-dimethyl benzene	1148	Aromatic Hydrocarbon	0.73	-	-	-	-	-
29	D-limonene	1150	Monoterpene	1.82	-	-	-	-	-
30	Eucalyptol	1153	Sesquiterpenoid	0.52	-	-	-	-	-
31	Benzeneacetaldehyde/ 2-phenylethanal	1157	Aldehyde	0.67	-	-	-	-	-
32	3-hydroxybenzaldehyde	1159	Aldehyde	0.51	-	-	-	-	-
33	Nonanal	1477	Aldehyde	-	-	-	-	-	1.02
34	2-methoxyphenol	1484	Ether/ alcohol	0.83	-	-	-	-	-
35	3,7-dimethyl-1,6-octadien-3-ol	1487	Alcohol	0.56	-	-	-	-	-

Table 2 Contd.

36	2-Nonanal	1504	Aldehyde	-	-	-	-	-	0.31
37	3-phenylbut-1-ene	1509	Aromatic Hydrocarbon	0.42	-	-	-	-	-
38	2-butenyl-benzene	1513	Aromatic hydrocarbon	-	-	0.52	-	-	-
39	1-ethenyl-3-ethylbenzene	1513	Aromatic Hydrocarbon	0.69	-	-	-	-	-
40	1,3-dimethoxy-benzene	1516	Aromatic Hydrocarbon	-	0.52	-	-	-	-
41	1,7,7-trimethyl(1S-endo)-bicyclo[2.2.1]heptan-2-ol	1522	Alcohol	0.64	-	-	-	-	-
42	Methylsalicylate	1528	Ester	40.68	-	4.29	-	0.59	-
43	Naphthalene	1530	Aromatic hydrocarbon	-	-	0.61	-	-	-
44	Cis-2,3-epoxyheptane	1538	Saturated Hydrocarbon	-	-	-	-	-	0.37
45	1-methyl-1-(1-methylethyl)-2-nonyl-cyclopropane	1546	Cyclic Hydrocarbon	-	-	-	-	-	0.82
46	3,7-dimethyl-(E)-2,6-octadienal	1551	Aldehyde	0.45	-	-	-	-	-
47	di-t-butylacetylene	1558	Unsaturated Hydrocarbon	-	-	-	-	-	0.32
48	2,4-decadienal	1567	Aldehyde	-	-	-	-	-	0.85
49	2-methyl-naphthalene	1570	Aromatic hydrocarbon	0.62	-	0.54	-	-	-
50	1-methylnaphthalene	1906	Aromatic HC	0.42	-	-	-	-	-
51	Eugenol	1912	Monoterpenoid	0.43	-	-	-	-	-
52	(2-methylpropyl)-cyclohexane	1912	Cyclic Hydrocarbon	-	-	-	-	-	0.83
53	1-methyl-4-(1-methylidene)cyclohexene	1936	Unsaturated Hydrocarbon	0.8	-	-	-	-	-
54	1-(1,5-dimethyl-4-hexenyl)-4-methylbenzene	1953	Aromatic Hydrocarbon	1.95	-	0.74	-	-	-
55	6-methyl-2-methylene-6-(4-methyl-3-pentenyl)-[1R-1α,5α,6β]-bicyclo[3.1.1]heptane	1957	Bicyclic Hydrocarbon	2.5	-	-	-	-	-
56	5-(1,5-dimethyl-4-hexenyl)-2-methyl-1,3-cyclohexadiene	1957	Unsaturated hydrocarbon	-	-	1.6	-	-	-
57	2,4a,5,6,7,8,9,9a-octahydro-3,5,5-trimethyl-9-methylene-1H-benzocycloheptene	1961	Unsaturated hydrocarbon	-	-	0.53	-	-	-
58	1-methyl-4-(5-methyl-1-methylene-4-hexenyl)-S-cyclohexene	1961	Unsaturated Hydrocarbon	0.84	-	-	-	-	-
59	Epizonarene	1965	Unsaturated Hydrocarbon	0.54	-	-	-	-	-
60	Octahydro-3,8,8-trimethyl-6-methylene-[3R-(3α,3aβ,7β,8aα)]-1H-3a,7-methanoazulene	1967	Azulene Hydrocarbon	1.27	-	-	-	-	-

Table 2 Contd.

61	3-(1,5-dimethyl-4-hexenyl)-6-methylene-cyclohexene	1967	Unsaturated hydrocarbon	-	-	0.72	-	-	-
62	Dodecanoic acid	1969	Carboxylic acid	0.5	2.05	1.69	2.34	1.46	0.52
63	3-(4,8-dimethyl-3,7-nonadienyl)-E-furan	1977	Ester	2.17	-	-	-	-	-
64	Tetradecanoic acid	2356	Carboxylic acid	0.55	1.68	1.41	1.87	0.91	0.4
65	1-(3,3-dichloropropyn-1-yl)adamantine	2360	Halogenated sesquiterpene	-	0.49	-	-	-	-
66	1-Methyl-4-[4,5-dihydroxyphenyl]-hexahydropyridine	2367	Cyclic Hydrocarbon	-	-	-	-	0.52	-
67	Benzylbenzoate	2370	Aromatic ester	0.67	-	-	-	-	-
68	3,3-Diisopropoxy-1,1,1,5,5,5-hexamethyltrisiloxane	2379	Organosilane	-	-	-	-	0.49	-
69	11,13-dimethyl-12-tetradecen-1-ol acetate	2379	Alcohol ester	0.95	-	-	-	-	-
70	2,3-dihydroxypropyl,9-octadecenoate(Z)	2393	Ester	-	-	-	0.77	-	-
71	2-oxo-cyclooctaneacetic acid	2393	Carboxylic acid	-	-	0.64	-	-	-
72	1,3-Bis(trimethylsilyl)benzene	2393	Aromatic Hydrocarbon	-	-	-	-	0.58	-
73	1-cyano-4-cyclohexylbenzene	2393	Aromatic Hydrocarbon	-	0.79	-	-	-	-
74	n-Hexadecanoic acid	2409	Carboxylic acid	2.4	8.86	-	9.63	7.85	2.28
75	3,7-dimethyl-8-oxo-5-dioxa-spiro[5.5]-3-methyl-undecanoate	2409	Ester	-	-	8	-	-	-
76	Trimethyl[5-methyl-2-(1-methylethyl)phenoxy]-silane/Thymol-TMS/ 2-isopropyl-5-methylphenol	2422	Aromatic hydrocarbon	-	-	-	-	0.41	-
77	4-(anisylideneamino)-cinnamic acid	2756	Carboxylic acid	-	-	-	1.05	-	-
78	3,5-bis(1,1-dimethylethyl)-4-hydroxy-2,4-cyclohexadien-1-one	2756	Ketone	-	-	-	-	0.71	-
79	3-(5-diethylamino-1-methyl-3-pentynyloxy)-propanenitrile	2756	Amine	-	-	0.64	-	-	-
80	2-Ethylacridine	2756	N-substituted aromatic	-	0.65	-	-	-	-
81	Diethylbis(trimethylsilyl)silicoate	2758	Ester	-	-	-	-	1.24	-
82	2-hydroxy-1-(hydroxymethyl)ethyl dodecanoate	2758	Alcohol ester	0.8	-	-	-	-	-
83	2,3-dihydroxypropyldodecanoate	2759	Ester	-	4.14	4.09	-	-	-
84	2-hydroxy-1-(hydroxymethyl)ethyl-dodecanoate	2759	Ester	-	-	-	4.44	-	0.83

Table 2 Contd.

85	Phytol	2761	Alcohol	0.6	-	-	-	-	-
86	Oleic acid	2767	Carboxylic acid	8.74	25.63	23.01	25.53	25.34	8.35
87	Octadecanoic acid	2771	Carboxylic acid	3.29	10.12	7.61	9.6	-	2.7
88	2,2-diphenyl-2h-1-benzopyran	2771	Aromatic HC	-	-	-	-	9.57	-
89	Hexamethyl-cyclotrisiloxane	2803	Organosilane	-	-	2.32	-	3.14	-
90	5-methyl-2-phenylindolizine	2803	Heterocyclic Indole	0.52	-	-	-	-	-
91	3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-1-propene	2803	Aromatic Hydrocarbon	-	2.75	-	-	-	-
92	1-methyl-2-phenyl-1H-indole	2803	Indole	-	-	-	2.81	-	-
93	1-(3-hydrohy-3-phenyl-1-triazenyl)-antra-9,10-quinone	2803	Ketone	-	-	-	-	-	0.36
94	Benz[b]-1,4-oxazepine-4(5H)-thione	2806	Ketone	-	-	2.29	-	-	-
95	3,5-bis-trimethylsilyl-2,4,6-cycloheptatrien-1-one	2806	Ketone	-	-	-	2.61	-	-
96	2-hydroxy-1-tetradecanoate	2806	Ester	-	-	-	-	-	0.39
97	2-(Acetoxymethyl)-3-(methoxycarbonyl)biphenylene	2806	Aromatic ether	-	1.8	-	-	-	-
98	1-methyl-3-phenylindole	2806	Indole	0.54	-	-	-	-	-
99	z-4-Nanodecen-1-ol acetate	3146	Ester	-	-	-	-	-	1.2
100	3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-1-propene	3146	Unsaturated Hydrocarbon	-	-	-	-	9.24	-
101	2-[(tert-butyldimethylsilyl)oxy]-1-isopropyl-4-methyl-benzene	3146	Aromatic ether	-	8.15	7.31	9.83	-	-
102	1-(3-hydroxy-3-phenyl-1-triazenyl)-antra-9,10-quinone	3146	Quinone	1.59	-	-	-	-	-
103	Trimethyl-[4-(2-methyl-4-oxo-2-pentyl)phenoxy]silane	3152	Organosilane	0.94	-	-	-	-	-
104	Methyltris(trimethylsiloxy)silane	3152	Organosilane	-	4.09	-	-	-	-
105	2,4-dimethyl-benzo[h]quinolone	3152	Ketone	-	-	-	4.82	-	-
106	2-(trimethylsiloxy)-propiophenone	3152	Ketone	-	-	3.71	-	-	0.64
107	2-(acetoxymethyl)-3-(methoxycarbonyl)biphenylene	3152	Unsaturated Hydrocarbon	-	-	-	-	5.29	-
108	Hexamethyl-9-10-anthracenedione,1-amino-4-hydroxycyclotrisiloxane	3157	Organosilane	-	-	5.03	-	-	-

Table 2 Contd.

109	5-methyl-2-phenylindolyzine	3157	Amine	-	-	-	-	4.65	-
110	2-hydroxy-1-(hydroxymethyl)ethyl-hexadecanoate	3157	Ester	-	-	-	5.03	-	-
111	2-amino-3hydroxy-9,10-anthracenedione	3157	Ketone	-	4.93	-	-	-	1.32
112	1-amino-4-hydroxy-9,10-anthracenedione	3157	Aromatic ketone	1.43	-	-	-	-	-
113	Decamethyl-tetracylosane	3222	Organosilane	-	-	-	-	12.73	-
114	2,4-dinitrophenylhydrazonecyclopentanone	3223	Ketone	-	-	-	-	-	2.82
115	2-morpholinophenazine	3223	N-substituted aromatic	5.2	-	-	-	-	-
116	2-[(tert-butyldimethylsilyl)oxy]-1-isopropyl-4-methyl-benzene	3223	Aromatic HC	-	14.83	-	-	-	-
117	1,3-dibromo-4,5-dimethylbenzene	3223	Hydrocarbon	-	-	15.91	-	-	-
118	1,2-bis-(trimethylsilyl)-benzene	3223	Aromatic HC	-	-	-	17.97	-	-
119	5-methyl-2-phenylindolyzine	3230	Amine	-	-	-	-	5.25	-
120	2-methyl-3-(1,1-dimethyl-2-propynyl)-1-(1-naphtyl)-isothiourea	3231	Amine	-	-	6.18	-	-	-
121	2-hydroxy-1-(hydroxymethyl)octadecanoate	3231	Ester	2.08	-	-	-	-	-
122	2-hydroxy-1-(droxymethyl)ethyloctadecanoate	3231	Ester	-	6.58	-	-	-	-
123	2-Benzylidenehydrazono-3-methyl-2,3-dihydrobenzothiazole	3231	Aromatic Hydrocarbon	-	-	-	-	-	1.16
124	1,3-Bis(trimethylsilyl)benzene	3541	Aromatic Hydrocarbon	-	-	-	-	-	0.64
125	β-Tocopherol	4239	Alcohol	-	-	-	-	-	1.74

[a] Name of authenticated and identified compound; [b]Calculated retention Indices with reference to homologous series of n-alkane; [c] %TIC (percentage total ion concentration).

Table 3. Classes of compounds of leaf, stem bark, stem, fruit with seed, flower and root essential oils of *Blighia unijugata.*

Class of compounds	Leaf (%TIC°)	Stem bark (%TIC°)	Stem (%TIC°)	Root (%%TIC°)	Flower (%%TIC°)	Fruit with seed (%TIC°)
Monoterpenes	2.25	-	-	-	-	-
Sesquiterpenoid	0.52	0.49	-	-	-	-
Hydrocarbons*	11.66	20.25	21.78	19.65	34.37	42.90
N-substituted aromatic	5.20	0.65	-	-	-	-
Ester	47.35	11.29	16.38	10.24	1.83	2.42
Carboxylic Acid	15.48	48.34	34.36	50.02	35.56	14.25
Organosilane	0.94	4.09	7.35	-	16.36	-
Alcohol	6.47	-	-	-	-	32.42
Ether	2.35	9.95	7.31	9.83	-	-
Aldehyde	2.43	-	-	-	-	2.86
Quinone	1.59	-	-	-	-	-
Ketone	1.43	4.93	6.00	7.43	1.97	5.14
Azulene	1.27	-	-	-	-	-
Indole	1.06	-	-	2.81	-	-
Amine	-	-	6.82	-	9.9	
Total% composition	**100**	**99.99**	**100**	**99.98**	**99.99**	**99.99**

***Include saturate; unsaturate and normal aromatic hydrocarbons.

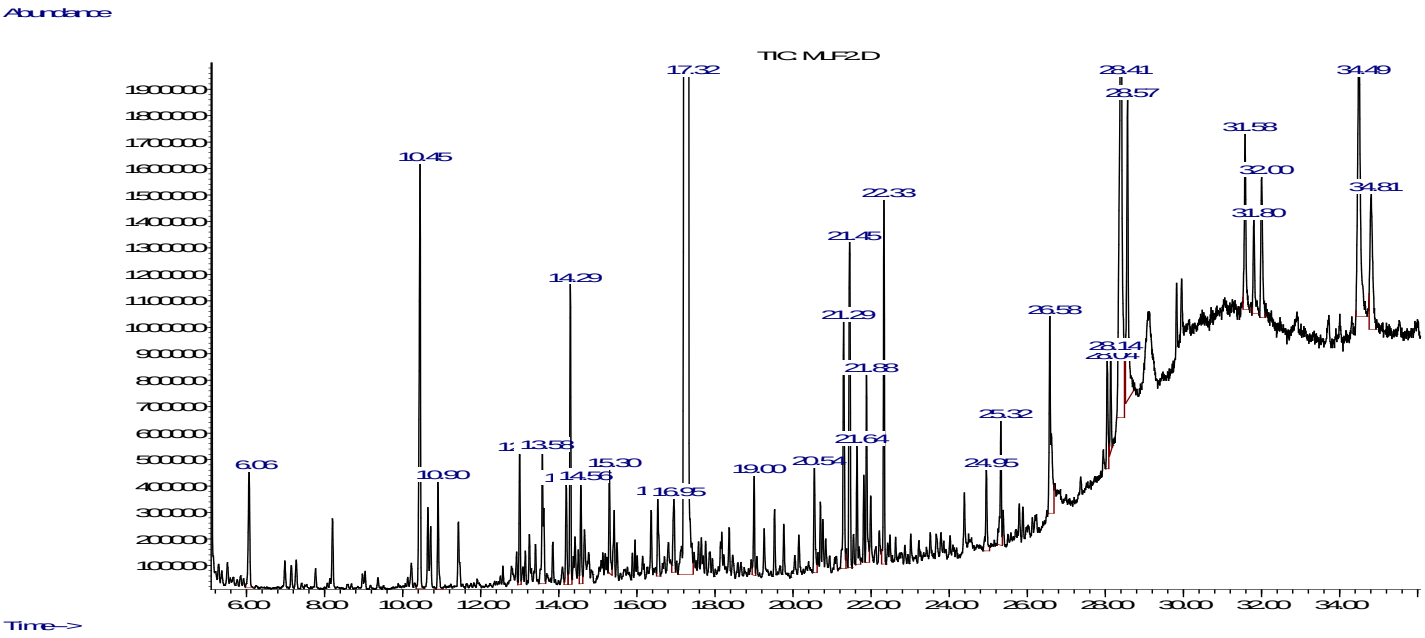

Figure 1. BU Leaf EO Chromatogram. Gas Chromatogram of the Leaf essential oil of *Blighia unijugata* (Baker).

identified in the six essential oils of *B. unijugata.* Our results indicate that oils from the leaf, stem bark, stem, root, flower and fruit with seed of the plant have varied compositions, with some of the compounds known to have bioactivities, which justifies the vast ethno-medicinal uses and applications of *B. unijugata*.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

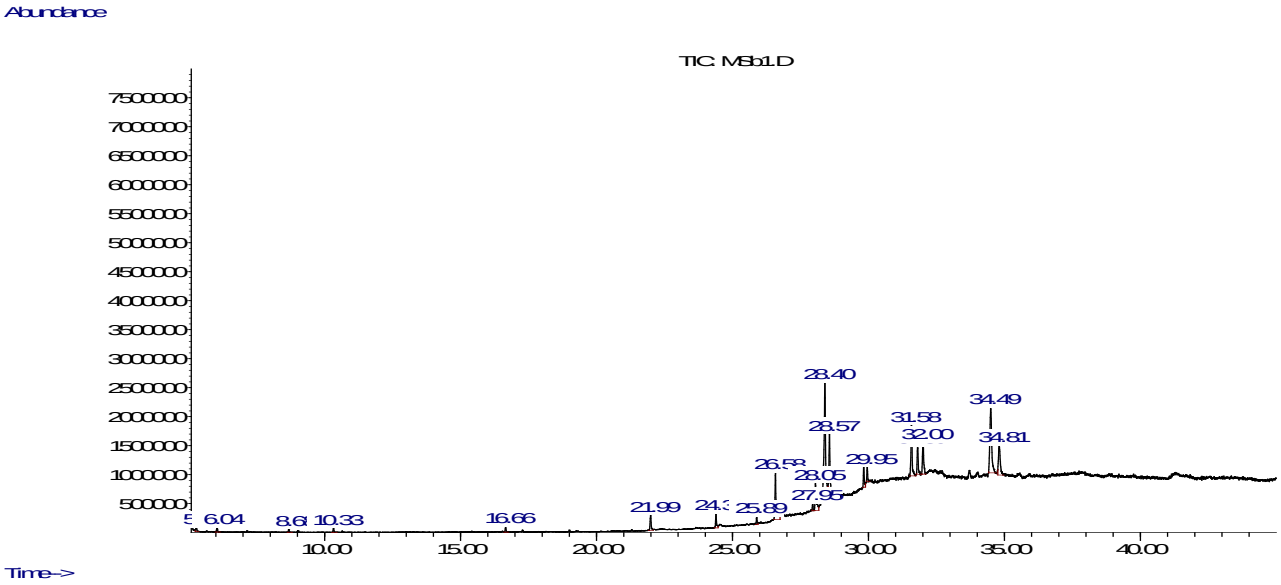

Figure 2. BU Stem bark EO Chromatogram. Gas chromatogram of the stem bark essential oil of *Blighia unijugata* (Baker).

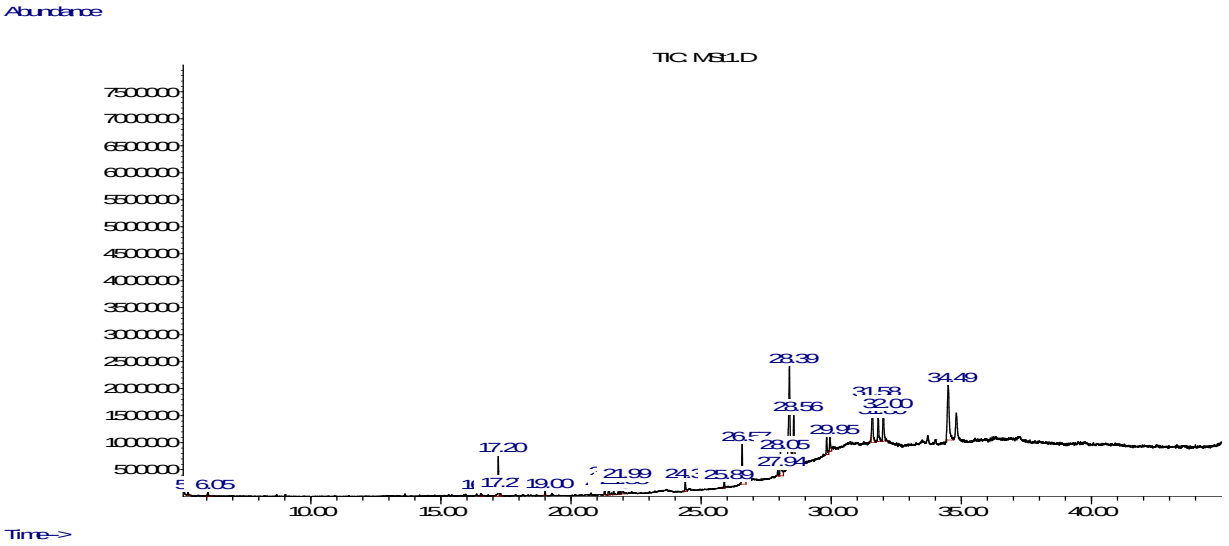

Figure 3. BU Stem EO Chromatogram. Gas chromatogram of the stem essential oil of *Blighia unijugata* (Baker).

ACKNOWLEDGEMENT

The authors acknowledge the use of J-laboratory standard facilities, Chemistry Department University of Ibadan, Ibadan, Nigeria for essential oil extractions. Also they acknowledge the use of GC-MS machine in Usmanu Danfodiyo University, Sokoto. Nigeria; where detailed analyses of the six essential oils were done.

REFERENCES

Acevedo-Rodriguez P, Van Welzen F, Adema F, Van der Ham RWJM (2011). “Sapindaceae” in klaus kubitzki. the families and genera of vascular plants. Berlin: Springer. 10:357-407.

Adams RP (2007). Identification of essential oils component by gas chromatography-mass spectrometry. Allured publishing corporation, USA. 4th edition. ISBN: 978-1-932633-21-4

Aquaisua NA, Rosemary BB, Bussey MI, Enobong IB (2011). Effect of crude extracts of *Blighia unijugata* on histology of the liver and kidney of adult wister rats. Int. Res. J. Pharm. Pharmacol. 1(2):17-22.

Burkill HM (2000). “The useful plants of west tropical africa” family s-z. Addenda. Royal botanic gardens, kew, richmond, United Kingdom. 2nd Edition, 5:11-13, 586-593.

Cunnane SC1, Schneider JA, Tangney C, Tremblay-Mercier J, Fortier M, Bennett DA, Morris MC (2012). Plasma and brain fatty acid profiles in mild cognitive impairment and Alzheimer's disease. J. Alzheimers Dis. 29(3):691-697.

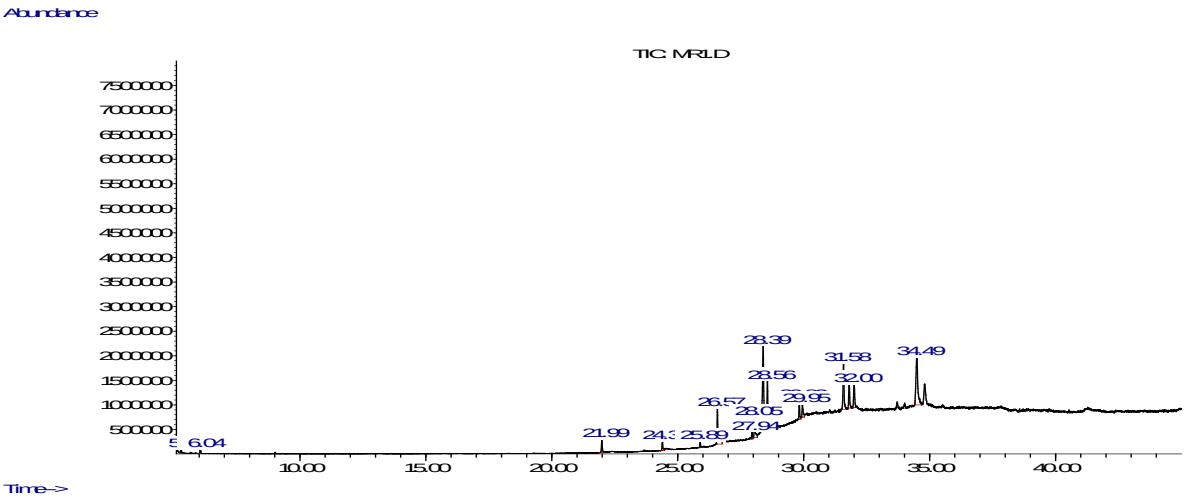

Figure 4. Gas Chromatogram of the Root essential oil of Blighia unijugata (Baker)

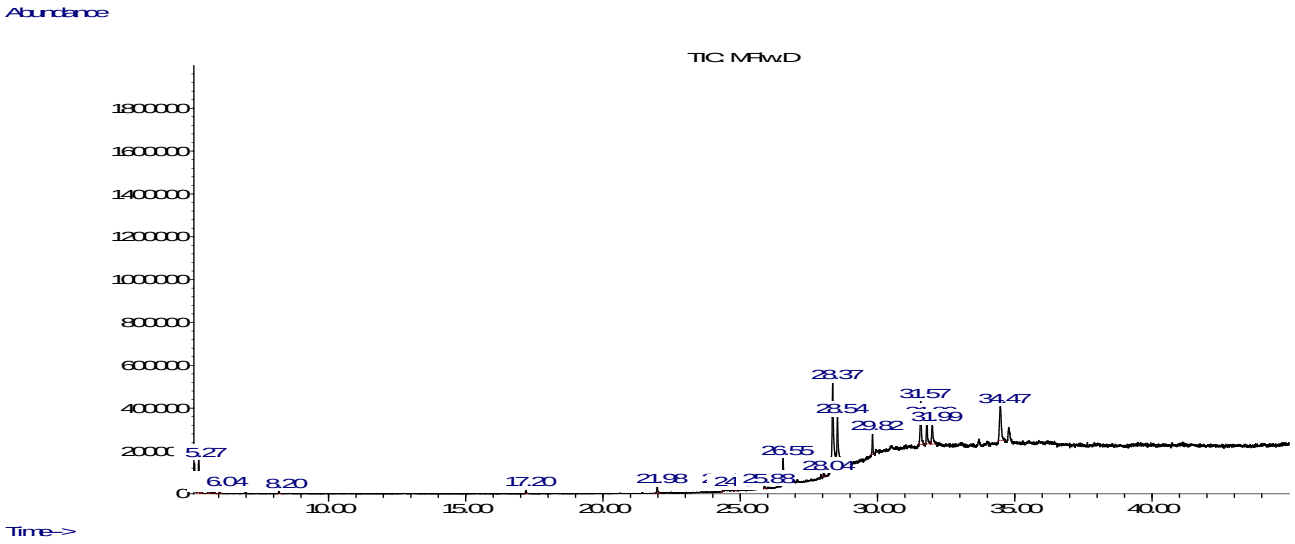

Figure 5. BU flower EO chromatogram. Gas chromatogram of the flower essential oil of *Blighia unijugata* (Baker).

Davies FG, Verdcourt B (1998). Sapindaceae. in beentje hj editor; flora of tropical east Africa. Rotterdam, Netherlands; AA Balkema: pp.101-108.

de Silva PS, Luben R, Shrestha SS, Khaw KT, Hart AR (2014). Dietary arachidonic and oleic acid intake in ulcerative colitis etiology: a prospective cohort study using 7-day food diaries. Eur. J. Gastroenterol. Hepatol. 26:11-18.

Hyde MA, Wursten B, Ballings P, Coates Palgrave M (2016). Flora of zimbabwe: species information: *Blighia unijugata*. http://www.zimbabweflora.co,zw/speciesdata/species.php?species_id=137480

Joulain D, Koenig WA (1998). The atlas of spectra data of sesquiterpene hydrocarbons: In mass finder 3.1 library. E. B Verlag, publishers. Hamburg, Germany.

Longanga AO, Vercruysse A, Foriers A (2000). Contribution to the ethno botanical, phytochemical and pharmacological studies of traditionally used medicinal plants in the treatment of dysentery and diarrhea in Lomola area, Democratic Republic of Congo (RDC). J. Ethnopharmacol. 71(3):411-423.

Mason L, Moore RA, Edwards JE, McQuay HJ, Derry S, Wiffen PJ (2004). Systematic review of efficacy of topical rubefacients containing salicylates for the treatment of acute and chronic pain. BMJ 328(7446):995.

Mshana NR, Abbiw DK, Addae-Mensah I, Adjanouhoun E, Ahyi MRA, Ekpere JA (2000). Traditional medicine and pharmacopoeia, contribution to the revision of ethnobotanical and floristic studies in Ghana. OAU/STRC. pp. 541-542.

Oderinde RA, Ajayi IA, Adewuyi A (2008). Nutritional elements, antibacterial activity and cytotoxicity of the leaf, root and stem bark of *Blighia unijugata* Baker (Sapindaceae). Med. Arom. Pl Sci. Biol. 2(2):137-140.

Oderinde RA, Ajayi IA, Adewuyi A (2009). Evaluation of the mineral nutrients characterization and some possible uses of *Blighia unijugata* Baker seeds and seed oil. EJEAFChe. 8(2):120-129.

Oderinde RA, Ajayi IA, Adewuyi A (2009). Preliminary toxicological evaluation and effect of the seed oil of Huracrepitans and *Blighia unijugata* Baker On the lipid profile of rat. EJEAFChe 8(3):209-217.

Oloyede GK (2011). Toxicity, antimicrobial and antioxidant activities of

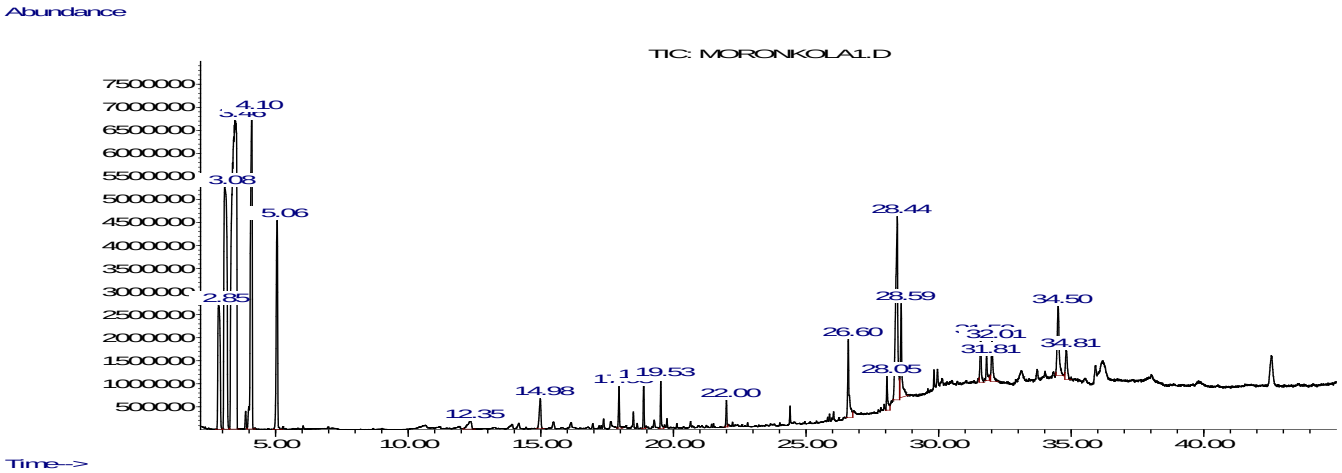

Figure 6. BU fruit with seed EO chromatogram. Gas chromatogram of the fruit with seed essential oil of *Blighia unijugata* (Baker)

methyl salicylate dominated essential oils of *Laportea aestuans* (Gaud). Arabian J. Chem. 9(Supplement 1):S840-S845.

Sales-Campos H, Souza PR, Peghini BC, da Silva JS, Cardoso CR (2013). An overview of the modulatory effects of oleic acid in health and disease. Mini. Rev. Med. Chem. 13(2):201-210.

Solo Build It - SBI. (2017). The chemistry of essential oil reveals aromatherapy as a true science. 2010-2017. Available at: http://www.experience-essential-oils.com/chemistry-of-essential-oil.html.

Teres S, Barcelo-Coblijn G, Benet M, Alvarez R, Bressani R, Halver JE, Escriba PV (2008). "Oleic acid content is responsible for the reduction in blood pressure induced by olive oil". Proc. Natl. Acad. Sci. USA. 105(37):13811-13816.

African Journal of Pharmacy and Pharmacology

Related Journals Published by Academic Journals

- *Journal of Medicinal Plant Research*
- *African Journal of Pharmacy and Pharmacology*
- *Journal of Dentistry and Oral Hygiene*
- *International Journal of Nursing and Midwifery*
- *Journal of Parasitology and Vector Biology*
- *Journal of Pharmacognosy and Phytotherapy*
- *Journal of Toxicology and Environmental Health Sciences*

academicJournals