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Bioactive Constituents of Methanol Extract of *Xylopia aethiopica* (UDA) Fruits from Nsukka, Enugu State, Nigeria

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Abstract

The bioactive compounds in methanol extract of *Xylopia aethiopica* fruits were determined using a combination of gas chromatography and mass spectrometry (GC-MS). The compound identification was based on the molecular structure, molecular mass and calculated fragments. Interpretation on mass spectrum of GC-MS analyzer (Hewlett Packard GC-MS system) was done using the database of National Institute Standard and Technology (NIST). The results showed different peaks representing the presence of about 58 bioactive compounds which are mainly carboxylic acids, esters, phenolic compounds and fatty acids. The most abundant bioactive compounds detected were 2,4,6-octatriene (2.74%), cyclohexanemethanol (2.57%), kaurene (3.59%), 9,12-octadecadienoic acid (5.63%), 1,6-cyclodecadiene (10.81%), terpineol (3.22%), cyclohexene (3.32%), copaene (3.04%), 1,6-cyclodecadiene (5.53%), 1-hexadecyne (5.63%) and silane (4.63%). The presence of these bioactive components suggests that the extract is of great pharmaceutical value.

Subject Areas

Biological Chemistry, Medicinal Chemistry

Keywords

Xylopia aethiopica, Bioactive Compounds, Gas Chromatography, Mass Spectrometry, Methanol Extract

1. Introduction

Africa is blessed with lots of medicinal plants that contain active principles that make them useful to cure Man's diseases. Medicinal plants are locally accepted because they are believed to have less or no side effects when compared to synthetic drugs. They are also available and cheap to obtain [1]. The analysis of the chemical constituents of these medicinal plants would be necessary in determining and isolating the active principles of these plants and hence, making way for the assessment of their biological activities. Currently, there are lots of techniques that can be employed to identify these constituents of plants such as chromatographic and spectroscopic techniques. A combination of gas chromatography (GC) and mass spectrometry (MS) has over the years proven to be one of the best combinational techniques in the identification of the chemical constituents of various plants. While gas chromatography separates the constituents, mass spectrometry helps to determine the molecular weight of these compounds [2]. The GC also separates volatile components in a sample while MS fragments the components and identifies them on the basis of their mass. Separation in GC is based on their boiling point where the substances with higher boiling point come out later and those with lower boiling point come out first. When they are out, they go into the MS which identifies them using their mass to charge ratio [3]. *Xylopia aethiopica* is a plant that is widely spread in the tropical Africa, especially in Ghana, Zambia, Mozambique and Angola. It is abundant in lowland rainforest and most fringe forest in the savanna zones of Nigeria [4]. It matures as a slim, tall tree of approximately 60 cm in diameter and up to 30 m high with a straight stem having a slightly stripped or smooth bark [5]. The taxonomical classification of *Xylopia aethiopica* includes:

Kingdom	→	Plantae
Subkingdom	→	Viridiplantae
Infra-kingdom	→	Streptophyta
Super-division	→	Embryophyta
Division	→	Tracheophyta
Subdivision	→	Spermatophytina
Class	→	Magnoliopsida
Superorder	→	Magnolianae
Order	→	Magnoliales
Family	→	Annonaceae
Genus	→	Xylopia L
Species	→	*Xylopia aethiopica*

Xylopia aethiopica has been recorded to have so many medicinal and nutritional values such as treatment of sores, boils, cough, wounds and cuts, among others [5]. [6] reported that fruits of the plant are used by herbalists for increasing menstrual flow and for terminating unwanted pregnancy. It is also added as a stimulant to several other herbal preparations in traditional medicine for treating stomach ache, bronchitis, dysentery, neuralgia and biliousness. Several biological activities such as promotion of prostaglandin synthesis [7], hypertensive and diuretic effects as well as antimicrobial, antimalarial and anti-parasitic activities have been reported of the plant [8]. Some of the chemical constituents of this plant include resins, annonacin, reberoside, avicien, rebersole, alkaloids, tannin, oxalate and flavonoids [9]. Anonaceine, an alkaloid similar to morphine was found in the essential oil from *X. aethiopica* [10]. The antifertility effect of the plant has also been reported [8]. The plant has been shown to elevate intraocular pressure [11], induce hepatic [12] and renal cell damages [13], and decreases sperm quality [8]. The major bioactive components of *X. aethiopica* fruits varied based on the location of source [14]: that from Cameroun were *β*-phellandrene +1,8-cineole (31%), *β*-pinene (8%) and *α*-pinene (3.4%) [15] while that from Ivory Coast was *β*-pinene (20.56%) [16]. In Chad, the major constituents were *α*-pinene (5.56%), *β*-pinene (24.6%), *β*-phellandrene (12.36%) and *α*-phellandrene (7.16%) [17]. From Togo, *α*-pinene (23.6%), *β*-pinene (11%), sabinene (9.8%), germacrene D (8.3%) and 1,8-cineole (8.2%) were detected by [18]. In Sudan, the GC-MS results revealed the presence of monoterpenes (78.58%): monoterpene hydrocarbons (42.31%) and oxygenated monoterpenes (36.27%) and sesquiterpenes (18.85%): sesquiterpene hydrocarbons ((15.88%) and oxygenated sesquiterpenes (2.97%) [19]. It is also believed that solvent extraction affects the chemical content of plant materials; hence, this study was therefore designed to determine the bioactive compounds of methanol extract of *Xylopia aethiopica* fruits from Enugu State, Nigeria using gas chromatography-mass spectrometry (GC-MS) technique.

2. Materials and Methods

2.1. Collection, Authentication and Extraction of Plant Material

The plant material used in this study, dried fruits of *Xylopia aethiopica* (**Figure 1**), was collected from Ogige Main-Market in Nsukka, Enugu State, Nigeria in the month of March, 2017. It was authenticated at the Herbarium of the Department of Plant Science and Biotechnology, University of Nigeria, Nsukka, Enugu State,

Figure 1. *Xylopia aethiopica* fruits.

Nigeria. The dried fruits were ground into powder using a mechanical grinder. The powdered sample (1000 g) was soaked in 4.5 litres of methanol (JHD, China) in an air-tight container and was left for 48 hours with occasional stirring. The suspension was filtered and the filtrate concentrated using a rotary evaporator under reduced pressure at 40˚C. The oily dark brown concentrate of percentage yield of 17.8% was subjected to GC-MS analysis.

2.2. Determination and Identification of Bioactive Compounds in Methanol Extract of *Xylopia aethiopica* Fruits

The bioactive components of methanol extract of *Xylopia aethiopica* fruits were determined using a GC-MS analyzer (Hewlett Packard GC-MS system with Purge and Trap, US EPA 8260/5035 by GC/MSD and ASTM D2600/D2908). The fused silica HP-20 M polyethylene glycol column (50 m × 0.2 mm, 0.2 μm thickness) was directly coupled to the mass spectrometer. The carrier gas was helium (1 mL/min). The program used was 4 min isothermal. The injection port temperature was 250˚C and the detector temperature 280˚C. Mass spectra were taken at 70 eV; a scan interval of 0.5 s and fragments from 45 to 450 Da. The relative percentage amount of each component was calculated by comparing its average peak area to the total area. Software adopted to handle mass spectra and chromatograms was Turbomass version 5.2.0. Identification of the compounds were based on the molecular structure, molecular mass and calculated fragments. Interpretation of mass spectrum from GC-MS was conducted using the database of National Institute Standard and Technology (NIST) having more than 82,000 patterns. The name of each bioactive component of the extract was ascertained and the percentage amount of each was calculated by comparing its average peak area to the total area. The spectrum of unknown components was compared with the spectrum of the known components stored in the NIST library. This was done in order to determine whether this extract contains any individual compound or group of compounds, which may substantiate its ethno-medicinal applications.

3. Results

Bioactive Compounds in Methanol Extract of *Xylopia aethiopica* Fruits

The identities of the bioactive compounds in methanol extract of *Xylopia aethiopica* fruits were confirmed based on the peak area and retention time and presented in Table 1. The GC-MS analysis of methanol extract of *X. aethiopica* fruits revealed fifty eight compounds representing 99% of the total extract and ten compounds representing only 1% unidentified. The major constituents were 2,4,6-octatriene (2.74%), cyclohexanemethanol (2.57%), kaurene (3.59%), 9,12-octadecadienoic acid (5.63%), 1,6-cyclodecadiene (10.81%), terpineol (3.22%), cyclohexene (3.32%), copaene (3.04%), 1,6-cyclodecadiene (5.53%), 1-hexadecyne (5.63%) and silane (4.63%).

Table 1. Bioactive compounds in methanol extract of *Xylopia aethiopica* fruits.

Peak No.	Retention Time	Area %	Identified compound
1.	4.361	3.22	Terpineol, cis-*β*-terpineol cyclohexene, 1-methyl-3-(1-methylethenyl)
2.	4.533	1.07	1,6-Octadien-3-ol, 3,7-dimethyl-bicyclo [2.2.1] hept-2-ene, 2,7,7-trimethyl-1,6-Octadien-3-ol, 3,7-dimethyl
3.	4.751	2.74	2,4,6-Octatriene, 2,6-dimethyl-, (E, Z), 2,4,6-Octatriene, 3,4-dimethyl-
4.	4.905	0.43	Tricycle [4.4.0.0(2,8)] dec-4-ene 1,3-cyclohexadiene, 5-(3-butene-1-γ 1), Bicyclo [3.1.0] hex-2-ene, 4-methylene-1-(1-methylethyl)-
5.	5.019	0.34	Bicyclo [6.1.0] non-1-ene cyclohexanone, 5-methyl-2-(1-methylethlidene)-2-methyl-1-octen-3-yne
6.	5.088	0.37	2-(5-Aminohexyl) furan ethanone, 1-(methylenecyclopropyl) 3-Methylenecyclohexene
7.	5.174	1.69	3-cyclohexen-1-ol , 4-methyl-1-(1-methylethyl)-
8.	5.266	1.59	Cyclohexane, 1-methylene-3-(1-methylethyl)-, (R)-, 3 cyclohexene-1-methanol, *α*,*α* 4-trimethyl-, cyclohexene, 5-methyl-3-(1-methylethenyl) -, trans-(-)-
9.	5.317	0.44	Bicyclo [3.1.1] hept-2-ene-2-methanol, 6,6-dimethyl-, cis-bicyclo [3.3.0] oct-2-ene, BIcyclo (3.2.1) oct-2-ene
10.	6.032	0.57	Benzenemethanol, 4-(1-methylehyl)
11.	6.484.	3.32	Cyclohexene, 4-ethynyl-4-methyl-3-(1-methylethenyl) -1-(1-methyethyl)-(3R-trans)-, (+)-4-Carene
12.	6.582	1.37	*α*-cubebene
13.	6.862	3.04	Copaene, *α*-Cubebenecopaene
14.	6.982	2.84	1H-cyclopropa [a] naphthalene, 1a,2,3,5,6,7,7a,7b-Octahydro-1,1,7,7a-tetramethyl-, [1aR-(1a *α*, 7*α*, 7a*α*, 7b*α*)]-, Bicyclo [4.4.0] dec-1-ene, 2-isopropyl-5-methyl-9-methylene-
15.	7.137	0.49	3H-3a, 7-Methanoazulene, 2,4,5,6,7,8-hexahydro-1,4,9,9-tetramethyl-,[3aR-(3a*α*, 4β, 7*α*), 3H-3a, 7-Methanoazulene, 2,4,5,6,7,8-hexahydro-1,4,9,9-tetramethyl-,[3aR-(3a*α*, 4β, 7*α*)] δ-selinene
16.	7.303	5.53	1,6-cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [s-(E,E)]-1H-cyclopenta [1,3] cyclopropa[1,2] benzene, octahydro-7-methyl-3-methylene-4-(1-methyethyl)-, [3aS-(3a*α*, 3bβ, 4β, 7*α*, 7aS*)]-, Bicyclo [4.4.0] dec-1-ene, 2-isopropyl-5-methyl-9-methylene-
17.	7.406	3.76	(+)-Epi-bicyclosesquiphellandrene 1H-cyclopenta [1,3] cyclopropa [1,2] benzene, octahydro-7-methyl-3-methylene-4-(1-methylethyl)-, [3aS-(3a*α*, 3bβ, 4β 7*α*, 7aS*)]-, Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, 1*α*,4aβ, 8a*α*)
18.	7.537	2.34	Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, 1*α*,4aβ, 8a*α*)-, Bicyclo[4.4.0] dec-1-ene, 2-isopropyl-5-methyl-9-methylene-
19.	7.640	2.65	Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, 1*α*,4aβ, 8a*α*)-, Naphthalene, 1,2,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-,
20.	7.709	0.79	1,6-cyclodecadiene, 1-methyl-5-methlylene-8-(1-methylethyl)-, [s-(E,E)]-, 1H-cyclopenta [1,3] cyclopropa [1,2] benzene, octahydro-7-methyl-3-methylene-4-(1-methylethyl)-, [3aS-(3a*α*, 3bβ, 4β,7*α*,7aS*)]-
21.	7.921	10.81	1,6-cyclodecadiene, 1-methyl-5-methlylene-8-(1-methylethyl)-, [s-(E,E)]-, 1H-cyclopenta [1,3] cyclopropa [1,2] benzene, octahydro-7-methyl-3-methylene-4-(1-methylethyl)-, [3aS-(3a*α*, 3bβ, 4β,7*α*,7aS*)]-, (+)-Epi-bicyclosesquiphellandrene
22.	8.046	1.10	Bicyclo [4.4.0] dec-1-ene, 2-isopropyl-5-methyl-9-methylene-, (+)-Epi-bicyclosesquiphellandrene, Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, 1*α*,4a*α*, 8a*α*)
23.	8.109	1.78	Naphthalene, 1,2,4a,5,6,8a-hexahydro-4,7-dimethyl -1-(1-methylethyl)-, 1,6-cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [s-(E,E)]-, Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, 1*α*,4a*α*, 8a*α*)
24	8.212	1.76	Cyclohexene, 6-ethenyl-6-methyl-1-(1-methylethyl)-3-(1-methyethylidene)-, (S)-, Copaene, Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, 1*α*,4a*α*, 8a*α*)

Continued

25.	8.247	2.47	Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl -1-(1-methylethyl)-(1S-cis)
26.	8.355	0.71	Naphthalene, 1,2,3,4,4a,7-hexahydro-1,6-dimethyl -4-(1-methylethyl)-, 1H-3a, 7-methanoazulene, 2,3,4,7,8,8a-hexahydro-3,6,8,8-tetramethyl-[3R-(3*α*,3aβ, 7β,8a*α*)], *α*-cubebene
27.	8.395	0.34	Naphthalene, 1,2,4a,5,6,8a-hexahydro-4, 7-dimethyl-1-(1-methylethyl)-, [1R-(1*α*,4aβ, 8a*α*)]-, Isoledene, Naphthalene, 1,2,3,5,6,7,8a-octahydro-1-8a-dimethyl-7-methylene-7-(1-methylethyl)-, [1R-(1*α*,7β, 8a*α*)]-
28.	8.521	2.57	Cyclohexanemethanol, 4-ethenyl-*α*,*α*, 4-trimethyl-3-(1-methylethenyl)-[1R-(1*α*,3a, 4β)]
29.	8.573	0.59	1H-Indene, 2,3-dihydro-2,2-dimethyl 4, 4-dimethyl-3-(3-methybut-3-enylidine)-2-methylenbicyclo [4.1.0] heptane, 1H-Indene, 2,3-dihydro-2,2-dimethyl 4, 4-dimethyl-
30.	8.807	0.43	1-Hydroxy-1, 7-dimethyl -4-isopropyl -2, 7-cyclodecadiene, Bicyclo [2.2.1] heptan-2-ol, 1,3,3-trimethyl-, acetate, (1S-exo)-, ethanone, 1-(2-methyl-2-cyclopenten-1-y1)-
31.	8.859	0.90	Tricyclo [5.2.2.0 (1,6)] undecan-3-ol, 2-methylene-6,8,8-trimethly-, Tricyclo [4.4.0.0(2,7)] dec -3-ene-3-methanol, 1-methyl-8-(1-methylethyl)-, 1H-cycloprop [e] azulen-7-ol, decahydro-1,1,7-trimethyl-4-methylene-, [1ar-(1a*α*, 4a*α*, 7β, 7aβ, 7b*α*)]
32.	8.928	0.46	2-(4a,8-demethyl-1,2,3,4,4a,5,6,7-octahydro-naphthalen-2-yl)-prop-2-en-1-ol, Patchoulene γ Gurjunenepoxide-(2)
33.	9.156	1.14	4,4-Dimethyl-3-(3-methylbut-3-enylidene)-2-methylenbicyclo [4.1.0] heptanes, ledene oxide-(II), 8-Quinolinol, 4-methyl-
34.	9.254	0.49	Cyclohexene, 6-ethenyl-6-methyl-1-(1-methyethyl)-3-(1-methylethylidene)-, (S)-, 4,7-Methanoazulene, 1,2,3,4,5,6,7,8-Octahydro-1,4,9,9-tetramethyl-[1S-(1*α*, 4*α*, 7*α*)], Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)-
35.	9.351	3.25	1H-cycloprop[e]azulen-7-ol, decahydro-1,1,7-trimethyl-4-methylene-, [1ar-(1a*α*, 4a*α*, 7β,7aβ, 7b*α*)]-(-)-spathulenol, 1,7,7-Trimethyl-2-vinylbicyclo [2.2.1]hept-2-ene
36.	9.431	0.48	Aromadendrene, cedren-13-ol, 8-thujopsene-13
37.	9.488	0.77	Aromadendrene oxide-(2), 2-(4a, 8-dimethyl-1,2,3,4,4a,5,6,7-octahydro-naphthalen-2-yl)-prop-2-en-1-ol, longipinocarveol, trans-
38.	9.614	1.68	1H-Indole-3-carboxylic acid, 4-hydroxy-,6-isopropenyl-4, 8a-dimethyl-1,2,3,5,6,7,8,8a-octahydro-naphthalen-2-ol, Naphthalene, 1,2,3,4-tetrahydro-1, 6-dimethyl-4-(1-methylthyl)-, (1S-cis)-
39.	9.877	0.60	Cycloisolongifolene, 8-hydroxy-, endo-, isolongifolene, 7,8-dehydro-8a-hydroxy-, 2-oxa-1,3-disilacyclohexane, 1,1,3,3,-tetramethyl-
40.	9.958	3.06	Cycloisolongifolene, 8,9-dehydro-Cycloisolongifolene, 8-hydroxy-, endo-, 10-oxatricyclo [4.2.1.1(3,9)] dec-4-ene, 9-ethenyl-
41.	10.221	0.37	7R, 8R-8-Hydroxy-4-isopropylidene-7-methylbicyclo [5.3.1]undec-1-ene, isolongifolene, 9,10-dehydro-Neoisolongifolene, 8,9-dehydro-
42.	10.427	0.45	Benzoic acid, 2-amino-3-hydoxy-phenol, 4-methyl-2-nitro-thiourea, N-ethyl-N’-tricyclo[3.3.1.1 (3,7)]dec-1-yl-
43.	10.581	0.46	Tricycle [4.4.0.0(2,7)] dec-3-ene-3-methanol, 1-methyl-8-(1-methylethyl)-, calarene epoxide 1-(3,3-Dimethyl-1-1-yl)-2,2-dimethylcyclopropene-3-carboxylic acid
44.	10.719	0.37	Cyclooctene, 4-methylene-6-(1-propenenylidene)-Isolongifolene, 7,8-dehydro-8a-hydroxy-4-(2-Nitrophenylimino)) -2-pentanon
45.	10.764	0.51	1H-cycloprop[e]azulen-7-oL, decahydro-1,1,7-trimethyl-4-methylene-, [1ar-(1a*α*, 4a*α*,7β, 7b*α*)], acetic acid, 6,6-dimethyl-2-methylene-7-(3-oxobutylidene) oxepan-3-yl methyl ester, isolongifolene, 7,8-dehydro-8a-hydroxy-
46.	10.999	0.58	Aromadendrene oxide-(1), Alloaromadendrene oxide-(2) Glaucyl alcohol
47.	11.119	0.34	2-Butenal, 2-methyl-4-(2,6,6-trimethyl-1-cyclohexen-1-yl)-, 2-(4a,8-dimethyl-1,2,3,4,4a,5,6,7-octahydro-naphthalen-2-yl)-prop-2-en-1-ol, isoaromadendrene epoxide

Continued

48.	11.296	0.42	Benzeneethanol, 2-methoxy-*α*-methyl-(+)-2-carene, 4-*α*-isopropenyl-, Boldenone
49.	11.428	0.41	(-)-Neoclovene-(I), dihydro-1H-Cycloprop[e]azulene, decahydro-1,1,4,7-tetramethyl-, [1aR-(1a*α*, 4β, 4aβ,7β,7aβ,7b*α*)], 1-cyclohexene, 1,3,3-trimethyl-2-(1-methylbut-1-en-3-on-l-yl)-
50.	11.617	0.59	3-Heptadecene, (Z)-, 8-Heptadecene, n-Nonadecanol-1
51.	11.657	0.61	δ-Gurjunenepoxide-(2), 9-isoprop-yl-1-methyl-2-methylene-5-oxatricyclo [5.4.0.0 (3,8)] undecanecyclohexane, 1,5-diethenyl-3-methyl-2-methylene-, (1*α*,3*α*,5*α*
52.	12.510	2.62	n-Hexadecanoic acid
53.	13.179	0.63	1H-Naphtho[2,1-b]pyran, 3-ethenyldodecahydro-3, 4a,7,7,10a-pentamethyl-, [3R-(3*α*,4aβ,6a*α*,10aβ,10b*α*)], 1H-Naphtho[2,1-b]pyran, 3 ethenyldodecahydro-3 , 4a,7,7,10a-pentamethyl-, [3S-(3*α*,4a*α*,6aβ,10a*α*,10bβ)], Acetamide, N-(3-methylphenyl)-2-phenylthio-
54.	13.499	3.59	Kaur-16-ene, Kaurene
55.	14.198	5.63	9,12-Octadecadienoic acid (z,z)-, 1-Hexadecyne
56.	14.358	0.58	Octadecanoic acid
57.	15.508	4.78	Silane, dimethyl (3-methylbut-2-enyloxy) heptyloxy-, Galaxolide 1 (3E, 5E, 7E)-6-Methyl-8-(2.6.6-trimethyl-1-cyclohexenyl) -3,5,7-octatrien-2-one
58.	16.263	3.08	Naphthalene, decahydo-1,1, 4a-trimethyl-6-methylene-5-(3-methylene-4-pentenyl)-, [4aS-(4a*α*, 5*α*,8aβ)], Benz [c] acridine, 7,9-demethyl-3-Methyl-1-phenyl-2-azafluorene.

4. Discussion

This study demonstrated the usefulness of GC-MS as a valuable tool for the identification of bioactive compounds present in plant materials. The analysis of the methanol extract of *X. aethiopica* fruits revealed the presence of 58 bioactive compounds. Among the identified compounds, the presence of fatty acids like n-hexadecanoic acid, 9,12-octadecanoic acid, hexadecanoic acid and methyl ester may be associated with the reported antioxidant property of the plant [16] [20]. Also, the presence of these fatty acids and esters in the extract suggests that it can serve as a pesticide, an anti-androgenic flavor, and *α*-reductase inhibitor [21]. It can also serve as cancer preventive, [22], hepatoprotective, antieczemic, hypocholesterolemic and anticoronary agent [23]. In traditional practice, the fruits are crushed and mixed with Shea butter and used as body creams or perfumes [5]. This is could be due to the presence of carboxylic acids such as octadecanoic acid and esters such as acetic acid, 6,6-dimethyl-2-methylene-7-(3-oxobutylidene) oxepan-3-yl methyl ester in the plant [23]. *Xylopia aethiopica* has been applied in traditional medicines as an effective antimicrobial agent [5]. This antimicrobial activity could be due to the presence of some aliphatic alcoholic compounds like octadiene-3-ol, which has earlier been shown to possess antimicrobial effects [24]. The compound, 1,6-cyclodecadiene, otherwise known as Germacrene D, was also identified by [25]. The compound is a class of volatile organic hydrocarbons, which plays a role as a precursor of various sesquiterpenes such as cadinenes and selinenes [26]. Reports showed that Germacrene D has insecticidal activity against mosquitoes [27], antibacterial activity [28], as well as repellent activity against aphids [29] and ticks [30]. [25] also detected the presence of spathulenol, an oxygenated sesquiterpene that has immunomodulatory effects, mosquito repellant activity, antimicrobial and anti-inflammatory activities [31]. This could be the reason why essential oil from the plant is used as mosquito and housefly repellents, and termite antifeedant in traditional practice [32]. *Xylopia aethiopica* has been reported to be of help in enhancing the healing of some ailments in man [33] and this may be associated with the presence of phenolic compounds such as 2-amino-3-hydroxy phenol as detected in extract in the present study and by [24]. *Xylopia aethiopica* has been used as flavour pepper and spice in food and for management of liver diseases [34]. This could be as a result of the compound, terpineol, cis-β-terpineol cyclohexene, 1-methyl-3-(1-methylethenyl) which is a citrus essential oil. Citrus essential oils could be considered suitable alternatives to chemical additives for use in various industrial areas such as food, cosmetics and pharmaceuticals. They also have an attractive and mild aroma that can mask food smells from fish, meat, garlic and onion. These seem to be positive functions for use as industrial antimicrobial agents such as preservatives. Cyclohexanones and cyclohexanols such as bicyclo [6.1.0]-non-1-ene-cyclohexanone, 5-methyl-2-(1-methylethlidene)-2-methyl-1-octen-3-yne, 3-cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-, and others identified in the plant can be used as solvents for paints and dyes, in pesticides, and as an intermediate for pharmaceuticals, films, soaps, and coatings [35]. Naphthalene identified in the plant is said to be hazardous [36]. This could be the reason excessive consumption of the plant has been reported to be toxic [13]. This study has also shown the presence and amount of bioactive components in plant materials depend on the location of the plant source.

5. Conclusion

The present study identified 58 bioactive compounds in the methanol extract of *Xylopia aethiopica* fruits using gas chromatography-mass spectrometry (GC-MS). This plant has many bioactive compounds that possess antioxidant, anti-inflammatory, anti-microbial and anticancer properties. This showed that the plant extract should be of great pharmaceutical interest. Haven identified many bioactive compounds in methanol extract of *Xylopia aethiopica* fruits in the present study, and it is recommended that the active ingredients are isolated and subjected to further tests to compare their usefulness in the prevention and treatment of various conditions.

Conflict of Interest

The authors declare no conflict of interest.

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