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ORIGINAL RESEARCH

Ethnobotany and Phytochemical Composition of *Alchornea cordifolia* in Abia State Nigeria

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Abstract
Objective: This study was carried out to document the medicinal values and therapeutic applications of different parts of *A. cordifolia* in Ekebedi Oboro ancient Kingdom of Abia State, Nigeria, and profile its bioactive constituents.
Material-Method: The ethno-botanical survey involved questionnaires and oral interviews of 81 randomly selected traditional medicine doctors and natives on medicinal values of *A. cordifolia*. GC-MS fingerprinting was adopted to elucidate the bioactive constituents of the methanol leaf extract of the plant.
Results: The survey showed that *A. cordifolia* is prescribed in different treatment regimens for coughs, bronchitis, post-partum bleeding, lacerations, wounds, vaginitis, diarrhea, sickle cell anemia, and venereal diseases, including gonorrhea, syphilis, and prostatitis. Phytochemical fingerprinting revealed the presence of several bioactive compounds as the major active ingredients of the plant. A total of 27 fatty acids and volatile hydrocarbons were detected in the leaf extract of the plant with 9, 12-Octadecadienoic acid (Z, Z)- methyl ester (18.42%), 9-Octadecenoic acid methyl ester (19.93%), Dodecanoic acid 1,2,3-propanetrieyl (15.87%) as most abundant ingredients.
Conclusion: *A. cordifolia* is used to treat various diseases such as sickle cell anemia, diabetes, post-partum bleeding, and HIV infections amongst others. The fatty acids identified in *A. cordifolia* possibly underscored these antimicrobial and therapeutic actions of the plant in traditional medicine.
Keywords: *Alchornea cordifolia*, Medicinal Plant, Phytochemical Composition, Leaf Extract, Chemical Fingerprinting, Therapeutic Action

INTRODUCTION

Alchornea cordifolia (Christmas bush or dove wood) is a straggling evergreen shrub in the family Euphobiaceae which is distributed throughout West Africa.[1] It grows up to 8 meters tall. The leaves are simple, triangular, and margin-toothed. The flowers are unisexual, and the fruit is a 2-lobed capsule whereas the fruits are ovoid, elliptical, smooth, and bright red in color when ripe. In some Nigerian cultures, the young leaves are eaten as appetizers or added to soups as a substitute for the potherb known as, *Ptericarpus osun* also called *"Uha"*. On the other hand, the older leaves are utilized for packaging kola nuts.[2-4] Also, the leaves are eaten to help prevent bleeding on wounds. Moreover, the infusion derived from the plant is utilized in the treatment of various ailments including sore throat, cough, ulcers, bronchitis, dysentery, worms, venereal diseases, and female sterility. Furthermore, it is known to possess sedative and antimicrobial properties.[5-9]

The root and leaf decoctions are used as a mouthwash against mouth ulcers, toothache and decay, stopping post-partum bleeding, bleeding gums, hemorrhage, and treatment of vaginitis. A poultice of leaves and stem bark is used to cure yaw, chancre and dried tissue powders are used to facilitate the healing of fractures.[10-12] A variety of bioactive compounds, including ellagic acid, hyperin, and eugenol have been isolated from the plant.[2,7,13-15] Also, strong anti-inflammatory compounds including 3, 5, 7, 3'-tetrahydoxyflavone-3-0-α-L-rhamnoside, lupenol (lup-20(29)-en-3c-ol, and methyl gallate has also been isolated from different parts of the plant.[16-18]

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Some workers reported the presence of bioactive fatty acids such as dodecanoic (lauric) acid, n-hexadecenoic (palmitic) acid, 9, 12-octadecadienoic acid (alpha-linolenic acid), pentadecanoic acid, nonacosane, 9-octadecenoic (oleic) acid, octadecanal, and terpinolene etc. in extracts of *Alchornea* species which contributed to the plants' bio-efficacy.[19-21]

Antimicrobial, antiretroviral, antioxidant and antitoxin activities of *A. cordifolia* have been documented.[22-24] Organic extracts and isolates from the plant demonstrated antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli* and *Plasmodium berghei in vitro* and mice, respectively.[9,25-26] The root and bark extracts of *A. cordifolia* have shown strong antiviral activity against strains of HIV I, out-performing AZT in some trials.[2,27] The anti-HIV activity of this plant may be due to its content of hexadecenoic acid reported to bind directly to CD4 receptors and actively blocking HIV-1 entry and infection in humans.[28] Methanol extracts of *A. cordifolia* similarly inhibited *Botrydiplodia theobromae in vitro*. This fungus has been implicated in invasive fungemenia in humans.[29-30] The presence of dodecanoic acid in extracts of *Alchornea* known to exhibit antibacterial, antifungal and anti-inflammatory properties in both fungi and humans may account for these activities.[31-32]

Several workers have reported higher plants as major sources of potential drugs and healthcare materials in tropical localities.[22,33-35] This paper presents the ethno-botanical potentials of A. cordifolia in Abia state, Nigeria, and its phytochemical fingerprints.

MATERIALS AND METHODS

Study area

Ekebedi Oboro ancient Kingdom is located in Ikwuano Local Government Area (LGA) of Abia State, in the rainforest belt of Southeast Nigeria, on latitude 5° 24' 22"N and longitude 7° 34' 5"E (Fig. 1). The Kingdom has 200 households with a population numbering about 6,000 people. Most of the people of the Kingdom practice mixed farming as predominant occupation, with fishing, traditional medicinal practices and bone setting as minor occupations.

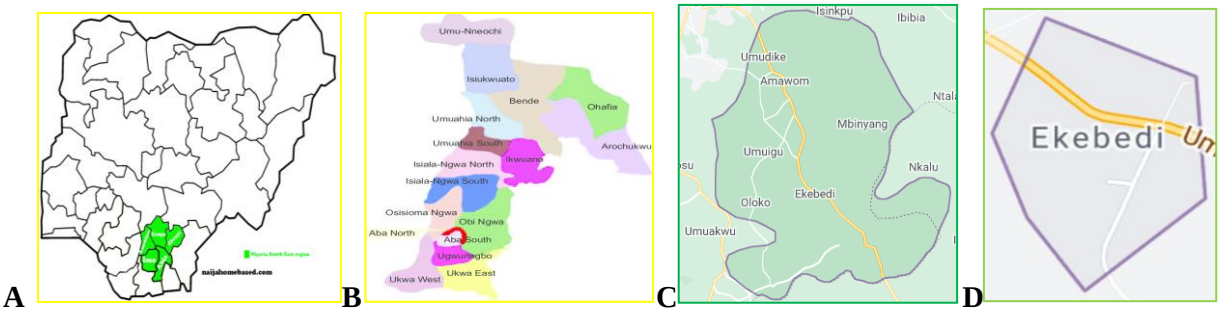

Figure 1. Study area. **A:** Map of Nigeria, Southeastern region in green. **B:** Abia State Map and 17 Local Government Areas (L.G.As.). **C:** Ikwuano L.G.A. of Abia State. **D:** Map of Ekebedi Kingdom.

The ancient Kingdom is known to be endemic to parasitological, pathological and metabolic diseases due to high temperatures and humidity for most of the year. Herbal recipes are frequently employed by indigenes of the area in the management of these diseases.[36-37]

Plant materials

Fresh aerial portions of *Alchornea cordifolia* (twigs, leaves, flowers and fruits) were collected from bushes in the ancient Kingdom. The plant sample was authenticated by Prof. M. C. Dike of the Department of Forestry, College of Natural Resources and Environmental Management (CNREM) of the Michael Okpara University of Agriculture, Umudike, Abia State; and the plant specimen (Voucher number: AC/7344) was deposited at the Herbarium of the Department.

Preparation of *Alchornea cordifolia* leaf extract

The leaves of the plant were washed in tap water and rinsed in 2 changes of sterile distilled water. They were dried on the laboratory bench for 21 days, enveloped and oven-dried at 40°C for 30 minutes, and then milled into powder using a Thomas Wiley machine (ED-5, USA). Then 100g of the milled powder was packed separately into a 2-liter soxhlet apparatus and extracted exhaustively with 250 ml of analytical grade methanol for 24 h. The methanol leaf extract was concentrated using a rotary evaporator at 45°C and left on the laboratory bench for two days to afford residue.[1,14]

Survey and data collection

This study sought to document and validate the medicinal uses of *A. cordifolia* by people of Ekebedi ancient Kingdom, in Abia State, Nigeria. For this purpose hence, a random survey to collect data on ethno-botanical and therapeutic significances of *A. cordifolia* was conducted in the Kingdom, using simple questionnaires and, oral interviews methods as adopted by some workers.[36-38] The survey involved a house to house strategy which lasted over a period of 8 weeks (June 04, 2022 – August 07, 2022). Four herbalists (traditional medicine practitioners), 21 herbal vendors and 56 indigenes/natives were randomly selected and interviewed on medicinal uses of *A. cordifolia* in the ancient Kingdom.

Gas chromatography-mass spectrometry (GC-MS) analysis of plant extract

This was conducted following the method of previous workers.[39-41] One ml of leaf extract of *A. cordifolia* residue reconstituted with analytical grade methanol was injected into GC-MS equipment (Model: QP 2010 Plus Schmadzu, Tokyo, Japan) comprising of an AOC-20i auto-sampler and gas chromatograph inter-phased to a mass spectrometer (GC-MS) instrument equipped with a VF 5 MS fixed silica capillary column of 30m length, 0.25 mm diameter and 0.25µm film thickness. The carrier gas was helium (99.99%), flow rate of 1.58 ml/min, injector and mass transfer line temperatures (250 and 200^{o}C respectively), and an injection volume of 1 µl was employed with Split ratio set at 10:1. The oven temperature was programmed from 80^{o}C (Isothermal from 2 min), with an increase of 9^{o}C to 200^{o}C for 4 min, then 10^{o}C/min to 280^{o}C, and end with isothermal at 5^{o}C. The MS operating parameters were as follows: ionization energy 70ev, ion source temperature 200^{o}C, solvent cut time 2.5min, relative detector gain mode, scan speed n/sec, scan range 40-80u, while the interface temperature was 250^{o}C. The total running time of the GC-MS was 1 h.

The percentage of the extract was expressed as percentage with peak and normalization. The relative percentage amount of each phyto-component was calculated by comparing its average peak area to the total areas. The detection process employed was that of the National Institute of Standards and Technology (NIST) (Version 2.0, 2005). The compound prediction was based on the Phytochemical and Ethno-botanical Databases of USDA.[42] The interpretation of GC-MS was conducted using the National Institute of Standard and Technology (NIST) database, which has more than 62,000 structural patterns. The spectra of the unknown phyto-components were compared with that of known components stored in the NIST library. The name, molecular weight and chemical structures of the extracts-derived compounds were ascertained from the National Institute of Standard and Technology (NIST).[43]

Data analysis

Data generated from this study were analyzed using simple descriptive statistical tools such as range, means, and percentages.

RESULTS

Medicinal Importance of *Alchornea cordifolia* in Ekebedi Oboro Kingdom

The results of the survey on uses of *A. cordifolia* as crude medicine in the study area are presented in Table 1. The survey results showed that the plant is used to treat many important pathological and parasitological diseases in the area. All the respondents in the study agreed to use one part or the other of the plant either singly or in combination with other parts of the same or other herbs for treating cases of fevers especially malaria, venereal diseases, toothache, fracture, mouth ulcers etc. Similarly, about 90% of the respondents use different preparations of leaves and twigs of the plant for treating gonorrhea, post-partum bleeding, lacerations, piles etc. About 50% of the respondents on the other hand, prescribe or use the stem bark of *A. cordifolia* for diverse purposes, while 70% others employ the root and root bark of the plant in treating cases of bronchitis, coughs, dysentery (blood in faeces), venereal diseases, toothache, rheumatoid diseases and post-partum bleeding etc. Whereas all the respondents accented to using one or more parts of the plant in treatment regimes, the lowest number of respondents (14%) use the seeds for the treatment of skin diseases (Table 1).

Several solvents are used in preparing these local crude drugs. These include water, palm wine, local gin (popularly called *kai kai*) and supernatant from ground maize kernels (*Mmiri akamu*) (Fig. 2). In this study also, preparations of the test plant as medicine takes the forms of macerations, poultices, decoctions, infusions, tinctures or alcoholic elixirs (*Huma*) using *kai kai* (Fig. 3). *Mmiri akamu* is prescribed for decocting medicines for those who are sensitive to alcohol contents in palm wine or *kai kai*.

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Table 1. Medicinal Importance of *Alchornea cordifolia* (Schumach and Thonn.) Arg. Mull. in Ekebedi kingdom

Common/ Local Name of the plant	Number of medicine men interviewed	Respondents Interviewed (%)	Parts Used for Treatment	Uses and significance of charismas bush in folk-Medicare system
Christmas bush	81	90	Leaf / twigs	Malaria fever, typhoid fever, dysmenorrhea, gonorrhea, venereal diseases, syphilis, HIV, diarrhea, toothache, lacerations, sore throat, bronchitis, prostatitis, piles, post-partum bleeding, sickle cell anemia etc.
Ububе in Igbo	81	50	Stem bark	Fever, toothache, mouth sores, rheumatism, prostatitis, HIV, sickle cell anaemia,
	81	70	Root / root bark	Bronchitis, coughs, blood in faeces, prostatitis, venereal diseases, toothache, rheumatism, post-partum bleeding, syphilis, HIV infections.
	81	14	Ripe and unripe seeds	Skin diseases, dyes
	81	100	All parts	Prostatitis, genital discharge, gonorrhea, malaria, toothache, coughs, fevers, venereal diseases, syphilis, toothache, fractures, dysmenorrhea,, rheumatisms

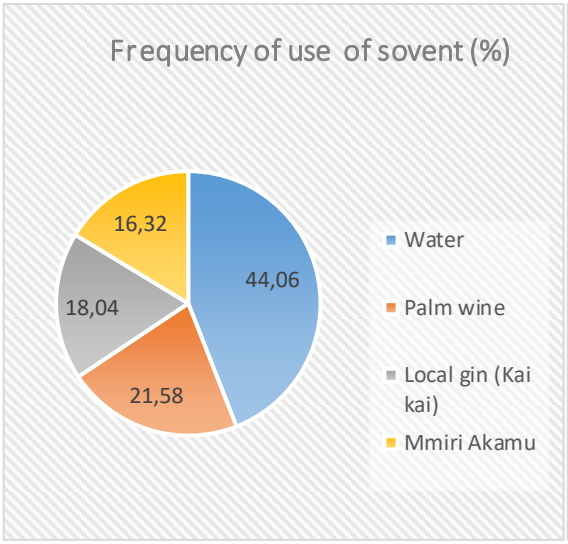

Figure 2. Solvents used in preparing *A. cordifolia* recipes

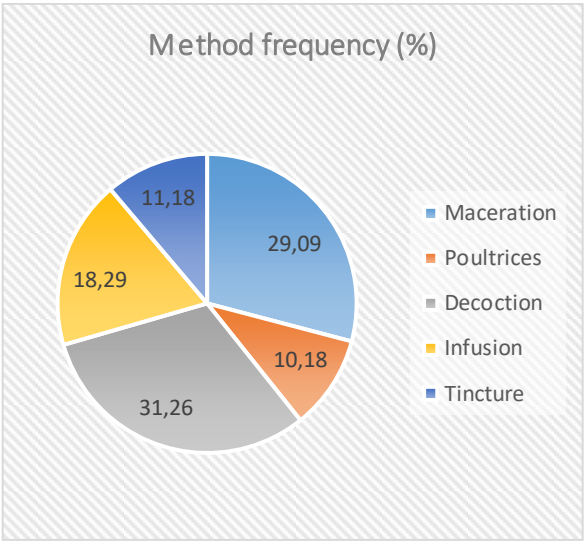

Figure 3. Methods used in preparing *A. cordifolia* recipes

GC-MS analysis of methanol leaf extract of *Alchornea cordifolia*

Mass spectral data of *Alchornea cordifolia*

The gas chromatogram of the GC-MS analysis of the volatile components of 2µl of the methanol leaf residues from *A. cordifolia* are presented in Fig. 4. The mass spectral data shows the presence of bioactive volatile compounds in *A. cordifolia* leaf. A total of 27 volatile compounds (Table 2) were identified which were represented by the various peaks in the chromatogram and some of the peaks and predominant compounds include: peak **7** (9,12-Octadecadienoic acid (Z,Z)- methyl ester (18.42%), **8** (9-Octadecanoic acid methyl ester (19.93%), **11** (Oleic acid, 7.33%); **24** (Dodecanoic acid 1,2,3-propanetriyl (7.79%), **25** (9-. Octadecenoic acid (Z)-2-hydroxy-1- (6.75%), **26** (Dodecanoic acid 1,2,3-propanetrieyl (15.87%); and **27** (2-Methyltetracosane, 8.78%). Amongst the bioactive constituents which were detected in lower quantities (area %) in the extract as shown in Table 2 include: 9-Octadecenal (3.64%), Hexadecanoic acid (3.09%), Methyl stearate (1.33%), 9-Octadecanoic acid (Z)-2-hydroxy-1- (1.06%), nonanal, trans-1-Nitro-1-propene, Z-10-pentadecen-1-ol and Z,Z-8,12-Hexadecadien-ol-1. Several possible isomers of the same compound were also captured in the chromatogram. Peaks 8, 23 and 25 are possible isomers of 9-octadecenoic acid; peaks 24 and 26 possible isomers of lauric acid while Peaks **13** and **17** are possible isomers of the aldehyde nonanal. The structures of some of the bioactive compounds isolated from *A. cordifolia* are shown in Figure 4.

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Table 2. Bioactive volatile compounds identified from *Alchornea codifolia*

Peak#	R.Time	Area	Area %	Height	Height%	A/H	Name of compound
1	4.981	83277	0.09	20218	0.13	4.12	Cyclopropene
2	26.344	521594	0.54	165190	1.05	3.16	Diethyl Phthalate
3	26.582	32036	0.03	17612	0.11	1.82	Phthalic acid, ethyl pentyl ester
4	30.852	63466	0.07	24109	0.15	2.63	trans-1-Nitro-1-propene
5	36.756	2974763	3.09	936288	5.97	3.18	Hexadecanoic acid, methyl ester
6	37.880	421676	0.44	91709	0.59	4.60	n-Decanoic acid
7	41.298	17721159	18.42	4686154	29.90	3.78	9,12-Octadecadienoic acid (Z,Z)-, methyl ester
8	41.479	19166079	19.93	5216986	33.29	3.67	9-Octadecenoic acid, methyl ester, (E)-
9	41.594	538512	0.56	140724	0.90	3.83	11-Octadecenoic acid, methyl ester
10	42.133	1281690	1.33	403295	2.57	3.18	Methyl stearate
11	42.721	7051263	7.33	536147	3.42	13.15	Oleic Acid
12	44.980	8070	0.01	8864	0.06	0.91	9-Octadecenal
13	46.268	360617	0.37	61350	0.39	5.88	Nonanal
14	47.617	44051	0.05	20557	0.13	2.14	2-Nonen-1-ol, (E)-
15	49.166	247831	0.26	70979	0.45	3.49	1-Hexadecyne
16	49.297	345184	0.36	88350	0.56	3.91	Z-10-Pentadecen-1-ol
17	50.012	96266	0.10	26665	0.17	3.61	Nonanal
18	50.256	1322796	1.38	308143	1.97	4.29	Z,Z-8,10-Hexadecadien-1-ol
19	50.371	3499521	3.64	502875	3.21	6.96	9-Octadecenal, (Z)-
20	51.618	173846	0.18	46096	0.29	3.77	Cyclopropanepentanoic acid, 2-undecyl-, methyl
21	54.279	56671	0.06	19704	0.13	2.88	Oxalic acid, allyl pentadecyl ester
22	54.899	597632	0.62	163300	1.04	3.66	Z,Z-8,10-Hexadecadien-1-ol
23	54.983	1883864	1.96	327059	2.09	5.76	9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)- E,E
24	56.850	7490583	7.79	495679	3.16	15.11	Dodecanoic acid, 1,2,3-propanetriyl ester
25	56.967	6493004	6.75	482196	3.08	13.47	9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)- E,E
26	57.720	15259931	15.87	558205	3.56	27.34	Dodecanoic acid, 1,2,3-propanetriyl ester
27	59.065	8446482	8.78	252854	1.61	33.40	2-methyltetracosane
		96181864	100.00	15671308	100.00		

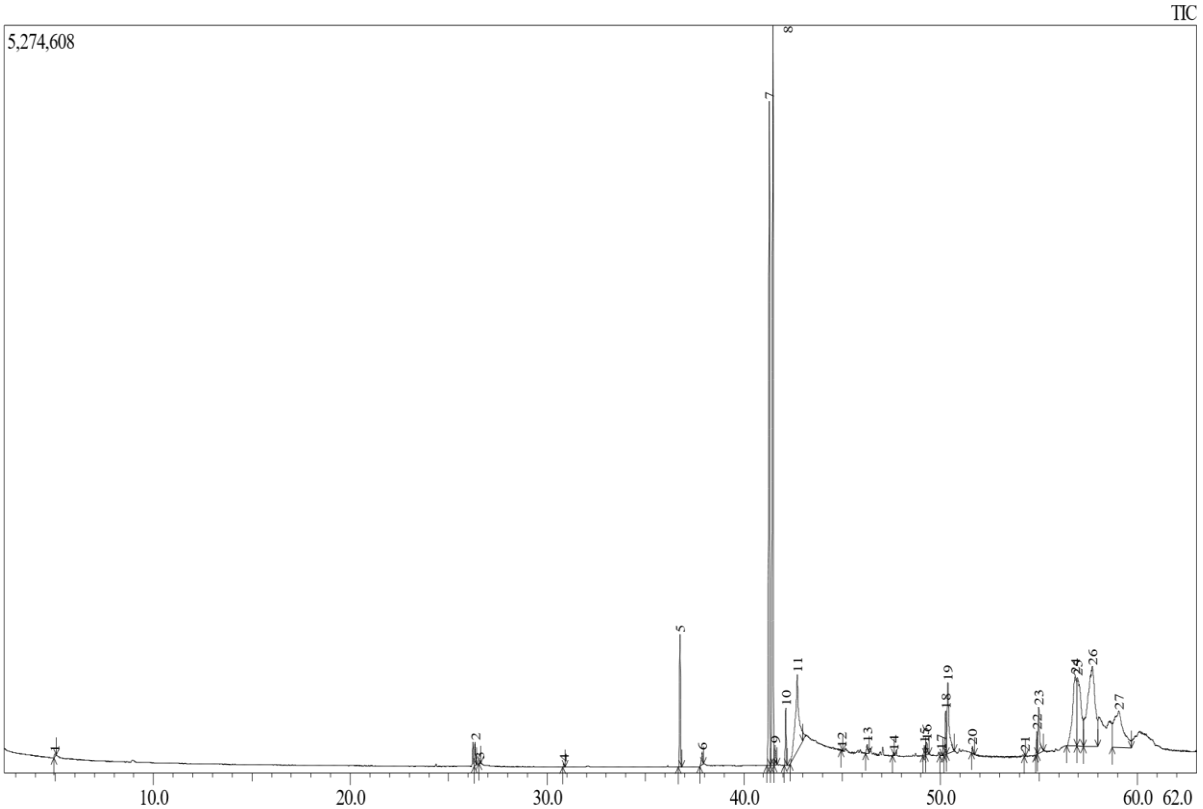

Figure 4. Chromatogram of methanol leaf extract of *Alchornea cordifolia*.

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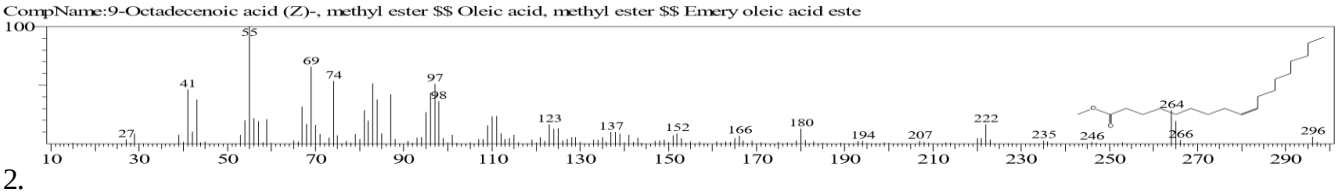

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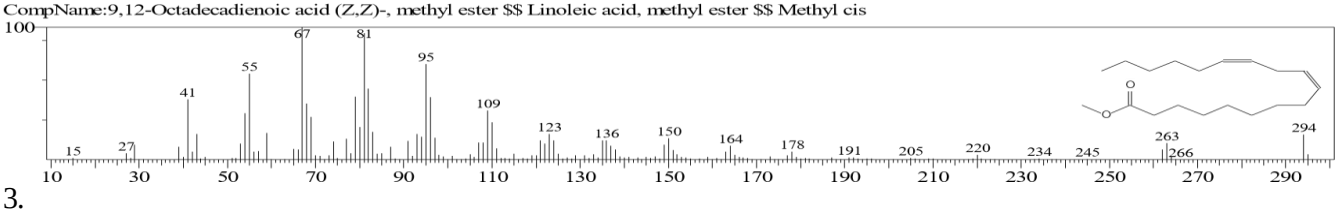

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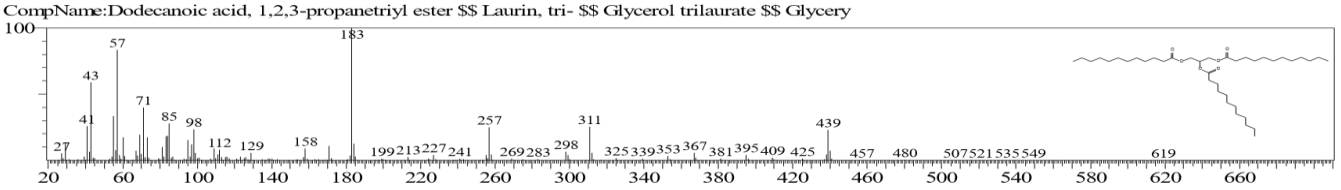

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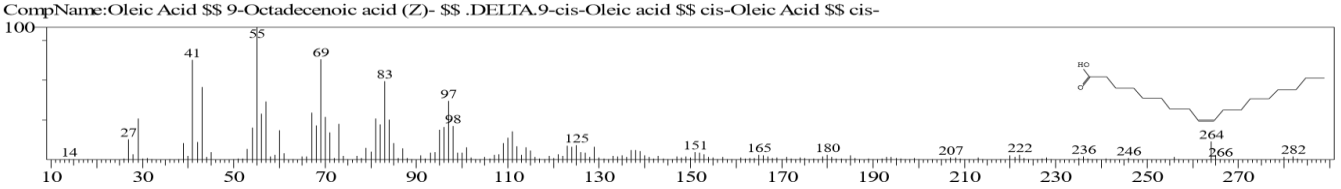

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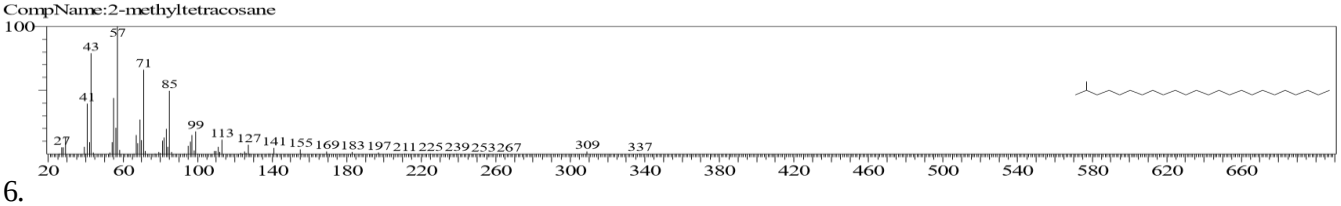

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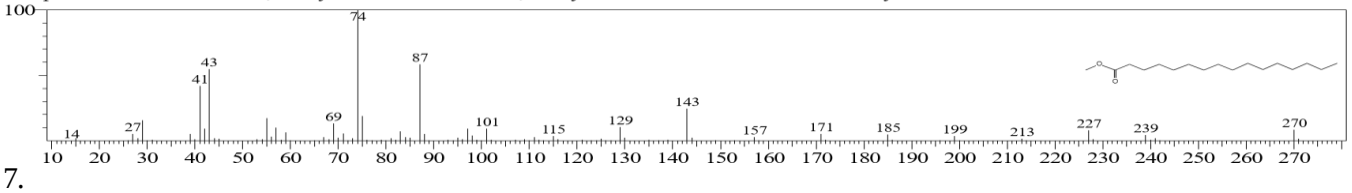

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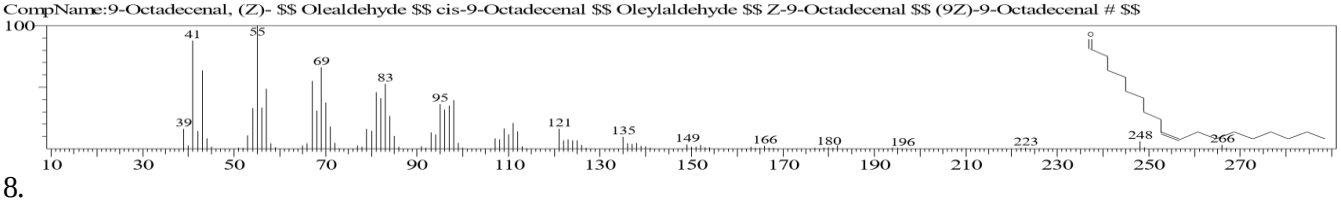

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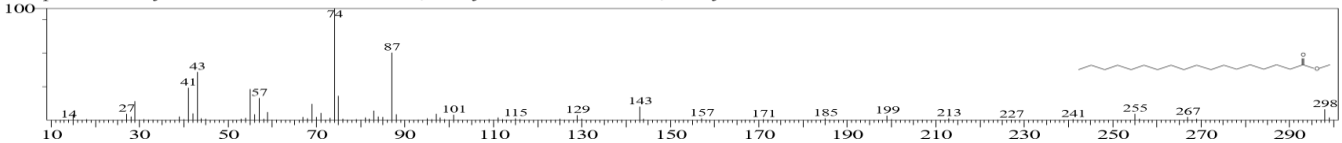

Figure 5. Structures of some compounds detected in methanol leaf extract of *Alchornea cordifolia*. **1.** 9-Octadecenoic acid ME; **2.** 9,12-Octadecadienoic acid ME; **3.** Dodecanoic acid ME; **4.** Oleic acid; 5. 2-Methyl tetracosane; **6.** Hexadecanoic acid; **7.** 9-octadecenal; **8.** Methyl Stearate)

DISCUSSION

Results presented in Table 1 indicated that *A. cordifolia* is medicinally relevant in the traditional healthcare system of the people of the study area. Our findings lend support to the fact that the people of the Kingdom use various parts of the plant (leaves, stem, roots and barks) for treating human diseases. Coughs, bronchitis, gonorrhea, toothache, mouth ulcers, piles, lacerations, post-partum bleeding, sore throats, sickle cell anaemia, boils and venereal diseases amongst other malaises are challenged with preparations from sole or combinations of different parts of *A. cordifolia* in this study. The submissions of previous workers that leaves, stems and roots of *A. floribunda* and *A. cordifolia* are used in various traditional medical practices of Africans for the management of pathogenic diseases, inflammatory, ulcerogenic, respiratory, urino-genital, HIV infections and gastrointestinal conditions or wound infections actively corroborates our findings in this regard.[44-47] Findings in this survey showed that natives of the study area use root bark, stem and leaf extracts of *A. cordifolia* in health matters related to sickle cell anemia, venereal diseases, diabetes, arthritis, rheumatoid challenges, ulcers, HIV infections and its opportunistic microbial overloads etc. This corroborated the report and views of several other workers where extracts of the plant has been employed to treat diabetes, sickle cell disease, arthritis amongst other human disease.[48] It is also consistent with the submission of other investigators where alcoholic root extracts of the plant proved more effective than AZT in inhibiting advancement of HIV.[2,27] Hexadecanoic (palmitic) acid found in moderate amount in the test plant extract has been linked with blocking HIV-1 entry and infection in humans.[28] Mechanism of action of extracts of this plant against microbial and mesobiotic agents appear to hinge on disruption of mitosis and cell proliferation through the arrest of microtubules and spindle formations[20-21,49-52] and/or inhibition of certain enzymes such as HIV integrase and topoisomerase I involved in relaxing DNA supercoils during viral replication and translation.[50-51,53] Our results also indicated that natives of Ekebedi kingdom use *A. cordifolia* to manage conditions of rheumatoid pains, prostatitis, bacterial infections-induced infertility and diarrhea, a view also held by some workers where various preparations of the plant is used for tackling pains, piles, rheumatism and toothaches in humans etc.[11-12,48,54] The anti-arthritic and anti-stress properties of *A. cordifolia* as seen in its use against rheumatoid pains in this study is supported by similar and parallel reports of other workers whereby decoctions and topical applications of *A. cordifolia* effectively ameliorated pains in assayed indigenous phyto-medicine systems.[6,11-12,48,55] Similarly, oral administration of hydro-ethanolic extracts of the plant decreased duration of immobility and paw edema in mice and artificially-induced arthritic rats.[44,56-57] These workers suggested that the mechanism of anti-arthritic activity of this plant may have involved antioxidant action due to suppression of elastase and superoxide anions and increased enzymes (SOD, CAT and GSH) levels observed in both animal and human systems. With respect to prostate conditions, our data showed that *A. cordifolia* is used for treating prostate conditions in the study area. This finding is consistent with submissions from other investigators who reported that extracts and powder formulations of *A. cordifolia* in combination with *Seteria sp., Plastoma sp., Boerhavia* sp. are effectively used to cure sickle cell disease and prostate conditions in South-south, Nigeria.[58-59] Inhibition of certain enzymes involved in cancer cell proliferation is suggested as one of the possible mechanisms for this reported activity.[60]

Plants have a long history of use in many traditional Medicare systems of different rural and sub-urban cultures of Africa where over 80% of the population have been reported to use them to prevent or treat malaises.[34,36-37] Presence of active principles such as alkaloids, flavonoids, tannins, anthocyanins and anthraquinones etc. are reported to exert potency, and lend scientific support for the use of many herbs including *A. cordifoli*a in traditional medicines.[46-47]. In this study, *A. cordifolia* is used effectively for treating coughs and bronchitis in the surveyed Kingdom. In tropical locations, fevers and upper respiratory tract infections (URTI) such as common colds, sore throats, sinusitis, influenza, pneumonia and bronchitis are common diseases of viral origin in humans. These conditions characterized by violent sneezes, headaches, aches, body pains and shortness of breath or syncope in some cases underscore many diseases induced by rhinovirus, adenovirus, influenza virus and coronavirus. In most developing countries, URTIs so far accounts for 40% disability in infants and children, and up to 80-90% deaths of elderly people[19]. The anti-bronchitis activity of *A. cordifolia* in this study is

supported by similar reports in which administration of ethanol root extract of *A. cordifolia* to histamine-induced broncho-constriction in guinea pigs effectively delayed onset of the disease symptoms in the test animal.[22] So far, multiple scientific evaluations, in which 4000 mg/kg body weight of plant extracts were administered to laboratory animals, have upheld that plant extract is non-toxic to mammals.[44,47] Similarly, bio-safety tests on mice (1g/kg body weight) in the tropics affirmed that aqueous extracts of *A. cordifolia* leaves did not adversely affect the anxiolytic and depressant activities of CNS of the animals.[61]

Phytochemicals demonstrate high pathogen-specificity, and pathogen resistance to them are unlikely; therefore they could be useful compounds to complement or potentiate existing azoles against antifungal resistant species.[53] Recent studies showed that traditional medicine has been recognized as a veritable complement to conventional forms of healthcare in developing countries.[22] This was warranted by increasing cases of antimicrobial resistance (AMR) to orthodox drugs and its consequences in terms of loss of human lives, man hours, and economic returns to many nations, and reinforced resort to medicinal plants for health and vitality[62] In many cultures, medicinal plant leaves, twigs, roots, barks, flowers, fruits and stems find extensive applications in different forms of preparations of crude drugs and constitute principal sources of potential antimicrobial candidates than any other.[22,26-27,33,54] Findings in this study (Table 1) is congruent with the reports of several previous workers in which preparations from *A. cordifolia* were reported to be used effectively for the treatment of various ailments including coughs, bronchitis, dysentery, sickle cell anemia and venereal diseases, etc.[3,26-27]

Though all parts of the plant were used in preparing medicines (Table 1), the leaves and twigs found more applications as crude drugs than the stem bark and roots, being used against diverse ailments by about 90% of the respondents in this study, and this is consistent with the views held by other workers.[3,22,63-64]

Data obtained from this survey indicated that water followed by palm wine were the commonest solvents used for preparing *A. cordifolia*-based medicines while *mmiri akamu* was the least. This is in line with the observation of some scholars.[63] These methods used in preparing medicines from *A. cordifolia* are consistent with those reported for other herbs by other workers.[24,30] Decoction and maceration ranked foremost as popular ways of preparing *A. cordifolia*, and this strongly agrees with the observations from similar studies.[34,63] The routes of administration are mainly oral as decoctions, infusions and elixirs (*Huma*), and topically as poultices, powders or tinctures. This finding is also in harmony with the views expressed by other workers.[63]

Different chemical compounds were identified in the chromatogram of methanol leaf extract of *A. cordifolia* in this study (Fig. 5, Table 2). The results of GC-MS chemical profiling in this study showed that the most abundant compounds detected in *A. cordifolia* leaf extracts were Dodecanoic acid 1,2,3-propanetriyl (lauric acid), 9-Octadecenoic acid methyl ester (commonly called oleic acid) and 9,12-Octadecadienoic acid (Z,Z)- methyl ester (commonly referred to as linoleic acid). Similar studies indicated that 9-octadecenoic acid and 9,12-Octadecadienoic acid (Z,Z)- methyl ester were among the highest occurring fatty acid constituents of different solvent extracts of *Onosma gmelinii*, *Cnidoscolus aconitifolius* and *Entandrophragma angolense* (Mahogany).[40,65-66] Dodecanoic acid 1,2,3-propanetriyl ester made up 12.8% of oil fraction of *Alstonia boodei*.[67] These results are in agreement with findings in this study where these fatty acid compounds constitute the most abundant constituents in *A. cordifolia* (Table 2). Similar investigations also detected octadecane, oleic acid and cyclopentene in *A. flourubunda*.[68-69] These compounds or their closely related hydrocarbons were also identified in varying concentrations in this study.

Strong antimicrobial and antifungal activities have been ascribed to the predominant and common chemical ingredients in *A. cordifolia* (9, 12-Octadecadienoic acid (Z,Z)- methyl ester, 9-Octadecanoic acid methyl ester, and Dodecanoic acid 1,2,3-propanetriyl.[40,70] Methanol extract and fractions of *A. cordifolia* significantly inhibited growth and replication of the human HSV II *in vitro* in a study.[71] Some scholars attributed the strong anti-HIV I and II, HSV I and II, anti-measles virus and COVID-19 virus activities to dodecanoic acid which is abundantly present in this plant, and this may explain its therapeutic use in HIV cases in the study area.[72,73] The compound in parallel studies has also been implicated for antibacterial and antifungal activities against the growth and reproduction of *Streptococcus* sp., *S. aureus* and *Candida albican* in

a manner which was favorably comparable to ciproflaxacin.[74-75]

Methanol extract of *Alchornea coelophylla* inhibited *in vitro Fusarium spp., Escherichia coli* and *Pseudomonas aureginosa* causal agents of recalcitrant fungenemia and bacteremia in humans.[76] Fatty acids occur widely in plant and animal tissues where they play antimicrobial roles in their cuticles.[77] Dodecanoic, hexadecanoic acid and tetradecanoic acid exert efficient toxicity against phytonotic moulds including *Beauveria bassianai.*[78] Also, the antifungal activity of leaf extracts of *Sesuvium portulacastrum* against various phyto-pathogens was due to its content of some of these fatty acid methyl esters, their derivatives or related compounds while octanoic (caprylic) acid has been reported to potentiate fungitoxicity of some synthetic azoles *in vivo*.[51,79-82,83] The degree of potency of fatty acids reportedly correlated with their chain length and degree of unsaturation.[84] Mechanisms for the antifungal activity of fatty acids against susceptible microbial agents have been suggested to include penetration and disruption of cell membranes, and inhibition of protein synthesis or enzymatic function.[53,83] According to these workers, fatty acids penetrate into cell membrane bilayers of target organisms and upset its integrity, leading to increased fluidity and loss of cellular radicals. These mechanisms may underpin inhibition of fungal agents causing human diseases and their therapeutic action.

Many biological activities such as anti-arthritic, antihistaminic, anti-coronary, anti-androgenic, anti-acne, anti-inflammatory, hepatoprotective, antimicrobial and antioxidant activities have been ascribed to 9,12-octadecadienoic acid (Z,Z)- and related methyl ester.[85] The compound, 9, 12-octadecadienoic acid (Z, Z)- methyl ester was associated with impeding cell proliferation and antimicrobial activity of extracts of *Albisia adiathofolia*.[86] The polyunsaturated fatty acids (PUFA) – 9, 12-octadecadienoic acid and 9, 12, 15-octadecatrienoic acid are known precursors of prostaglandins. Lack of PUFA predisposes humans to inflammations, cancers, viral infections and various kinds of neuro- or cardiovascular diseases.[66] Besides, octadecenoic acids are analogues of hexadecanoic acid and these compounds exhibit significant biological activities including antidiabetic, antioxidant, antimicrobial and anticancer activities.[87] Hexadecanoic and octadecanoic acids were reported to underscore antibacterial, anticancer, and antimicrobial efficacies in methanol extracts of *Spermacoce articularis* and neem extract against the human pathogen *Salmonella* species respectively. Tetracosane though found in small concentration in the studied extract is known to demonstrate antioxidant and strong effectiveness against some cancer cell lines and forms one of the principles underscoring the efficacy of *Dendrobium crepidatum* used in treating fevers, diabetes, cataracts and cancers in Chinese medicine.[86-88] It was also reported as one of the principal compounds detected in *Acacia pennata* a herb used in Thailand; that is associated with inhibiting β-amyloid aggregation in brain tissues of persons suffering from Alzheimer's disease.[89] 2-Methyl tetracosane may exhibit similar chemical properties. Some studies indicated that oleic acid detected in moderate quantity in this present study demonstrated anticancer, anti-inflammatory, hypocholesterolomic, anti-androgenic, antifungal and food preservative activities.[90-91] It is reported as one of the major constituents of *Sida cordata* used in Asia and Nigeria for treating microbial infections, stomach upset, bronchial asthma, wheezing and edema.[92-93] These compounds may underscore and possibly explain the medicinal or therapeutic significance of *A. cordifolia* in the ethnobotany of the people of Abia State, Nigeria.

The people of the study area practice slash and burn agriculture characterized by land rotation. The survey coincided with the cropping season which made accessing interviewees difficult and erratic. Another limitation encountered during this study was in terms of method of isolation and analysis of the active principle of the test plant adopted in the study which did not allow for isolation and identification of nonvolatile bioactive compounds other than fatty acids from the test plant.

Finally, this study confirms that *A. cordifolia* is used to treat various diseases such as fevers, sickle cell anaemia, prostatitis, lacerations, wounds, venereal diseases etc. in the ancient Ekebedi Kingdom. The natives prepare the crude drug mainly as alcoholic macerations, decoction or infusion using water, local gin (*kai kai*) or palm wine. Phytochemical fingerprinting of the methanol leaf extract of the plant revealed the presence of 27 Fatty acid compounds with linoleic, linolenic and lauric acids being the most abundant active ingredients present in the plant, and these compounds possibly underscored its therapeutic activities in traditional

medicine.

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