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Ethnomedicinal survey of plants used in the treatment of malaria in Southern Nigeria

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ABSTRACT

Ethnopharmacological relevance: Malaria is one of the most severe public health problems worldwide. It is a leading cause of death and disease in many developing countries, where young children and pregnant women are the groups most affected. Spread of multidrug-resistant strains of *Plasmodium* and the adverse side effects of the existing anti-malarial drugs have necessitated the search for novel, well tolerated and more efficient antimalarial drugs. This ethnomedicinal study surveyed the different types of medicinal plants used for the treatment of malaria in Southern Nigeria with the intent of identifying plants that are traditionally employed in the treatment of malaria across geopolitical boundaries.

Materials and methods: Data were collected from 79 respondents composed of 50 traditional herbsellers and 29 herbal practitioners using a semi-structured questionnaire. Data was analyzed using frequency and percentages.

Results: Of the 79 respondents interviewed, 24% were males while 76% were females. A total of 156 species belonging to 60 families were reported being used to treat malaria in the study area. Fabaceae was the most represented family having fourteen (14) plant species. Of the plants identified during the survey, *Azadirachta indica* was the species of highest relative frequency of citation (RFC – 1.0). The dominant plant parts used in the preparation of remedies were leaves (50.50%) and Decoction was the main method of preparation. Analysis of regional plant occurrence revealed that South-Western Nigeria represented the region with the highest plant occurrence (60.7%) followed by South–South (24%) and South–East (15.3%). Regional occurrence of plants used in the treatment of malaria in Southern Nigeria is reported here for the first time.

Conclusion: This study has documented a great diversity of plants used in the treatment of malaria in Southern Nigeria. Extracts prepared strictly according to the practitioners' recipes should therefore be screened for antiplasmodial activity and toxicity by *in vitro* and *in vivo* standard tests to justify their local usage. These studies might lead to the isolation and possible identification of potentially active compounds, which may be regarded as future promising phytomedicines in the treatment of malaria. Conservation of these plant species is also recommended to ensure their continuous availability for future use.

1. Introduction

Traditional medicine has been the focus for wider coverage of primary health care delivery in Africa and the rest of the world (Elujoba et al., 2005). According to WHO (1978), traditional medicine refers to the sum total of knowledge or practices whether explicable or inexplicable used in diagnosing, preventing or eliminating a physical, mental or social disease, which may rely exclusively on past experience or observation handed down from generation to generation, verbally or in writing. It comprises therapeutic practices in existence for hundreds of years before the development of modern scientific medicine and is still in use today without much documented evidence of adverse effects (Okigbo and Mmeka, 2006). Plants have always been a major component of traditional system of healing in developing countries, which have also been an integral part of their history and cultural practices. Medicinal plants offer alternative remedies with tremendous opportunities. Many traditional healing herbs and plant parts have been shown to have medicinal value especially in the rural areas and that these can be used to prevent and cure several human diseases. Even today, majority of the world population depends on herbal healthcare practice.

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Malaria disease is caused by parasites of the genus *Plasmodium* and is spread by the female anopheles mosquitoes. In adults, its common symptoms are headaches, weakness, fever, aches and pains, high body temperature (chills and rigors) and bitterness of the mouth (and loss of appetite) while in children, in addition to the above-mentioned symptoms, it may also manifest in more than normal sleeping, nausea and vomiting (Jimoh et al., 2007). Malaria is one of the most severe public health problems worldwide. It is a leading cause of death and disease in many developing countries, where young children and pregnant women are the groups most affected. According to the World Health Organization's Report, 2013 and the Global Malaria Action Plan, 3.4 billion people (half the world's population) live in areas at risk of malaria transmission in 106 countries and territories. In 2012, malaria caused an estimated 207 million clinical episodes, and 627,000 deaths. An estimated 90% of deaths in 2012 were in the African Region (WHO, 2013). In 2013, 97 countries had on-going malaria transmission. 80% of estimated malaria deaths occur in 18 most affected countries. About 40% of malaria deaths occur in just two countries: Nigeria and the Democratic Republic of the Congo (WHO, 2013). Spread of multidrug-resistant strains of *Plasmodium* and the adverse side effects of the existing anti-malarial drugs have necessitated the search for novel, well tolerated and more efficient antimalarial drugs (Olliaro and Trigg, 1995; Bickii et al., 2000). The need for an alternative drug has initiated intensive efforts for developing new anti-malarials from indigenous plants. Various studies have been documented with over 1200 plant species from 160 families used in the treatment of malaria or fever (Willcox et al., 2004). Similar investigations have been carried out in many African nations like Ethiopia (Bekalo et al., 2009), Kenya (Bussmann, 2006; Njoroge and Bussmann, 2006), Ghana (Asase et al., 2005), Cameroon (Titanji et al., 2008) and Nigeria (Odugbemi et al., 2007; Ajibesin et al., 2008; Olowokudejo et al., 2008; Idowu et al., 2009; Kayode et al., 2009; Dike et al., 2012). Most of the cited studies in Nigeria were mostly restricted to single states in the federation and this may have posed some limitations on them such as the exclusion of some potential antimalarial plants. The present study however covers the Southern region of Nigeria with the intent of filling these gaps and identifying plants that are traditionally employed in the treatment of malaria across geopolitical boundaries.

2. Materials and methods

2.2. Description of study area

The study area covers Southern Nigeria, comprising of three (3) regions (geopolitical zones) namely: the south–west region (comprising of Lagos state, Ondo state, Ogun state, Ekiti state, Oyo state and Osun state), south–south region (comprising of Delta state, Edo state, Bayelsa state, Rivers state, Cross rivers state and

Fig. 1. Map showing the states making up the Southern regions of Nigeria.

Akwa-ibom state) and south–east region (comprising of Anambra state, Imo state, Abia state, Enugu state, Ebonyi state) (Fig. 1). The indigenes encountered in these regions were of different ethnic groups. However, six (6) main ethnic groups were encountered in these areas namely; the Yoruba, Igbo, Edo, Urhobo, Efik and Ijaw. The selected regions were found to be malaria endemic in Southern Nigeria with similar tropical climatic conditions. Their tropical climate is characterized by two distinct conditions of wet and dry seasons. These regions experience high rainfall and high humidity for most of the year with an average annual rainfall of 250 cm near the coastal areas and 150 cm in the northern parts of the region.

2.2 Interview and ethical considerations

The objectives of the study were clearly explained and verbal consent was obtained from each study participant. The present study was conducted from June 2014 to November 2014 to document an indigenous anti-malarial plant traditional knowledge. A total of 79 randomly selected knowledgeable male and female respondents from all age-groups were included during the interview. Of which, 50 were traditional herb sellers and 29 were herbal practitioners (Table 1). Most collections were made by the second author (M. Idu) who could speak the local language and was also familiar with some of the traditional plants used by the local tribal people of the region. Study participants were interviewed using a semi-structured questionnaire with some modifications for collection of information on plants used for treating malaria by the herb sellers and herbal practitioners in the different regions of Southern Nigeria. A total of 200 questionnaires were administered and a total of 156 plants species were identified in the study.

2.3 Plants identification

Voucher specimens were collected with the aid of informants for all quoted plant species during the survey. Preliminary identification of the plants was done with the literature and the help of Dr. Odaro Timothy, a plant taxonomist at the University of Benin, Benin City, Edo state, Nigeria. Herbarium specimen were also prepared and deposited at the Department of plant biology and biotechnology, University of Benin, Benin City, Edo state, Nigeria.

2.4 Data analysis

The knowledge on medicinal plants used in the treatment of malaria and related symptoms between the local populations of the study area was analyzed using the relative frequency of citation, frequency of occurrence across the three regions; frequency of plant parts used and sex and age distribution of respondents.

Table 1
Sex and age distribution of respondents.

Respondents	Herb sellers	Herbal practitioners	Total interviewed persons
Male (< 40)	2	5	7
Male (> 40)	4	8	12
Female (< 40)	26	7	33
Female (> 40)	18	9	27
Total interviews	50	29	79
Percentage (%) males	12	45	24
Percentage (%) females	88	55	76

2.4.1. Relative frequency of citation (RFC)

Local importance of each plant species was calculated based on the relative frequency of citation (Tardio and Pardo-De- Santayana, 2008; Yetein et al., 2013). The RFC was calculated as follows: number of respondents, who mentioned the use of the species (Fc), divided by the total number of respondents (*N*).

$$RFC = Fc/N.$$

3. Results

3.1. Medicinal plants used in malaria treatment

Of the 79 respondents interviewed, 24% were males while 76% were females (Table 1). A total of 156 species belonging to 60 plant families were reported being used to treat malaria and related symptoms by the respondents in the study area (Table 2). Fig. 2 shows the frequency of plant parts usage and Fig. 3 shows regional occurrence of the plants across Southern Nigeria.

3.2 Relative frequency of citation (RFC)

The species *Azadirachta indica* was the most frequently quoted (RFC=1.0), followed by *Cymbopogon citratus* (RFC=0.95), *Mangifera indica* (RFC=0.95), *Carica papaya* (RFC=0.81), *Psidium guajava* (RFC=0.70), *Citrus aurantifolia* (RFC=0.67), *Enantia chlorantha* (RFC=0.57) *Vernonia amygdalina* (RFC=0.53), *Morinda lucida* (RFC=0.52), *Ocimum gratissimum* (RFC=0.51), *Chromolaena odorata* (RFC=0.49), *Anacardium occidentale* (RFC=0.48), *Ananas comosus* (RFC=0.47), *Persea americana* (RFC=0.47), *Nauclea latifolia* (RFC=0.46) and *Alstonia boonei* (RFC=0.46) accounted for the most used species in malaria treatment (described in detail in Table 3). The relative frequency of citation for the rest of the species ranged from 0.01 to 0.43 (Table 2).

3.3 Frequency of family occurrence

From the results obtained from this study, the family of Fabaceae had the highest frequency of occurrence having fourteen (14) plant species, followed by Asteraceae with ten (10) species, Rutaceae having eight (8) species, Euphorbiaceae having seven (7) species, Apocynaceae and Rubiaceae having (6) species each, as well as Annonaceae and Meliaceae having five (5) species each (Table 2).

3.4 Frequency of plants parts used

In the study area, the leaves (50.50%) were the most common parts used in the preparation of herbal remedies followed by the stembark (25%), roots (10.70%), fruits (7.10%), seeds (2.60%), whole plant (2.60%), and rhizome (1.50%) (Fig. 2).

3.5 Frequency of plants regional occurence

In the study area (Southern Nigeria), South-Western Nigeria represented the region with the highest plant occurrence (60.7%) followed by South–South (24%) and South–East (15.3%) (Fig. 3).

3.6 Previous studies or documentation

Of the 156 identified plants, 16 plants had the highest relative frequency of citation ranging from 0.46 to 1.0 (*Azadirachta indica, Cymbopogon citratus, Mangifera indica, Carica papaya, Psidium guajava, Citrus aurantifolia, Enantia chlorantha, Vernonia*

Table 2
Plants used in the treatment of malaria in Southern Nigeria.

S/N	Plant name/voucher numbers	Family	Local name	Common name	Parts used	Method of preparation	Frequency of citation (FC)	Relative frequency of citation (RFC). RFC=FC/*N* (*N*=79)
1	*Abrus precatorius* L. UBHdt/SN/006	Fabaceae	Oju-ologbo (Y)	Crab's eye, Bead tree	Leaves	Decoction	4	0.05
2	*Acacia nilotica* (L.) Wild. Ex Del UBHdt/SN/032	Fabaceae	Boonii (H)	Acacia, Egyptian mimosa	Seeds	Decoction	6	0.08
3	*Acacia senegal* (L) Wild UBHdt/SN/051	Fabaceae	Dakwara (H)	Acacia, Gum Arabic	Stembark	Decoction	5	0.06
4	*Acanthospermum hispidum* D.C UBHdt/SN/147	Asteraceae	Dagunro (Y) Gorogoro(U)	Starburr	Leaves	Decoction	10	0.13
5	*Achyranthes aspera* .L. UBHdt/SN/021	Amaranthaceae	Aboro, Abora (Y)	Prickly chaff flower	Leaves, Roots	Decoction	4	0.05
6	*Adansonia digitata* L. UBHdt/SN/039	Bombacaceae	Ose (Y)	Baobab tree	Leave	Decoction	9	0.11
7	*Aframomum melegueta* K. Schum UBHdt/SN/003	Zingiberaceae	Atare (Y), Ose-oji (I)	Alligator pepper	Stembark	Decoction	7	0.09
8	*Ageratum conyzoides* L. UBHdt/SN/148	Asteraceae	Ako-yunyun (Y)	Goat weed	Leaves	Juice extract	12	0.15
9	*Allamanda cathartica* L. UBHdt/SN/030	Apocynaceae	Ako-dodo (Y)	Yellow allamanda, Golden trumpet	Leaves, Roots	Decoction	4	0.05
10	*Allanblackia floribunda* Oliv *Syn A. parviflora* A. chev UBHdt/SN/005	Clusiaceae	Orogboerin (Y), Egba (I)	Fallow tree	Leaves	Decoction	5	0.06
11	*Allium cepa* L. UBHdt/SN/099	Liliaceae	Alubosa (Y), Uta (E)	Onions	Leaves, Stembark	Decoction	4	0.05
12	*Allium sativum* L. UBHdt/SN/033	Liliaceae	Ayuu (Y)	Garlic	Fruits	Infusion/tincture	6	0.08
13	*Aloe vera* (L.) Burm. f . UBHdt/SN/050	Liliaceae		Barbados Aloe	Leaves	Decoction	3	0.04
14	*Alstonia boonei* De Wild UBHdt/SN/100	Apocynaceae	Ahun (Y)	Stool wood	Stembark	Decoction	36	0.46
15	*Alstonia congensis* Engl. UBHdt/SN/087	Apocynaceae	Awun (Y)	Stool wood	Stembark	Decoction	2	0.03
16	*Anacardium occidentale* L. UBHdt/SN/124	Anacardiaceae	Kasu (Y)	Cashew	Leaves, Stembark	Decoction	38	0.48
17	*Ananas comosus*(L). Merr. UBHdt/SN/004	Bromeliaceae	Ope-Oyibo (U)	Pineapple	Fruits	Decoction	37	0.47
18	*Anogeissus leiocarpus*(D.C). Guill. & Perr UBHdt/SN/146	Combretaceae	Egbo-anyin (Y)	Axle wood	Roots	Decoction	2	0.03
19	*Anthocleista djalonensis*A. Chev UBHdt/SN/139	Loganiaceae	Sapo (Y)	Cabbage tree	Stembark	Decoction	4	0.05
20	*Argermone mexicana* Linn. UBHdt/SN/123	Papaveraceae	Mafowokon (Y)	Mexican Poppy, Prickly Poppy	Leaves	Decoction	1	0.01
21	*Aspilla Africana* (Pers.) C.D. Adams UBHdt/SN/084	Asteraceae	Yunyun (Y), Uranjilalu (I).	Hemorrhage plant	Leaves	Juice extract	6	0.08
22	*Axonopus compressus* (Sw.) P. Beauv UBHdt/SN/093	Poaceae	Idi (Y)	Tropical carpet grass	Whole plant	Decoction	5	0.06
23	*Azadirachta indica* A. Juss UBHdt/SN/131	Meliaceae	Dongoyaro (H)	Neem	Leaves	Decoction	79	1.0
24	*Balanites aegyptiaca* (L) Del UBHdt/SN/130	Zygophylaceae	Aduwa (Y)	Desert Date	Roots	Decoction	3	0.04
25	*Bambusa vulgaris* L	Poaceae	Oparun (Y)	Common Bamboo	Leaves	Decoction	21	0.27

	UBHdt/SN/083							
26	*Baphia nitida* Lodd.	Fabaceae	Irosu (Y)	Cam wood	Leaves, Stembark	Decoction	3	0.04
	UBHdt/SN/150							
27	*Berlinia grandifolia* (Vahl) Hutch. & Dalziel	Fabaceae	Omuasin (E), Ubaba (I), Apado (Y).	Red Oak	Leaves, Stembark	Decoction	2	0.03
	UBHdt/SN/034							
28	*Blighia sapida* Konig.	Sapindaceae	Isin (Y)	Akee apple	Leaves	Decoction	4	0.05
	UBHdt/SN/001							
29	*Blumea perrottetiana* D.C(syn *Blumea axilliaris*(Lam). D.C)	Asteraceae	Aruntaba, Erutaba (Y)	Camphos	Leaves	Decoction	3	0.04
	UBHdt/SN/091							
30	*Burkea africana* Hook.	Fabaceae	Apasha (Y)	Burkea, Wild Seriga	Stembark	Decoction	5	0.06
	UBHdt/SN/094							
31	*Cactus opuntia* syn *Opuntia inermis* DC. (DC.)	Cactaceae		Prickly Pear Cactus	Leaves	Juice extract	6	0.08
	UBHdt/SN/085							
32	*Caesalpinia pulcherima* (L.) S.W	Fabaceae	Eko-omode (Y)	Pride of Barbados	Leaves	Decoction	2	0.03
	UBHdt/SN/145							
33	*Cajanus cajan* (L.). Millsp	Fabaceae	Ewe-otili (Y)	Pigeon pea	Leaves	Decoction	9	0.11
	UBHdt/SN/092							
34	*Canna indica* L	Cannaceae	Ido (Y)	Wild canna lily, Indian shot plant	Leaves	Decoction	4	0.05
	UBHdt/SN/090							
35	*Capscicum frutescens* L.	Solanaceae	Ata-ijosi (Y)	African /Guinea Pepper	Fruits	Decoction	12	0.15
	UBHdt/SN/101							
36	*Capsicum annum* L	Solanaceae	Ata-jije (Y)	Pepper	Fruits	Decoction	4	0.05
	UBHdt/SN/035							
37	*Carica papaya* L	Caricaceae	Eto-oyibo (U), Ibepe (Y)	Pawpaw	Leaves	Decoction	64	0.81
	UBHdt/SN/086							
38	*Ceiba petandra* L. Gaertn	Bombacaceae	Akpu-owu (I), Araba, Egungun (Y).	Kapok, Silk cotton tree	Leaves	Decoction	7	0.09
	UBHdt/SN/052							
39	*Chasmanthera dependens* Hochst	Menispermaceae	Igi-ato, Ato (Y)	Chasmanthera	Stembark	Infusion	5	0.06
	UBHdt/SN/122							
40	*Chromolaena odorata* (L).R King & H. Robinson	Asteraceae	Ewe-akintola, Ewe-awolowo (Y)	Siam weed	Leaves	Decoction	39	0.49
	UBHdt/SN/002							
41	*Chrysophyllum albidum* G.Don	Sapotaceae	Agbalumo (Y)	African star apple	Leaves	Decoction	4	0.05
	UBHdt/SN/151							
42	*Cinchona pubescens* Vahl	Rubiaceae		Quinine tree	Stembark	Decoction	6	0.08
	UBHdt/SN/110							
43	*Citrullus lanatus* (Thunb.)Matsum.& Nakai.	Curcubitaceae	Egusu-baara (Y), Uko (E)	Water melon	Fruit, Seeds	Juice extract	4	0.05
	UBHdt/SN/082							
44	*Citrus aurantifolia* (Chrism.). Swingle	Rutaceae	Osan-wewe (Y), Oroma-nkirisi (I), Alimo-ebo (E)	Lime	Fruits	Decoction	53	0.67
	UBHdt/SN/121							
45	*Citrus aurantium* L	Rutaceae	Osan-ijagoin (Y)	Sour/Bitter orange	Fruits	Decoction	8	0.10
	UBHdt/SN/152							
46	*Citrus limon* (L.) Burm. f	Rutaceae	Alimo-negieghe (E)	Lemon	Fruits	Decoction	6	0.08
	UBHdt/SN/008							
47	*Citrus medica* L	Rutaceae			Leaves, Fruits	Decoction	6	0.08
	UBHdt/SN/010							
48	*Citrus paradisi* Macf	Rutaceae	Osan-gerepu (Y)	Grape	Fruits	Decoction	10	0.13
	UBHdt/SN/028							
49	*Citrus sinensis* Osbek	Rutaceae	Osan-mimo (Y)	Sweet orange	Fruits	Decoction	9	0.11
	UBHdt/SN/081							
50	*Clausena anisata* (Will)Hook-f ex Bth	Rutaceae	Atapari, Obuko (Y)	Clausena	Leaves	Decoction	4	0.05

Table 2 (*continued*)

	UBHdt/SN/029							
51	*Cleistopholis patens* (Benth.) Engl. & Diels	Annonaceae	Out (E).Ojo (I), Orila, Ator-angbo (Y).	Salt and oil tree	Leaves, Stembark	Decoction	3	0.04
	UBHdt/SN/007							
52	*Clerodendrum paniculatum* L.	Verbanaceae	Ora-ojola, Adabi (Y)	Garden Quinine	Leaves, Roots	Decoction	2	0.03
	UBHdt/SN/027							
53	*Cochlospermum tinctorium* A.Rich	Cochlospermaceae	Feru (Y), Gbutu (E)	Cotton plant	Roots	Decoction	4	0.05
	UBHdt/SN/095							
54	*Cocos nucifera* L.	Araceae	Agbon (Y)	Coconut	Stembark, Fruits	Decoction	15	0.19
	UBHdt/SN/036							
55	*Cola acuminata* (P. Beauv.) Schott and Endl.	Sterculiaceae	Oji-hausa (I), Obi-abata (Y)	Kola	Stembark	Decoction	8	0.10
	UBHdt/SN/009							
56	*Corchorus olitorus* L.	Tiliaceae	Ewedu (Y)	Jute Plant	Leaves	Decoction	2	0.03
	UBHdt/SN/109							
57	*Costus Afer* Ker	Zingiberaceae	Ireke-omode (Y),	Common ginger lily, Bush-cane	Leaves, Stembark	Decoction	4	0.05
	UBHdt/SN/153							
58	*Crotalaria retusa* L.	Fabaceae	Koropo, Alatunse (Y)	Rattle pea, Rattle Box	Leaves, Roots	Decoction	2	0.03
	UBHdt/SN/020							
59	*Cryptolepis sanguinolenta* (Lindl) Schtlr	Periplocaceae	Gangamau (H)	Cryptolepis	Stembark, Roots	Decoction	6	0.08
	UBHdt/SN/111							
60	*Curcuma longa* L.	Zingiberaceae	Buru, Simogo (U), Laali-pupa (Y)	Tumeric	Rhizome	Decoction/ infusion	22	0.28
	UBHdt/SN/088							
61	*Cymbopogon citratus* (D.C) Stapf.	Poaceae	Ewe-tea, Kooko-oba (Y)	Lemon grass	Leaves	Decoction	75	0.95
	UBHdt/SN/011							
62	*Dacryodes edulis* (D.Don) Lam.	Burreraceae	Elemi (Y), Ube (I)	Native pear	Leaves	Decoction	8	0.10
	UBHdt/SN/125							
63	*Dennettia tripetala* Bak. F	Annonaceae	Nimi (I), Ata-igberi (Y).	Pepper Fruit	Leaves	Decoction	10	0.13
	UBHdt/SN/080							
64	*Dioscorea dumentorium* (Knuth) Pax	Dioscoreaceae	Ona ochao (I),Esuru-igbo (Y)	African bitter Yam	Leaves	Powdered	5	0.06
	UBHdt/SN/096							
65	*Elaeis guineensis* Jacq	Araceae	Ope (Y)	Oil Palm	Leaves	Decoction	4	0.05
	UBHdt/SN/012							
66	*Emilia sonchifolia* (L) D.C	Asteraceae	Odundunodo (Y)	Tassel Flower	Whole plant	Decoction	3	0.04
	UBHdt/SN/115							
67	*Enantia chlorantha* Oliv	Annonaceae	Awopa (Y)	African yellow wood	Stembark	Decoction/Infu-sion/Powdered	45	0.57
	UBHdt/SN/053							
68	*Erythrinia senegalensis* D.C	Fabaceae	Ologbo-sere (Y)	Parrot tree	Roots	Decoction	6	0.08
	UBHdt/SN/154							
69	*Eucalyptus camaldulensis* Dehn	Myrtaceae		Eucalyptus	Leaves, Stembark	Decoction	4	0.05
	UBHdt/SN/155							
70	*Ficus exasperata* Vahl	Moraceae	Epin (Y)	Sand paper tree	Leaves	Decoction	9	0.11
	UBHdt/SN/015							
71	*Fluerya aestuans* (L) Gaud ex mig	Urticaceae	Ipe-eri (Y)	Old woman smokes tobacco	Roots	Decoction	2	0.03
	UBHdt/SN/089							
72	*Funtumia africana* (Benth). Stapf.	Apocynaceae	Ako-ire (Y)	Male Funtum	Roots	Infusion	12	0.15
	UBHdt/SN/037							
73	*Garcinia cola* Heckel	Clusiaceae	Orogbo (Y)	Bitter Kola	Leaves, Stembark	Decoction/ infusion	23	0.29
	UBHdt/SN/040							
74	*Glyphaea brevis* (Spreng.) Monach	Tiliaceae	Atori (Y)	Masquerade stick	Leaves, Stembark	Decoction	5	0.06
	UBHdt/SN/108							

75	*Gongronema latifolium* Benth. UBHdt/SN/126	Asclepiadaceae	Utazi (I)	Amaranth globe	Leaves	Juice extract	4	0.05
76	*Gossypium barbadense* L. UBHdt/SN/102	Malvaceae	Ewe-owu (Y)	West Indian Cotton	Leaves	Decoction	25	0.3
77	*Gossypium hirsutum* L. UBHdt/SN/103	Malvaceae	Ela-owu (Y)	Cotton	Leaves	Decoction	17	0.22
78	*Harungana madagascariensis* Lam ex Poir UBHdt/SN/149	Hypericaceae	Amuje, Asunje (Y), Uwara (U).	Dragon's blood tree	Leaves and Stembark	Decoction	13	0.16
79	*Heliotropium indicum* L UBHdt/SN/017	Boraginaceae	Akuko (Y)	Heliotrope, Cock's comb	Leaves	Decoction	8	0.10
80	*Hyptis suaveolens* (L.) Poit UBHdt/SN/022	Lamiaceae	Jogbo (Y)	Hyptis	Leaves	Decoction	15	0.19
81	*Icacina trichanta* Oliv UBHdt/SN/026	Icacinaceae	Gbegbe (Y)	Icacina	Leaves	Decoction	5	0.06
82	*Jatropha curcas* L. UBHdt/SN/097	Euphorbiaceae	Lapalapa-funfun (Y)	Physic nut, Pig nut	Stembark	Decoction	10	0.13
83	*Jatropha gossypifolia* L. UBHdt/SN/098	Euphorbiaceae	Botuje-pupa (Y)	Wild cassava	Leaves	Juice extract	12	0.15
84	*Khaya grandifolia* C.DC. UBHdt/SN/041	Meliaceae	Oganwo (Y)	Mahogany	Stembark	Decoction/ infusion	16	0.20
85	*Khaya ivoriensis* A. Chev UBHdt/SN/038	Meliaceae	Oganwo (Y)	African Mahogany	Stembark	Decoction	18	0.23
86	*Kigelia Africana* (Lamb) Benth UBHdt/SN/065	Bignoniaceae	Rawuya (H)	Sausage tree	Root	Infusion	6	0.08
87	*Lantana camara* L. UBHdt/SN/104	Verbanaceae	Ewon-agogo (Y)	Wild Sage	Leaves	Decoction	4	0.05
88	*Lawsonia inermis* L. UBHdt/SN/127	Lythraceae	Laali (Y)	Henna plant	Leaves	Decoction	14	0.18
89	*Lecaniodiscus cupanoides* Planch ex Benth UBHdt/SN/025	Sapindaceae	Akika (Y)	Lecaniodiscus	Leaves	Decoction	11	0.14
90	*Lippia multiflora* Poir UBHdt/SN/141	Verbanaceae	Efinrin-gorogoro, Efinrin-oko (Y)	Sweet leaf	Whole plant	Decoction	3	0.04
91	*Lophira alata* Banks ex Gaertn. f. UBHdt/SN/019	Ochnaceae	Pahan (Y)	Iron wood	Stembark	Decoction	2	0.03
92	*Ludwigia hyssopifolia* (G. Don) Exell UBHdt/SN/116	Onagraceae	Bini-sensen (B)	Water primrose	Leaves	Decoction	2	0.03
93	*Mallotus cordifolia* Muell.arg UBHdt/SN/073	Euphorbiaceae	Ebewosa (B)		Leaves	Decoction	3	0.04
94	*Mangifera indica* L. UBHdt/SN/023	Anacardiaceae	Mangoro (Y)	Mango	Leaves, Stembark	Decoction	75	0.95
95	*Manihot esculenta* Crantz UBHdt/ SN/064	Euphorbiaceae	Icassava (U)	Cassava	Leaves	Decoction	7	0.09
96	*Milicia excelsa* (Welw.) C.C.Berg UBHdt/SN/054	Meliaceae	Iroko (Y), Oje (I)	Iroko	Stembark, Roots	Decoction	12	0.15
97	*Microdesmis puberula* Hook.f. ex Planch UBHdt/SN/156	Euphorbiaceae	Ido-apata (Y), Uperi (I).	Microdesmis	Leaves	Decoction	3	0.04
98	*Momordica charantia* L. UBHdt/SN/024	Curcubitaceae	Ejinrin-were (Y)	African cucumber	Leaves	Decoction/Juice extract	8	0.10
99	*Mondia whitei* (Hook.f.) Skeels UBHdt/SN/112	Periplocacaeae	Isirigun (Y)	Mondi	Roots, Whole plant	Decoction	10	0.13
100	*Morinda lucida* Benth	Rubiaceae	Oruwo (Y), Njisi (I).	Brimstone tree	Leaves,	Decoction/Juice	41	0.52

Table 2 (*continued*)

					Stembark	extract		
	UBHdt/SN/072							
101	*Morinda morindiodes* (Barker). Milne-Redh	Rubiaceae	Poju-owiwi, Oju-ologbo (Y)	Morinda	Leaves, Stembark	Decoction	6	0.08
	UBHdt/SN/048							
102	***Moringa oleifera*** Lam	Moringaceae	Ewe-igbale (Y)	Horse radish tree	Leaves	Decoction/ Maceration	6	0.08
	UBHdt/SN/055							
103	*Musa paradisiaca* L.	Musaceae	Ogede (Y)	Plantain	Leaves	Decoction	14	0.18
	UBHdt/SN/016							
104	*Musa sapientum* L	Musaceae	Ogede-were (Y)	Banana	Leaves	Decoction	16	0.20
	UBHdt/SN/132							
105	*Musanga cecropioides* R.Br.	Moraceae	Agbawo, Oro (Y)	Cork wood, Umbrella tree	Leaves, Stembark	Decoction	1	0.01
	UBHdt/SN/140							
106	*Nauclea diderrichii* (De Wild) Merr	Rubiaceae	Ope (U), Opepe (Y)	African peach	Stembark	Decoction	7	0.09
	UBHdt/SN/138							
107	*Nauclea latifolia* (Smith) Bruce	Rubiaceae	Egbesi (Y)	African peach	Leaves, Stembark, Roots	Decoction/tincture	36	0.46
	UBHdt/SN/056							
108	*Newbouldia laevis* Seeman ex Bureau	Bignoniaceae	Oke-ogirishi (I), Akoko (Y).	Tree of life, Fertility tree	Leaves	Decoction	22	0.28
	UBHdt/SN/071							
109	*Ocimum gratissimum* L	Lamiaceae	Efinrin-ajase (Y), Ufuo-oyibo (U).	Tea bush, Scent leaf	Leaves	Decoction/Juice extract	40	0.51
	UBHdt/SN/047							
110	*Palisota hirsuta* Schum	Commelinaceae		Palisota	Leaves	Decoction	4	0.05
	UBHdt/SN/105							
111	*Parinari macrophylla* Sabine	Rosaceae	Abere (Y)	Neou oil tree	Seeds	Decoction	6	0.08
	UBHdt/SN/014							
112	*Parquetina nigrescens* (Afzel) Bullock	Periplocaceae	Ewe-ogbo (Y)	African parquetina	Leaves	Decoction/ infusion	10	0.13
	UBHdt/SN/049							
113	*Peperomia pellucida* (L.) H.B.&K.	Piperaceae	Rinrin (Y)	Silver Bush	Leaves	Decoction	6	0.08
	UBHdt/SN/118							
114	*Pergularia daemia* (Forsk.) Choiv	Asclepiadaceae	Jagborokun, rogbo-aguntan (Y).	Pergularia	Leaves	Maceration/ infusion	9	0.11
	UBHdt/SN/113							
115	*Persea americana* Mill	Lauraceae	Pia (Y), Ube-oyibo (I), Ur-uvwon (U)	Avocado pear	Leave, Stembark	Decoction/Juice extract	37	0.47
	UBHdt/SN/057							
116	*Petivera alliacea* L.	Phytolaccaceae	Awogba (Y)	Skunk weed, Gully-root	Leaves	Decoction	5	0.06
	UBHdt/SN/063							
117	*Phyllanthus amarus* Schum et Thonn	Euphorbiaceae	Eyin-olobe (Y)	Small leaf, stone breaker	Leaves	Infusion/ Decoction	26	0.33
	UBHdt/SN/045							
118	*Phyllanthus muellerianus* (O.Ktz) Exell	Euphorbiaceae	Egun-eja (Y)	Myrobalan	Leaves	Maceration	12	0.15
	UBHdt/SN/128							
119	*Physallis angulata* L.	Solanaceae	Koropo (Y)	Ground angular cherry	Leaves	Decoction	3	0.04
	UBHdt/SN/013							
120	*Picralima nitida* (Stapf) Th. & H.Dur	Apocynaceae	Erin, Eso-abere (Y)	Picralima	Seeds	Decoction	6	0.08
	UBHdt/SN/106							
121	*Piper guineense* Schum. & Thonn	Piperaceae	Iyere (Y)	Climbing black pepper	Fruits	Decoction	3	0.04
	UBHdt/SN/042							
122	*Psidium guajava* L.	Myrtaceae	Gilofa (Y)	Guava	Leaves	Decoction	55	0.70
	UBHdt/SN/079							
123	*Pterocarpus santalinoides* D.C	Fabaceae	Gbengben (Y), Nturukpa (I).	Winged fruit	Leaves	Decoction	2	0.03
	UBHdt/SN/066							

124	*Pycanthus angolensis* (Welw) Warb. UBHdt/SN/074	Myristicaceae	Akomu (Y)	African nutmeg	Leaves, Stembark	Decoction	13	0.16
125	*Pyrenacantha staudtii* Engl UBHdt/SN/046	Icacinaceae	Arorodegbo, Oroto-agba (Y)	Pyrenacantha	Leaves	Juice extract	4	0.05
126	*Ruawolfia vomitoria* Afzel UBHdt/SN/062	Apocynaceae	Asofeyeje (Y)	Serpent wood, Swizzle stick	Leaves	Decoction	10	0.13
127	*Rytigynia nigerica* (S.Moore). Robyns UBHdt/SN/059	Rubiaceae	Elegun-oko (Y)	Rytigynia	Stembark, Roots	Decoction	1	0.01
128	*Securidaca longipedunculata* Frer UBHdt/SN/107	Polygalaceae	Ofodo, Ipeta (Y)	Violet tree	Roots	Powdered	3	0.04
129	*Senna fistula* L. UBHdt/SN/058	Fabaceae	Aidan-toro (Y)	Pudding stick, Golden Shower, Indian Laburnum	Roots	Decoction	4	0.05
130	*Senna podocarpa* Guill. & Perr. UBHdt/SN/018	Fabaceae	Asunwonibile (Y)	Senna	Leaves, Stembark	Decoction	9	0.11
131	*Senna siamea* Lam. UBHdt/SN/119	Fabaceae	Kasia		Leaves, Stembark	Decoction	17	0.22
132	*Sida acuta* Burm f. UBHdt/SN/077	Malvaceae	Osoketu (Y)	Hornbean leaf, Sida	Whole plant	Decoction	16	0.20
133	*Solanum nigrum* L. UBHdt/SN/067	Solanaceae	Ebe-ape (U)	Black/ Common Nightshade	Whole plants	Decoction	14	0.18
134	*Sorghum bicolor* (L.) Moench UBHdt/SN/114	Poaceae	Poroporo-okababa (Y)	Guinea corn	Leaves	Decoction	16	0.20
135	*Spathodea Campanulata* P. Beauv UBHdt/SN/031	Bignoniaceae	Oruru, mojutoro (Y)	African tulip, Scarlet bells	Stembark	Decoction	2	0.03
136	*Sphenocentrum jollyanum* Pierre UBHdt/SN/129	Menispermaceae	Akerejupon (Y)	Sphenocentrum	Roots	Decoction	16	0.20
137	*Spondias mombin* L. UBHdt/SN/137	Anacardiaceae	Iyeye (Y)	Hogplum	Leaves, Stembark	Decoction	10	0.13
138	*Stachytarpheta cayennensis* (LC.Rich) Schua UBHdt/SN/142	Verbanaceae	Ebe (U), Obibo (Y).	Rats's rail Vervaine, Blue Snakeweed	Leaves	Decoction	3	0.04
139	*Syndrella nodiflora* Gaertn UBHdt/SN/133	Asteraceae	Aluganbi (Y).	Synedrella	Leaves	Decoction	2	0.03
140	*Terminalia avicennioides* Guill. & Perr. UBHdt/SN/076	Combretaceae	Idi (Y)	Baushe	Leaves, Stembark	Decoction	8	0.10
141	*Terminalia catappa* L. UBHdt/SN/120	Combretaceae	Furuntu (Y), Ebelebo (E)	Indian almond	Leaves	Decoction	3	0.04
142	*Terminalia ivoriensis* A.Chev UBHdt/SN/143	Combretaceae	Afara-dudu (Y)	Black afara	Leaves, Stembark	Decoction	10	0.13
143	*Theobroma cacao* L. UBHdt/SN/043	Sterculiaceae	Koko (Y)	Cocoa	Stembark	Decoction	8	0.10
144	*Tithonia diversifolia* (Helmsl) A. Gray UBHdt/SN/068	Asteraceae	Jogbo-agbale (Y)	Tree marigold	Leaves	Decoction	12	0.15
145	*Treculia Africana* Decne. UBHdt/SN/060	Moraceae	Afon (Y)	African Bread fruit	Stembark	Decoction	2	0.03
146	*Trema orientalis* (L.) Blume UBHdt/SN/144	Ulmaceae	Afefe (Y)	Charcoal tree, gunpowder tree	Leaves, Stembark	Decoction	17	0.22
147	*Trichilia monadelpha* (Thonn) J.J. De Wilde UBHdt/SN/075	Meliaceae	Akorere (Y)		Stembark	Infusion	5	0.06
148	*Tridax Procumbens* L.	Asteraceae	Sabaruma (Y)	Tridax	Leaves	Decoction	2	0.03

Table 2 (*continued*)

	UBHdt/SN/136							
149	*Triumfetta cordifolia* A. Rich	Tiliaceae	Abiko (B), Akee-eri (Y)		Leaves	Decoction	4	0.05
	UBHdt/SN/134							
150	*Urena lobata* L	Malvaceae	Odoazezo (I), Akeriri (Y)	Congo jute, Caesar weed	Leaves	Decoction	5	0.06
	UBHdt/SN/070							
151	*Uvaria chamae* P. Beauv	Annonaceae	Mmimi-ohia (I)	Cluster pear	Leaves, Stembark	Decoction	11	0.14
	UBHdt/SN/061							
152	*Vernonia amygdalina* L	Asteraceae	Kiriologbo (Ij), Ewuro (Y).	Bitterleaf	Leaves	Decoction/Juice extract	42	0.53
	UBHdt/SN/078							
153	*Ximenia americana* L	Olacaceae	Out-ugba, Otua (I), Igo (Y)	Wild Lime, Seaside plum	Stembark, Roots	Decoction	1	0.01
	UBHdt/SN/117							
154	*Xylopia aethiopica* (Dunal) A. Rich	Annonaceae	Eri-alamo (Y)	Ethiopian pepper	Fruits, Seeds	Decoction	24	0.30
	UBHdt/SN/069							
155	*Zanthoxylum leprieurii* Guill. & Perr.	Rutaceae	Ata (Y)	Fagara	Stembark, Roots	Tincture	8	0.10
	UBHdt/SN/135							
156	*Zingiber officinale* Roscoe	Zingiberaceae	Ajo, Ata-ile (Y)	Ginger	Rhizome	Decoction	23	0.29
	UBHdt/SN/044							

Local names: (Y) – Yoruba, (I) – Igbo, (H) – Hausa, (B) – Benin, (E) – Efik, (Ij) – Ijaw, (U) – Urhobo.

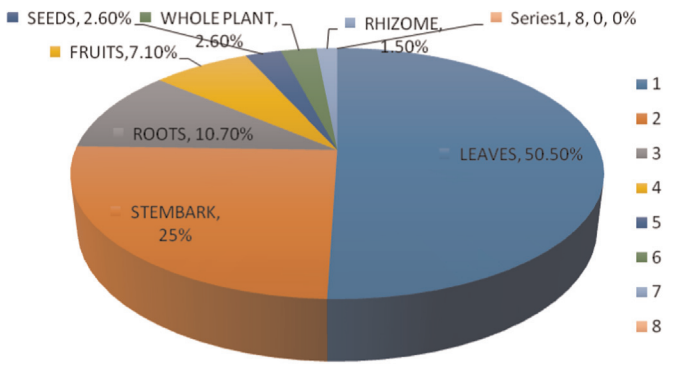

Fig. 2. Frequency of plant parts usage.

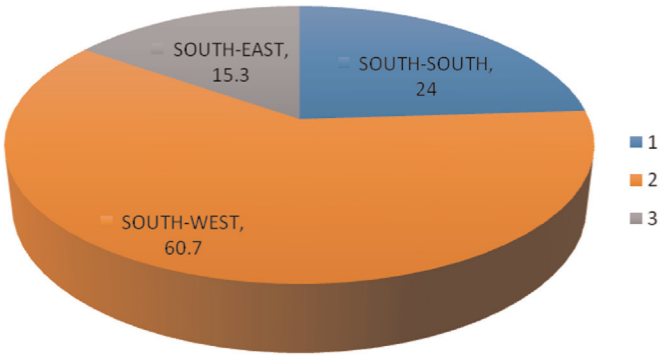

Fig. 3. Frequency of plant regional occurrence.

amygdalina, Morinda lucida, Ocimum gratissimum, Chromolaena odorata, Anacardium occidentale, Ananas comosus, Persea americana, Nauclea latifolia, and *Alstonia boonei*), 15 out of which have been previously investigated for anti-malarial properties. The parts used, regional distribution, ethmomedicinal uses, phytochemicals and active compounds as well as the status of scientific validation of the 16 listed plants, have been summarized in Table 3. Various plants showed the presence of various phytochemicals like tannins (*Anacardium occidentale, Azadirachta indica, Mangifera indica,* and *Nauclea latifolia*), alkaloids (*Alstonia boonei*, *Azadirachta indica, Nauclea latifolia, Citrus aurantifolia* and *Enantia chlorantha*), saponins (*Citrus aurantifolia, Psidium guajava, Nauclea latifolia* and *Mangifera indica*), glycosides (*Citrus aurantifolia,* and *Mangifera indica*), terpenoids (*Alstonia boonei, Cymbopogon citratus, Psidium guajava, Vernonia amygdalina* and *Nauclea latifolia*), flavonoids (*Citrus aurantifolia, Psidium guajava* and *Nauclea latifolia*), and essential oils (*Cymbopogon citratus* and *Ocimum gratissimum*) (Table 3).

4. Discussion

4.1 Information on respondents

From the total of 79 randomly selected knowledgeable male and female respondents included during the interview of which, 50 were traditional herb sellers and 29 were herbal practitioners, the results obtained indicated that there were more females than males with ages ranging from <40 to >40. More traditional herb sellers were included in this study than herbal practitioners because these traditional herb sellers come from backgrounds with very rich traditional knowledge of these herbs and their uses which have been handed down from generation to generation. In

Table 3
Indigenous medicinal plants shown to be anti-plasmodial or anti-malarial.

S/N	Plants/family	Parts used	Relative frequency of citation (RFC)	Regional distribution	Ethnomedicinal uses	Phytochemicals isolated	Stage of pre-clinical validation	References
1	*Azadirachta indica* (Meliaceae)	Leaves	1.0	S/W,S/S, S/E.	Malaria fever, jaundice, syphilis, anthelmintics, skin disease, eczema, ringworm, emetic, laxative, sore throat,antifungal, immunostimulant, antibacterial, antiviral, antimicrobial, measles.	More than 135 compounds have been isolated. The compounds have been divided into two major classes: isoprenoids and its derivatives–gedunin – possess anti-malarial properties.	Ivt, ivv	Odugbemi (2008), NNMDA (2005, 2008), Alshawsh et al. (2009), Udeinya et al. (2006), Adesegun and Coker (2001), Dhara et al. (1999), Udeinya (1993)
2.	*Cymbopogon citratus* (Poaceae)	Leaves	0.95	S/W,S/S, S/E.	Malaria, cough, sprains, lumbago, stomach tonic, stimulant, cold, chest pains, rheumatic joints, diaphoretic, diuretic, refrigerant, ringworm.	Terpenoids, aldehydes, Essential oils like geranial	Ivt, ivv	Bidla et al. (2004), Tchoumbougnang et al. (2005), Odugbemi (2008), NNMDA (2008).
3.	*Mangifera indica* (Anacardiaceae)	Leaves, Stembark.	0.95	S/W,S/S, S/E.	Malaria, yellow fever, anemia, liver disease, diarrhea, diabetes, skin lesion, high blood pressure, hemorrhage, emmenagogue, insomnia, insanity, anthelmintics, antimicrobials, astringent, asthma, cough.	Xanthone Glycosides – Mangiferin, saponins, steroids and tannins	Ivt	Awe (1998), NNMDA (2005, 2008), Aiyeloja and Bello (2006), Odugbemi (2008).
4.	*Carica papaya* (Caricaceae)	Leaves	0.81	S/W,S/S, S/E.	Malaria, gonorrhea, syphilis, amebic dysentry, round worms, abortifacients, emmenagogue, diabetes, medicinal recipes,hemostatic, hernia, infections of urinogenital systems, blennorrhoea, orchitis, papain enzyme as meat tenderizer, convulsion, mental disorder.	Papain	Ivt	Bhat and Surolia (2001), Odugbemi (2008); Avwioro (2010), NNMDA (2013).
5.	*Psidium guajava* (Myrtaceae)	Leaves	0.70	S/W,S/S, S/E.	Malaria fever, diarrhea, stomach ache, cough, laxative, dysentry, irregular menstruation sore throat, laryngitis, skin ulcers, astringent, antispasmodic, rheumatism, epilepsy, cholera, convulsions, mouth swelling.	Flavonoids, carbohydrates, saponins, anthraquinones and terpenoids	Ivt	Nundkumar and Ojewole (2002), NNMDA (2005, 2008), Obute (2006)
6.	*Citrus aurantifolia* (Rutaceae)	Fruits	0.67	S/W,S/S, S/E.	Fever, jaundice, stomache ache, antimicrobials, abdominal ulcer, gonorrhea, carminative, hypertensive, flavoring agents, measles, cough, toothache, anthelmintics, scurvy, insecticides.	Alkaloids, saponins, flavonoids and glycosides	Ivt	Obute (2006), Odugbemi et al. (2007, 2008), NNMDA (2013), Bapna et al. (2014).
7.	*Enantia chlorantha* (Annonaceae)	Stembark	0.57	S/W,S/S, S/E.	Malaria, typhoid fever, antimicrobials, jaundice, rickettsia, infective hepatitis, hemostatic, uterus stimulant, ulcer.	Alkaloids, Phenolics	Ivv	NNMDA (2008), Odugbemi (2008), Ayoade and Musbau (2010).
8.	*Vernonia amygdalina* (Asteraceae)	Leaves	0.53	S/W,S/S, S/E.	Malaria, itching, ring worms, weak erection, tonic, astringent, diarrhea, antimicrobials, nervous diseases, gingivitis, tootheache, stomach ache, impotency, laxative, acute pains, piles, rashes, hemostatic, diabetes, pneumonia, enema.	Bitter sesquiterpenes lactones compounds, such as, vernolide, vernodalin, hydroxyvernolide and the steroid related constituents, vernonioside B1 and vernonoid B1	Ivt	Tona et al. (2004), NNMDA (2005), Odugbemi (2008), Omoregie et al. (2011)
9.	*Morinda lucida* (Rubiaceae)	Leaves, Stembark.	0.52	S/W,S/S, S/E.	Malaria, typhoid fever, yellow fever, cerebral congestion, dysentry, dressing of wound, diabetes, heart disease, stomach ache, purgative, emetic, diuretic, jaundice, flatulence, anti cancer, low sperm count, analgesic, laxative, trypanocidal activity, ulcers, leprosy gonorrhea.	Damnacanthal	Ivt, ivv	Awe and Makinde (1998), NNMDA (2005, 2008), Odugbemi et al. (2007).
10.	*Ocimum gratissimum* (Lamiaceae)	Leaves	0.51	S/W,S/S, S/E.	Fever, cough, convulsion, cold, catarrh, bronchitis, colic, chest pain, stop diarrhea, prevent miscarriage, stop nasal bleeding, insect repellant, antimicrobials, anthelmintics, hypertension, diabetes, piles, antibacteria.	Essential oils	Ivt	Ngemenya et al. (2004), Olorunniyi and Morenikeji (2013)
11.	*Chromolaena odorata* (Asteraceae)	Leaves	0.49	S/W,S/S.	Malaria fever, typhoid fever, diabetes, diuretic, rheumatic pains, tumor, anti-inflammation, stomach pain, antimicrobial, dysentry, headache, toothache, hemostatic, skin diseases.	Quercetin-4'-methyl ether	Ivv	Odugbemi (2007, 2008), Ukpai and Amaechi (2012), Olorunniyi and Morenikeji (2013), Ezenyi et al. (2014)
12.	*Anacardium occidentale* (Anacardiaceae)	Leaves, Stembark.	0.48	S/W,S/S, S/E.	Malaria, typhoid fever, white coating of the tongue, toothache, sore gums, dysentry, purgative, elephantiasis, leprosy, ringworms, scurvey, diabetes, warts, anthelmintics, caries	Tannins	Ivt	Odugbemi (2007, 2008), Razalia et al. (2008), Orwa et al. (2009), Olorunniyi and Morenikeji (2013)
13.	*Ananas comosus* (Bromeliaceae)	Fruits	0.47	S/W,S/S, S/E.	Malaria, Typhoid fever, cough, anthelmintics, digestive problems, fibrinolytic action, inhibiting platelet	–	–	Olorunniyi and Morenikeji (2013)

Table 3 (*continued*)

S/N	Plants/family	Parts used	Relative frequency of citation (RFC)	Regional distribution	Ethnomedicinal uses	Phytochemicals isolated	Stage of pre-clinical validation	References
					aggregation, interferring with the growth of malignant cells, removing skin (debridement), anti-inflammatory, enhancing drug absorption, purgative, emmenagogue, vermifuge, enzyme- bromelaine for meat tenderizer			
14.	*Persea americana* (Lauraceae)	Leaves, Stembark.	0.47	S/W,S/S, S/E.	Malaria, hypertension, analgesic, anti-inflammatory, anti-convulsant, hypoglycaemic, vasorelaxant, diuretic, parasitic skin diseases, peptc ulcer, aphrodisiac, insomnia, gastro-intestinal disorders.	1,2,4-dihydroxy derivatives aliphatic alcohols, called avocadenols	Ivt	Dike et al. (2012), Falodun et al. (2014)
15.	*Nauclea latifolia* (Rubiaceae)	Leaves, Stembark, Roots	0.46	S/W,S/S, S/E.	Febrile conditions, cough, antifungal, thrush, jaundice, piles, emetic,menstrual disorders, stomach disorders, measles, sore.	Flavonoids, saponin, terpenoids and tannin, Alkaloids.	Ivt	Benoit-Vicala et al. (1998), Traore et al. (2000), Odugbemi (2008)
16.	*Alstonia boonei* (Apocynaceae)	Stembark	0.46	S/W,S/S.	Malaria fever, anti-inflammatory, stomach pain, tonic, anthelmintics, yellow fever, filaria worms, breast development, antidote.	Alkaloid-alstonine, Terpenoids	Ivt *Alstonia boonei* has been tested and prepared as tablet	Tantchou et al. (1986), Okpekon et al. (2004), NNMDA (2005, 2008), Obute (2006), Odugbemi (2008), Majekodunmi et al. (2008)

Key – S.W – South–West, S.S – South–South, S.E – South–East, ivt: *in vitro* inhibition assays; ivv: *in vivo* using animal models; ct: clinical trials.

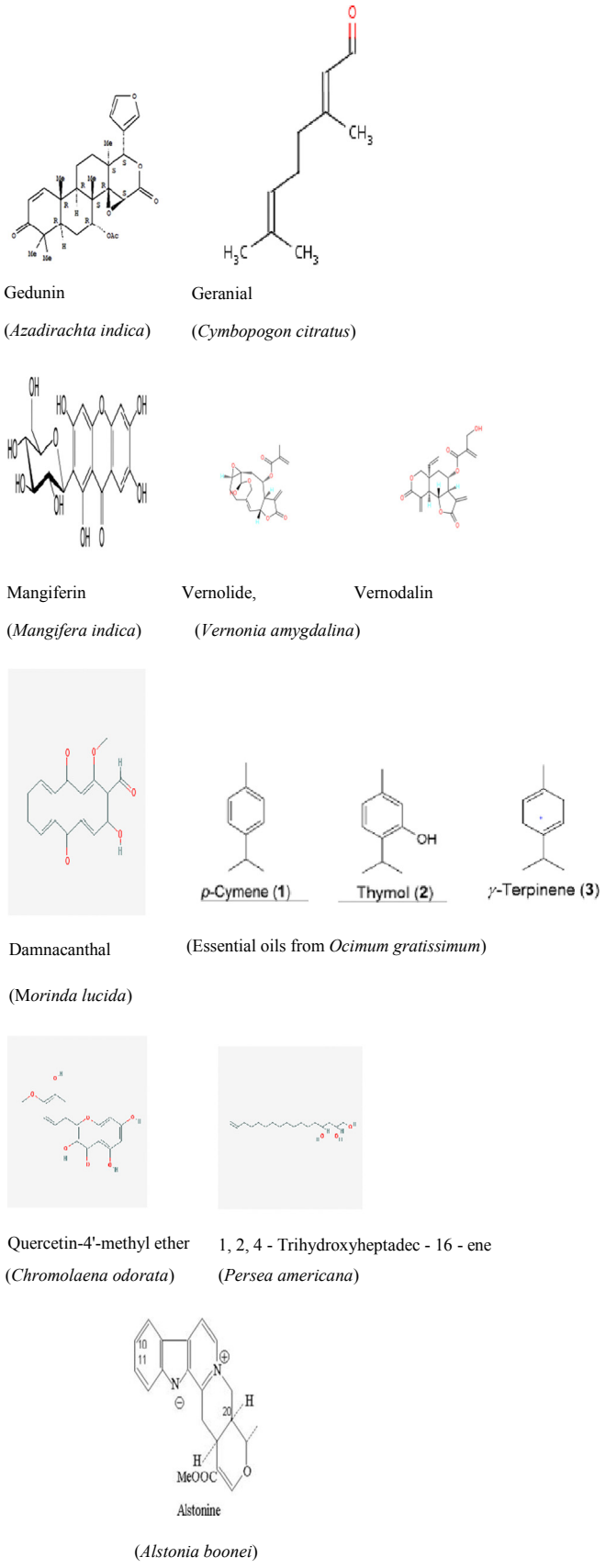

Fig. 4. Chemical structures of some isolated phytochemicals with antimalarial activity.

addition, in the southern part of Nigeria most of these herb sellers are practitioners themselves and do not only sell these herbs but prescribe the herbs to be used for a particular ailment, the method of preparation as well as the mode of administration. In some cases, these traditional herb sellers have been known to prepare these herbal decoctions themselves and administer to customers for rapid effects and efficacy. These traditional herb sellers play a primary role in the supply of these herbs and they are predominantly more accessible and open to sharing their knowledge of these herbs and their uses with researchers than their counterparts who are just herbal practitioners. Majority of the respondents however, acknowledged that they get regular feedbacks from their patients and also emphasized that the longstanding usage of these plant in the treatment of malaria is in fact enough proof of their efficacy and safety.

4.2 Diversity and plant species used most frequently in malaria treatment

In this study, we reported a total of 156 species belonging to 61 families used as antimalarial plants in Southern Nigeria both by herb sellers and herbal practitioners. The majority of the plant species mentioned by the respondents belongs to the family of Fabaceae with 14 species, followed by Asteraceae with ten species and Rutaceae having eight species. However results obtained by Olorunnisola et al. (2013), revealed that Asteraceae has the greatest number of plants species used in the treatment of malaria in Ogbomoso, South-west Nigeria. Among the recorded species in this study, 16 species were frequently quoted by the respondents including *Azadirachta indica, Cymbopogon citratus*, *Mangifera indica*, *Carica papaya*, *Psidium guajava*, *Citrus aurantifolia*, *Enantia chlorantha*, *Vernonia amygdalina*, *Morinda lucida*, *Ocimum gratissimum*, *Chromolaena odorata*, *Anacardium occidentale*, *Ananas comosus*, *Persea americana*, *Nauclea latifolia* and *Alstonia boonei*. From the description of these plants in Table 3, it is evident that these plants have been reported to have ethnomedicinal usage in the treatment of malaria as well as the treatment of other symptoms related to malaria infection. These symptoms include, fever, cold, cough, catarrh (*Cymbopogon citratus*, *Mangifera indica*, *Psidium guajava*, *Citrus aurantifolia, Ocimum gratissimum*, *Ananas comosus*, *Nauclea latifolia*), sore throat and white coating of the tongue (*Azadirachta indica, Psidium guajava*, *Anacardium occidentale*). Some of these plants have also been recorded to have analgesic (*Cymbopogon citratus*, *Psidium guajava*, *Citrus aurantifolia*, *Vernonia amygdalina*, *Morinda lucida*, *Ocimum gratissimum*, *Chromolaena odorata*, *Persea americana*, and *Alstonia boonei*), antimicrobial (*Azadirachta indica, Mangifera indica*, *Citrus aurantifolia*, *Enantia chlorantha*, *Vernonia amygdalina*, *Ocimum gratissimum*, *Chromolaena odorata*), immunostimulant (*Azadirachta indica*) and anti convulsant (*Carica papaya*, *Psidium guajava*, *Ocimum gratissimum* and *Persea americana*) activities. Some have also been used in the treatment of jaundice (*Azadirachta indica, Citrus aurantifolia*, *Enantia chlorantha*, *Morinda lucida* and *Nauclea latifolia*) Liver diseases (*Mangifera indica* and *Enantia chlorantha*) and also in improving drug absorption (*Ananas comosus*) as well as flavoring (*Citrus aurantifolia*). The chemical profile records of these plants have also shown the presence of several phytochemicals which have been shown to exhibit antiplasmodial activities including alkaloids (Oomah, 2003; Chan et al., 2004), flavonoids (Lehane and Saliba, 2008; Ferreira et al., 2010), tannins (Jigam et al., 2010), Terpenoids (Goulart et al., 2004; Su et al., 2008), glycosides, saponins (Desai et al., 2009) as well as essential oils (Tchoumbougnang et al., 2005; Mota et al., 2012). Fig. 4 shows the chemical structures of some isolated phytochemicals with antimalarial activity. In addition, the 16 most cited plants were found to be widely distributed in the treatment of malaria across the three

regions of Southern Nigeria except *Chromolaena odorata* and *Alstonia boonei* whose use were not mentioned in the South-eastern region. This may therefore indicate that the use of these medicinal plants correlates with their distribution and abundance in Southern Nigeria. Among these listed species however, *A. indica* was the most cited and used plant species in the treatment of malaria. This is in agreement with the reports of other researchers (Ene et al., 2009; Ighere et al., 2011; Dike et al., 2012; Olorunnisola et al., 2013). *Cymbopogon citratus*, *Mangifera indica*, *Carica papaya*, *Psidium guajava*, *Citrus aurantifolia* were also revealed to have high frequency of usage in accordance with the reports of Singh and Singh (2014), Dike et al. (2012) and Ighere et al. (2011). Thus, based on the results of the survey, these plants could be considered promising candidates for further scientific validation.

Among the 16 most cited species in this study, 15 species have been investigated for their antimalarial effects based on reports obtained from previous studies focused on *in vitro* and *in vivo* antiplasmodial activities of these species (Table 3). However, to the best of available knowledge, none of the 15 previously investigated plants have passed the stages of orthodox clinical trials for their anti-malarial properties, but *in vitro* and *in vivo* analyses demonstrating significant anti-malarial activity have been reported. Thus, further studies that might lead to the identification of new and cheaper antimalarial drugs are required.

Previous studies have indicated that *Azadirachta indica* contains phytochemicals such as alkaloids, flavonoids, terpenoids, saponins, tannins, phenols and cardiac glycosides (Ayeni and Yahaya, 2010) and *Cymbopogon citratus* evidently contains alkaloids, saponins, tannins, anthraquinones, steroids, phenols and flavonoids (Asaolu et al., 2009). Each of these phytochemicals is known for various protective and therapeutic effects (Dike et al., 2012). All the plants identified in the study are used traditionally in the treatment of malaria in Southern Nigeria, and mostly consumed orally in the form of decoction. Plant species identified in the study are employed both singly and in combination with other anti-malarial plants; this may be due to the synergistic effect of these plants in the destruction of the plasmodium species. However, none of the respondents provided any information on the optimization and standardization of the administration of these remedies. This represents the major drawback of traditional medicine (Asase et al., 2005).

It is also important to note that in some cases plants that were reported as being used for the treatment of malaria were found to have antipyretic properties and had no real antiplasmodial properties (Addae-Kyereme et al., 2001; Asase and Oppong-Mensah, 2009). Therefore, the need for antiplasmodial studies is recommended.

The majority of the respondents also believed that there were no adverse effects for the treatment of malaria. This confirms the previous reports from various studies (Avwioro, 2010; Wambebe, 2009). Although the effectiveness of *Azadirachta indica, Carica papaya, Mangifera indica* and *Anacardium occidentalis* has been reported earlier as having no side effects (Avwioro, 2010), there have also been reports of adverse effects in the use of other plants (Abosi and Raseroka, 2003; Ajaiyeoba et al., 2006). Despite the belief of indigenous community that herbal medicines are effective and safe, it is necessary to standardize and validate their safety, efficacy and recommend doses according to the scientific methods (Singh and Singh, 2014).

4.3 Method of preparation, mode of administration and efficacy

The results obtained from this study revealed that the different methods of preparation employed in the use of these plants included decoction, infusion, tincture, juice extract, powder and maceration (Table 2). However decoction was the main method of preparation used in the study area. This is also in accordance with the reports of Dike et al. (2012) and Yetein et al. (2013). In the preparation of these herbal recipes for malaria therapy, the respondents reported that a single plant or more than two different plants species or parts may be combined and used. Some of the plants combined may enhance the action and activities of other herbs. This report is consistent with the earlier reports of Idowu et al. (2009) and Olorunnisola et al. (2013). Majority of the respondents believed that boiling using water or aqueous extract from fermented maize starch is the best method of preparing malarial herbal remedy. However, the use of the aqueous extract from the fermented maize was more pronounced. This practice was also common among the people of Ogun state and Oyo state (Idowu et al., 2009; Olorunnisola et al., 2013). Scientific evidence has also shown that the antimalarial activities of plant extracts depend largely on the solvent used in the extraction. For example, the dichloromethane crude extracts of *Morinda moridoides* had the highest activity than the ethanolic crude extracts producing a 74% reduction in parasitaemia (Mesia et al., 2001). In addition, efficacy of a plant used in the treatment of malaria could also be dependent on the plant parts used. This is implicated in a study by Nundkumar and Ojewole (2002) which revealed that of the aqueous leaf, stem bark and fruit extracts of *Psidium guajava* tested on Chloroquine-sensitive *Plasmodium falciparum* D10 strain, the stembark extract was the most active *in vitro*, with IC_{50} of 10–20 μg/ml. In this study, it was however revealed that the dose of herbal remedy and the duration of treatment depend on the severity of the fever. The herbal remedy can be consumed orally, inhaled or used in a bath. However, majority of the herbal preparations identified in this study invoved boiling the plant material and then drinking the extract.

4.4 Frequency of plant parts used

The study showed that the practitioners utilized various parts of the medicinal plants in preparation of antimalarial remedies. However, the dominant plant parts used were leaves, followed by stembark. Similar observations have been recorded in several studies (Asase et al., 2010; Nguta et al., 2010; Koudouvo et al., 2011; Ighere et al., 2011; Olorunnisola et al., 2013; Traore et al., 2013). The preference towards leaves may be linked to the fact that leaves are the main photosynthetic organs in plants. Leaves also act as reservoirs for the products of photosynthesis or exudates which contain more bioactive secondary metabolites for protection against devourers (Herbivores). Some of these compounds may be of medicinal value to the human body (Balick and Cox, 1996; Bhattarai et al., 2006). Additionally, the use of leaves is less dangerous to the existence of plant species as compared to the use of underground parts (roots, stem, bark), or the use of entire plants (Abebe and Ayehu, 1993; Giday et al., 2003; Zheng and Xing, 2009; Yetein et al., 2013).

Most of the plant parts used was found to be in the dried state. This was the main methods used in the preservation of the plant materials. As water is a fundamental requirement in microbial growth (Asase and Oppong-Mensah, 2009), the dried plant materials are better protected from microorganisms infestations. However, if the active compounds in the plants are volatile compounds then the efficacy of the herbal remedies would be lost or reduced in the dried plant materials. In the present study, most of the herbal remedies were prepared by boiling and drinking the decoctions, which means that the active ingredients in most of the plants are not volatile.

4.5. Frequency of plants regional occurrence

The results obtained from this study revealed that several plant

species are used in the treatment of malaria across the three regions of Southern Nigeria (South–West, South–South and South–East). However, the South-Western region represented the region with the highest plant occurrence. This may be as a result of the region being mostly occupied by Yoruba people having a rich cultural background in the art of traditional medicine practice. The South–South region also had a high plant occurrence. However the South–East region recorded the least plant occurrence in Southern Nigeria.

5. Conclusion and recommendation

The need to search for more effective drugs to treat malaria cannot be over-emphasized. With the widespread of resistant malaria across Africa in general and Nigeria in particular, there is an urgent need to study the most commonly used remedies and plants implicated in their formulation to ascertain their capacity to reduce parasite densities and symptoms of malaria. This study has documented a great diversity of plants used in the treatment of malaria in Southern Nigeria. However, more of such ethnomedicinal studies could be conducted in different settings to gather available knowledge on preparation and toxicity risks. Extracts prepared strictly according to the practitioners' recipes should be screened for antiplasmodial activity and toxicity by *in vitro* and *in vivo* standard tests in order to justify their local usage. These studies might lead to the isolation and possible identification of potentially active compounds, which may be regarded as future promising phytomedicines in the treatment of malaria. Conservation of these plant species is also recommended to ensure their continuous availability for future use.

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References

Abebe, D., Ayehu, A., 1993. Medicinal Plants and Enigmatic Health Practices of Northern Ethiopia. B.S.P.E., Addis Ababa, Ethiopia.
Abosi, A.O., Raseroka, B.H., 2003. In vivo antimalarial activity of *Vernonia amygdalina*. Br. J. Biomed. Sci. 60 (22), 89–91.
Addae-Kyereme, J., Croft, S.L., Kendrick, H., Wright, C.W., 2001. Antiplasmodial activities of some Ghanaian plants traditionally used for fever/malaria treatment and of some alkaloids isolated from *Pleiocarpa mutica*; in vivo anti-malarial activity of pleiocarpine. J. Ethnopharmacol. 76, 99–103.
Adesegun, S.A., Coker, H.A.B., 2001. Plants used in tradition medicine against malaria. Niger. J. Pharmacol. 32, 50–62.
Aiyeloja, A.A., Bello, O.A., 2006. Ethnobotanical potentials of common herbs in Nigeria: a case study of Enugu state. Educ. Res. Rev. 1, 16–22.
Ajaiyeoba, E.O., Abiodun, O.O., Falade, M.O., Ogbole, N.O., Ashidi, J.S., Happi, C.T., 2006. *In vitro* cytotoxicity studies of 20 plants used in Nigerian antimalarial ethnomedicine. Phytomedicine 13, 295–298.
Ajibesin, K.K., Ekpo, B.A., Bala, D.N., Essien, E.E., Adesanya, S.A., 2008. Ethnobotanical survey of Akwa Ibom State of Nigeria. J. Ethnopharmacol. 115, 387–408.
Alshawsh, M.A., Mothana, R.A., Al-shamahy, H.A., Salah, F., Lindequist, A.U., 2009. Assessment of anti-malarial activity against Plasmodium falciparum and phytochemical screening of some Yemeni medicinal plants. Evid.-based Complement. Altern. Med. 6, 453–456.
Asase, A., Akwetey, G.A., Achel, D.C., 2010. Ethnopharmacological use of herbal remedies for the treatment of malaria in the Dangme West District of Ghana. J. Ethnopharmacol. 129, 367–376.
Asase, A., Oppong-Mensah, G., 2009. Traditional antimalarial phytotherapy remedies in herbal markets in southern Ghana. J. Ethnopharmacol. 126, 492–499.
Asase, A., Oteng-Yeboah, A.A., Odamten, T.G., Simmonds, M.S.J., 2005. Ethnobotanical study of some Ghanaian anti-malarial plants. J. Ethnopharmacol. 99, 273–279.
Avwioro, G., 2010. Effectiveness of some medicinal plant decoction in the treatment of malaria in Nigeria. Ann. Biol. Res. 1 (2), 230–237.
Awe, S.O., 1998. Anti-plasmodial and antipyretic screening of *Mangifera indica* extract. Phytother. Res. 12, 437.
Awe, S.O., Makinde, J.M., 1998. Effect of petroleum ether fractions of *Morinda lucida* on *Plasmodium berghei* berghei in mice. Pharm. Biol. 36, 301–304.
Ayeni, K.E., Yahaya, S.A., 2010. Phytochemical screening of three medicinal plants neem leaf (*Azadirachta indica*), hibiscus leaf (*Hibiscus rosa-sinensis*) and Spear grass leaf (*Imperata cylindrical*). Cont. J. Pharm. Sci. 4, 47–50.
Ayitey-Smith, E., 1989. Prospects and Scope of Plant Medicine in Health Care. Ghana University Press.
Balick, M., Cox, P., 1996. Plants culture and people. Sci. Am. N.Y.
Bapna, S., Ramaiya, M., Chowdhary, A., 2014. Brine shrimp toxicity and invitro antimalarial activity of *Citrus aurantifolia* (Christm.) Swingle against *Plasmodium falciparum* 3D7. IOSR J. Pharm. Biol. Sci. 9 (5), 24–27.
Bekalo, T.H., Woodmatas, S.D., Woldemariam, Z.A., 2009. An ethnobotanical study of medicinal plants used by local people in the lowlands of Konta Special Woreda, southern nations, nationalities and peoples regional state, Ethiopia. J. Ethnobiol. Ethnomed. 5, 26.
Benoit-Vicala, F., Valentina, A., Cournaca, V., Pelissierb, Y., Malliea, M., Bastidea, J.M., 1998. In vitro anti-plasmodial activity of stem and root extracts of *Nauclea latifolia* S.M. (Rubiaceae). J. Ethnopharmacol. 61, 173–178.
Bero, J., Ganfon, H., Jonville, M.C., Frederich, M., Gbaguidi, F., DeMol, P., Moudachirou, M., Quetin-Leclerq, J., 2009. In vitro antiplasmodial activity of plants used in Benin in traditional medicine to treat malaria. J. Ethnopharmacol. 122, 439–444.
Bhattarai, S., Chaudhary, R.P., Taylor, R.S., 2006. Ethnomedicinal plants used by the people of Manang district, central Nepal. J. Ethnobiol. Ethnomed. 2, 41 http://dx.doi.org/10.1186/1746-4269-2-41.
Bickii, J., Njifulie, N., Foyere, J.A., Basco, L.K., Ringwald, P., 2000. *In vitro* antimalarial activity of limonoids from *Khaya grandifoliola* C.D.C. (Meliaceae). J. Ethnopharmacol. 69, 27–33.
Bidla, G., Titanji, V.P.K., Jako, B., Ghazali, G.E., Bolad, A., Berzins, K., 2004. Antiplasmodial activity of seven plants used in African folk medicine. Indian J. Pharmacol. 36, 245–246.
Bumah, V.V., Essien, E.U., Agbedahunsi, J.M., Ekah, O.U., 2005. Effects of *Khaya grandifoliola* (Meliaceae) on some biochemical parameters in rats. J. Ethnopharmacol. 102 (3), 446–449.
Chan, K., Choo., C., Abbdullah, N.R., Ismail, Z., 2004. Antiplasmodial studies of *Eurycoma langifolia* Jack using the lactate dehydrogenase assay of *Plasmodium falciparum*. J. Ethnopharmacol. 92, 223–227.
Desai, S.D., Desai, D.G., Kaur, H., 2009. Saponins and their biological activities. Pharm. Times 41, 3.
Dhara, R., Zhang, K., Talwar, G.P., Gargb, S., Kumara, N., 1999. Inhibition of the growth and development of asexual and sexual stages of drug-sensitive and resistant strains of the human malaria parasite Plasmodium falciparum by Neem (*Azadirachta indica*) fractions. J. Ethnopharmacol. 61, 31–39.
Dike, P.I., Obembe, O.O., Adebiyi, E.F., 2012. Ethnobotanical survey for potential antimalarial plants in South-Western Nigeria. J. Ethnopharmacol. 144, 618–626.
Duker-Eshun, G., Joroszewski, J.W., Asomaning, W.A., Oppong-Boachie, F., Christensen, S.B., 2004. Antiplasmodial constituents of *Cajanus cajan*. Phytother. Res. 18 (2), 128–130..
Ezenyi, I.C., Salawu, O.A., Kulkarni, R., Emeje, M., 2014. Antiplasmodial activity-aided isolation and identification of quercetin-4′-methyl ether in Chromolaena odorata leaf fraction with high activity against chloroquine-resistant *Plasmodium falciparum*. Parasitol. Res. 113(12), 4415–4422.
Faizi, S., Siddiqui, B.S., Salccm, R., Siddiqui, S., Aftab, K., Gilani, A., 1995. Fully acetylated carbamate and hypotensive thiocarbamate glycosides from *Moringa oleifera*. Phytochemistry 38, 957–963..
Ferreira, J.F.S., Devanand, L., Luthria, T.S., Arne, H., 2010. Flavonoids from *Artemisia annua* L. as antioxidants and their potential synergism with Artemisinin against malaria and cancer. Molecules 15, 3135–3170.
Giday, M., Asfaw, Z., Elmqvist, T., Woldu, Z., 2003. An ethnobotanical study of medicinal plants used by the Zay people in Ethiopia. J. Ethnopharmacol. 85, 43–52.
Goffin, E., Ziemons, E., De Mol, P., Do Ceu De Madureina, M., Martins, A.P., Da Cunha, A.P., Phillips, G., Tits, M., Angenot, L., Frederich, M., 2002. In vitro antiplasmodial activity of *Tithonia diversifolia* and identification of its main active constituent: Tagitinin C. Planta Med. 68 (6), 543–545.
Hilda, A.P., De La Rosa, M., Rafael, A.P.I.T.Z., 1994. In vivo activity of ajoene against rodent malaria. Antimicrob. Agents Chemother. 38(32), 337–339.
Idowu, O.A., Soniran, O.T., Ajana, O., Aworinde, D.O., 2009. Ethnobotanical survey of anti-malarial plants used in Ogun State, Southwest Nigeria. Afr. J. Pharm. Pharmacol. 4, 055–060.
Ighere, D.A., Ajiboye, T.O., Edagbo, D.E., Borokini, T.I., Alowonle, A.A., Micheal, C., Giwa, A., Adeyemo, A., 2011. Ethnobotanical survey of local herbs used for the treatment of malaria fever among the Urhobo people in Delta State, Nigeria. Int. J. Curr. Res. 3, 336–339.
Iwu, M.M., 1993. Handbook of African Medicinal Plants. CRC Press, Inc., 2000 Corporate Blvd., Florida, pp. 167–267.
Jimoh, A., Sofola, O., Petu, A., Okorosobo, T., 2007. Quantifying the economic burden of malaria in Nigeria using the willingness to pay approach. Cost Effect. Resour. Alloc. 5, 6–13.
Jomaa, S., Rahmo, A., Alnori, A.S., Chatty, M.E., 2012. The cytotoxic effect of essential oil of Syrian *Citrus limon* peel on human colorectal carcinoma cellline (Lim1863). Middle East J. Cancer 3, 15–21.
Kohler, I., Janett-Siems, K., Siem, K., Haranadez, H.A., Ibarra, R.A., Berendsohn, W.G., Bienzle, U., Eich, E., 2002. In vitro antiplasmodial investigation of medicinal

plants from EL Salvandon. Z. Naturforsch. 57, 277–281.
Lumpu, S.L., Kikueta, C.M., Tshodi, M.E., Mbenza, A.P., Kambu, O.K., Mbamua, B.M., Cos, P., Maes, L., Apers, S., Pieters, L., Cimanga, R.K., 2013. Antiprotozoal screening and cytotoxicity of extracts and fractions from the leaves, stembark and root bark of *Alstonia congensis*. J. Ethnopharmacol. 148, 724–727.
Makinde, J.M., Amusan, O.O.G., Adesogan, E.K., 1988. The antimalarial activity of *Spathodea campanulata* stem bark extract on *Plasmodium berghei berghei* in mice. Phytother. Res. 4 (2), 53–56.
Mota, M.L., Lobo, L.T., Costa, J.M., Costa, L.S., Rocha, H.A., Rocha e Silva, L.F., Pohlit, A. M., Neto, V.F., 2012. In vitro and in vivo antimalarial activity of essential oils and chemical components from three medicinal plants found in northeastern Brazil. Planta Med. 78 (7), 658–664.
Murakami, H., Kitazono, Y., Jiwajinda, S., Koshimizu, K., Ohigashzi, H., 1998. Niaziminin, a thiocarbamate from the leaves of *Moringa oleifera* holds a strict structural requirement for inhibition of tumor-pro-moter-induced Epstein–Barr virus activation. Planta Med. 64, 319–323.
Nguta, J.M., Mbaria, J.M., Gakuya, D.W., Gathumbic, P.K., Kiamad, S.G., 2010. Traditional antimalarial phytotherapy remedies used by the South Coast community, Kenya. J. Ethnopharmacol. 131, 256–267.
Njoroge, G.N., Bussmann, R.W., 2006. Diversity and utilization of anti-malarial ethnophytotherapeutic remedies among the Kikuyus (Central Kenya). J. Ethnobiol. Ethnomed. 2, 8.
Nigeria Natural Medicine Development Agency (NNMDA), 2005. Medicinal Plants of Nigeria South-west Nigeria, vol. 1, NNMDA, Lagos, Nigeria, pp. 81–101.
Nigeria Natural Medicine Development Agency (NNMDA), 2008. Medicinal Plants of Nigeria Southeast Zone, vol. I, Lisinda Consulting, Lagos, Nigeria, pp. 13–65.
Nigeria Natural Medicine Development Agency (NNMDA), 2013. Medicinal Plants of Nigeria South–South Zone, vol. I, Koredex Associates, Lagos, Nigeria, 203 pp.
Obute, G.C., 2007. Ethnomedicinal plant resources of South Eastern Nigeria. Afr. J. Interdiscip. Stud. 3 (1), 90–94..
Odugbemi, T., 2008. A Textbook of Medicinal Plants from Nigeria Lagos. University of Lagos Press, p. 628.
Okigbo, R.N., Mmeka, E.C., 2006. An appraisal of phytomedicine in Africa. King Mongkut's Inst. Technol. Ladkrabang Sci. Technol. J. 6, 83–94.
Okpekon, T., Yolou, S., Gleye, C., Roblot, F., Loiseau, P., Bories, C., Grellier, P., Frappier, F., Laurens, A., Hoquemiller, R., 2004. . Antiparasitic activities of medicinal plants used in Ivory coast. J. Ethnopharmacol. 90, 91–97.
Olliaro, P.L., Trigg, P.I., 1995. Status of antimalarial drugs under development. WHO Bull. 73, 565–571.
Olorunnisola, O.S., Adetutu, A., Balogun, E.A., Afolayan, A.J., 2013. Ethnobotanical survey of medicinal plants used in the treatment of malaria in Ogbomoso, South-west, Nigeria. J. Ethnopharmacol. 150, 71–78.
Olorunniyi, O.F., Morenikeji, O.A., 2013. The extent of use of herbal medicine in malaria management in Ido/Osi Local Government Area of Ekiti State, Nigeria. J. Med. Plants Res. 7 (42), 3171–3178.
Olowokudejo, J.D., Kadiri, A.B., Travih, V.A., 2008. An ethnobotanical survey of herbal markets and medicinal plants in Lagos State of Nigeria. Ethnobot. Leafl. 12, 851–865.
Omoregie, E.S., Pal, A., Sisodia, B., 2011. In vitro antimalarial and cytotoxic activities of leaf extracts of *Vernonia amygdalina* (Del.). Niger. J. Basic Appl. Sci. 19 (1), 121–126.
Oomah, D.B., 2003. Isolation, Characterization and Assessment of Secondary Metabolites from Plants for Use in Human Health. PBI Bull No. 1.
Oreagba, I.A., Oshikoya, K.A., Amachree, M., 2011. Herbal medicine use among urban residents in Lagos, Nigeria. Complement. Altern. Med. 11, 117.
Perez, H.A., De La Rosa, M., Apiz, R., 1994. In vivo activity of ajoene against rodent malarial. Antimicrob. Agents Chemother. 38 (2), 337–339.
Ruiz, L., Maco, M., Cobos, M., Gutierrez-Choquevilca, A.-L., Roumy, V., 2011. Plants used by native Amazonian groups from the Nanay River (Peru) for the treatment of malaria. J. Ethnopharmacol. 133, 917–921.
Su, V., King, D., Woodrow, L., Mcfadden, G., Gleadow, R., 2008. Plasmodium falciparum growth is arrested by monoterpenes from eucalyptus oil. Flavour Fragr. J. 23, 315–318.
Tantchou, T.P.K., Aldivo, J., 1986. Studies on Cameroonian medicinal plants 1: antimalarial activity of the extracts of Alstonia boonei and Guibourtia tessmanii on the viet Nam Smith strain of *Plasmodium falciparum*. Rev. Sci. Tech. III (3–4), 69–77.
Titanji, V.P.K., Zofou, D., Ngemenya, M.N., 2008. The anti-malarial potential of medicinal plants used for the treatment of malaria in Cameroonian folk medicine. Afr. J. Tradit. Complement. Altern. Med. 5, 302–321.
Tona, L., Cimanga, R.K., Mesia, K., Musuamba, C.T., De Bruyne, T., Apers, S., Hernans, N., Van Miert, S., Pieters, L., Totte, J., Vlietinck, A.J., 2004. In vitro antiplasmodial activity of extracts and fractions from seven medicinal plants used in the democratic Republic of Congo. J. Ethnopharmacol. 93, 27–32.
Traore, F., Gasquet, M., Laget, M., Guiraud, H., Di-Giorgio, C., Azas, N., Doumbo, O., Timon-David, P., 2000. Toxicity and genotoxicity of antimalarial alkaloid rich extracts derived from *Mytragyna inermis* O. Kuntze and *Nauclea latifolia*. Phytother. Res. 14, 608–611.
Traore, M.S., Diane, S., Camara, A., Diallo, A., Balde, A., Keita, A., Keita, S.M., Outare, K., Magassouba, F.B., Diakite, I., Diallo, A., Peters, L., Balde, A.M., 2013. Ethnobotanical survey on plants used by Guinean traditional healers in the treatment of malaria. J. Ethnopharmacol. 150, 1145–1153.
Udeinya, I.J., Brown, N., Shu, E.N., Udeinya, F.I., Quakeyie, I., 2006. Fractions of an antimalarial neem-leaf extract have activities superior to chloroquine and are gametocytocidal. Ann. Trop. Med. Parasitol. 100, 17–22.
Ueno, H.M., Doyama, J.T., Padovani, C.R., Salata, E., 1996. Effect of *Momordica charantia* L. in mice infected with *Plasmodium berghei*. Rev. Soc. Bras. Med. Trop. 29, 455–460.
Ukpai, O.M., Amaechi, E.C., 2012. Evaluation of in vivo antimalarial activity of the ethanolic leaf extracts of *Chromolaena odorata* and *Cymbopogon citratus* in mice. Niger. J. Biotechnol. 24, 27–34.
WHO, 1978. Alma Ata Declaration Primary Health Care. Health for all Series No. 1.
WHO, 2013. 10 Facts on Malaria. World Health Organisation, Geneva.
Willcox, M., Burford, G., Bodeker, G., 2004. An overview of ethnobotanical studies on plants used for the treatment of malaria. In: Willcox, M., Bodeker, G., Rasoanaivo, P. (Eds.), Traditional Medicinal Plants and Malaria. CRC Press, Boca Raton, pp. 187–197.
Zheng, X., Xing, F., 2009. Ethnobotanical study on medicinal plants around Mt. Yinggeling, Hainan Island, China. J. Ethnopharmacol. 124, 197–210.
Zirihi, G.N., Mambu, L., Guiedie-Guina, F., Bodo, B., Grellier, P., 2005. In vitro antiplasmodial activity and cytotoxicity of 33 West African plants used for treatment of malaria. J. Ethnopharmacol. 98, 281–285.