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PLANTS USED BY THE INDIGENOUS PEOPLE OF ODEDA, OGUN STATE, NIGERIA FOR DIFFERENT AILMENTS: ETHNOBOTANICAL REPORTS AND PHARMACOLOGICAL EVIDENCE

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ABSTRACT

The indigenous people of rural and semi-urban regions of Nigeria have a rich traditional medicine practice (TMP) heritage. Despite their wealth of knowledge on the use of plants as medicines, many of these plants have not been adequately explored. This study aimed at documenting, reviewing and validating plant species and their therapeutic benefits by the indigenous people of Ọdẹdá Local Government Area (LGA), Ogun State. Semi-structured questionnaire was used to gather information on socio-demographic data and ethno-medicinal plants/practices from 21 traditional medicine practitioners in ten villages across the LGA. Information collected included the plant species/parts used, ailments, common/vernacular names of the plants and methods of preparation/administration. An extensive literature survey was thereafter done to authenticate the veracity of the claims and find extra information on what is known about the named plants. Diseases frequently managed in this study area were fever/malaria, typhoid and arthritis. A total of 36 plant species belonging to 27 plant families were documented with their leaves mostly used plant part as oral decoctions. *Aframomum melegueta* and *Citrus aurantifolia* were the plant species with the highest relative frequency of citation. Approximately 83 % of the named plant species were found to have similar ethnomedicinal uses with studies conducted in other parts of the world and 99 % have been reported to be pharmacologically active in the literature. Lack of proper documentation can lead to loss of the traditional knowledge which threatens the sustenance of rural healthcare system. Standardization, development of an integrative curriculum and formal training in TMP in Nigeria is urgently needed.

Keywords: medicinal plants, ailment, ethnomedicine, questionnaire, knowledge, Odeda

INTRODUCTION

The use of plants and its by-products is one of the most used applications traditionally by ethnic groups across the world (Zizka *et al.*, 2015). A large proportion of these ethnic groups are rural dwellers that mostly depend on traditional (herbal) medicine for their primary health care needs due to cultural ac-

ceptability, affordability, accessibility and presumed minimal side effects (Aziz *et al*., 2018). Medicinal plants owe their biological activities to a myriad of well-organized complex chemical molecules with differing properties, working synergistically to exert their effects. This offers many advantages in terms of efficiency and selectivity of molecular targets, while minimizing the potential for development of resistance by pathogenic organisms (Yuan *et al*., 2016).

Nigeria has over 250 ethnics groups with diverse cultural heritage of traditional medicine practice (TMP) (Asuzu *et al*., 2019). Its large land mass has over 7,895 plant species across 338 families and 2,215 genera (National Biodiversity Report, 2015). Apart from the antiglaucoma drug, physostigmine, whose discovery is from the folkloric use of the Calabar bean, *Physostigma venenosum* (Batiha *et al*., 2020), the potential of Nigeria's rich plant diversity as drug leads and molecules has not been fully exploited.

The use of medicinal plants in TMP cuts across all cultures, ethnicity, countries and continents of the world (Alalwan *et al*., 2019; Mabaleha *et al*., 2019; Salihu *et al*., 2020). Their application varies between different cultures, geographical locations, climatic regions, and even neighboring villages (Schultz, 2020). Proper documentation and validation of this knowledge is important in drug discovery and preservation of existing cultural heritage (Adenubi *et al*., 2019). In recent times, the search for new molecules has taken a slightly different route where the science of ethnobotany and ethnopharmacognosy are being used as a guide to lead chemists towards different sources and classes of compounds. The flora of Nigeria by its diversity has a significant role to play if fully exploited. This study aims to document, review and validate the biological uses and potentials of medicinal plants used by the indigenous people of Ọdédá Local Government Area (LGA), Ogun State, Southwest Nigeria.

MATERIALS AND METHODS

Study site

The study was carried out in Ọdédá LGA of Ogun state with coordinates of 7º13'N 3º31' E. It is bounded to the North by Ìbàràpá and Ìddó LGAs of Oyo State, to the West by Abẹòkúta North and Abeòkúta South LGAs, to the East and South by Ọbáfémi-Owódé LGA (Amori *et al.,* 2013)-Fig. 1. Odédá LGA is made up of three zones: Odédá zone (Odédá, Òsíele, Olúga, Olúgbo, Baálẹ Ògùn and Ewéjé); Ìlúgùn zone (Ìlúgùn, Olódó, Òkiri-Ojúlé, Aperin, Àkońkò, Olókèméjì and Kugbájàgbé) and Opejí zone (Obańtokò, Opejí, Àdàó, Alábàtà and Obete) (Soaga and Adekunle, 2015).

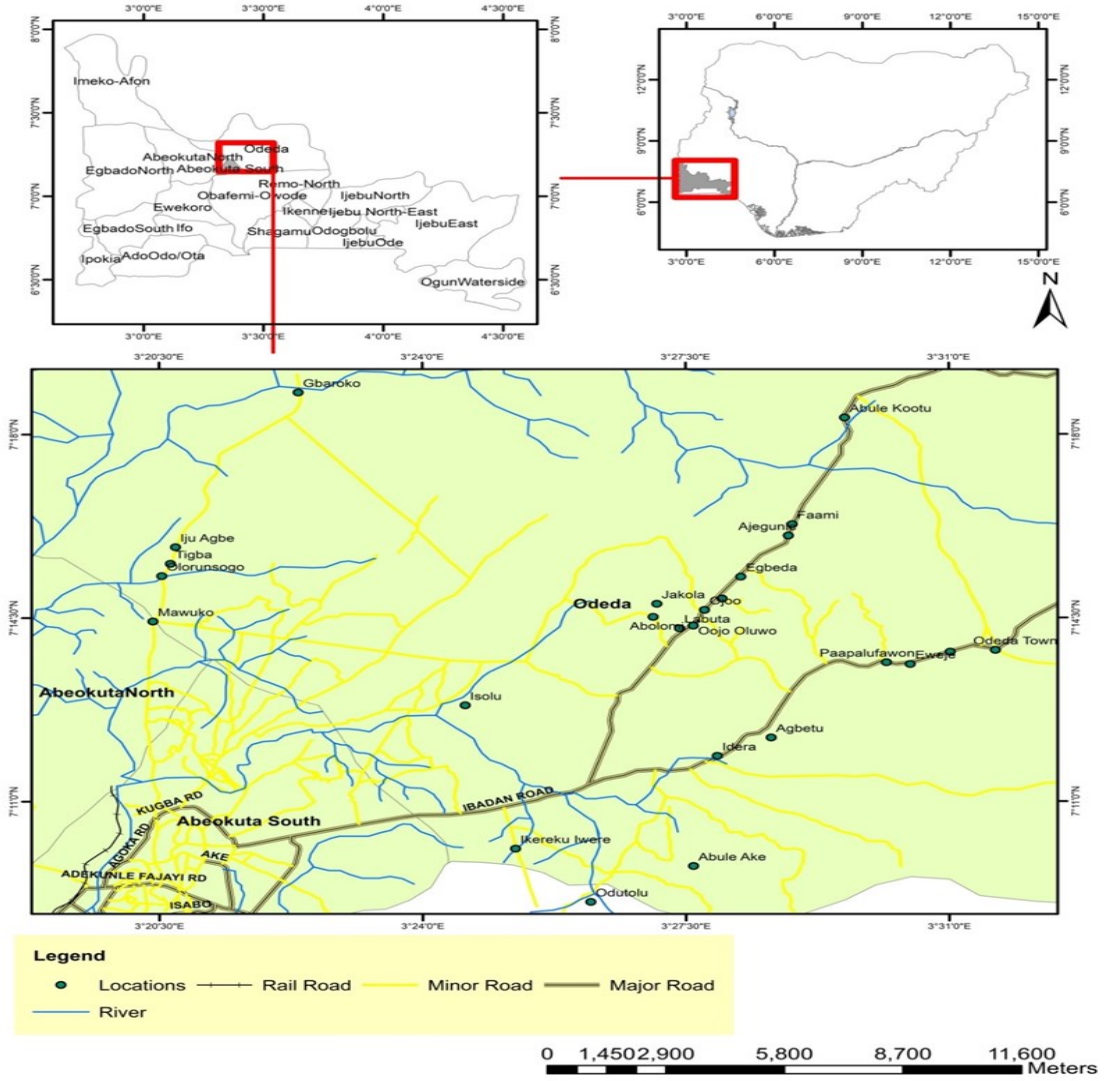

Figure 1: Villages visited in Ọdédá Local Government Area, Ogun State

Ethnobotanical survey and data collection

Ethical approval for this study was obtained from the College of Veterinary Medicine Research Ethics Committee. Approval number FUNAAB/COLVET/CREC/2019/07/03 was given.

Ten villages across the three zones of Ọdédá LGA were grouped into 4 cardinal points and surveyed. A cross-sectional survey involving the use of participatory epidemiological approaches (interviews, questionnaire and focused group discussions) was done. The village head ("Baálè") in each village was approached to assist in obtaining prior informed consent from the villagers, to create trust and ease the interview process. The investigators were introduced to the traditional medicine practitioners and other knowledgeable persons by the village heads.

A validated semi-structured questionnaire was used to obtain information on medicinal

plant knowledge and utilization. Informed consent was received from the respondents and they were assured that their responses would remain confidential and would only be used for research purposes. The interviews were conducted in Yoruba language and voice recording was done.

Questions asked focused on the sociodemographic profile of the respondents and their knowledge of medicinal plant utilization and other ethnomedicinal practices. Such questions included their sex, age, level of education; origin of knowledge (from parents, learned, others) and main clinical signs/ailments treated.

Information on the plant species included name of plant species used, the common/ vernacular names of the plants, parts of plants used (e.g. roots, leaves, seeds, flowers, stems or others), the methods of preparation (e.g. decoction, infusion, concoction, filtrate, paste, smoke bath, pounded or others), routes of administration (e.g. oral, topical, smoke bath, nasal or others), dosage (frequency and duration of treatment), effectiveness of the herbal remedy and adverse effects observed.

Sample collection and identification

The named plant species were collected from the wild, identified and authenticated from the Department of Forestry, Federal University of Agriculture, Abeokuta (FUNAAB). Voucher specimens were made and deposited at the Nigeria Natural Medicine Development Agency (NNMDA), Lagos State where each specimen was assigned a specific number.

Literature survey

Further information on the named plant species was obtained from published journal articles through three scientific databases (PubMed, CAB Abstracts and Global Health, and Google Scholar), using the keywords: "medicinal plants", "biological properties", "phytochemical constituents", "ethnomedicine", "Nigeria". All documents considered were in English or translated into English. The strength and validity of information obtained from the respondents were evaluated based on similar ethnomedicinal claims in the literature or evidence of phytochemical or pharmacological studies that support the claims.

Data analysis

Descriptive statistics such as frequencies and percentages were used to analyze and summarize the data obtained. The importance of each plant species was assessed by the relative frequency of citation (RFC) calculated using the following formula described by Tardio and Pardo-de-Santayana (2008)

$$RFC = \frac{FC}{N}$$

where FC is the number of respondents who mentioned the use of the plant species and N is the total number of respondents interviewed.

RESULTS

Socio-demographic data of respondents

Twenty males (95.24 %) and one female (4.76 %) were interviewed in the ten villages visited (Table 1). Approximately 19.05 % of the respondents were less than 40 years old, 38.10 % were between 41 and 60 years old, while 42.86 % were above 60 years old. Inheritance of the knowledge of traditional medicine through generation after generation was the major source of knowledge acquisition (95.24 %). The general level of education of the respondents was low with 33.33 % having some form of formal educa-

tion while 66.67 % were not educated (Table 1).

Medicinal plant family diversity

A total of 36 plant species belonging to 27 plant families were reported to be used for different ailments (Table 2). Plant families with the highest representation were Euphorbiaceae and Fabaceae with three plant species (11.11 %) each. The Poaceae, Anacardiaceae, Solanaceae, Curcubitaceae and Apocynaceae families were represented by two (7.41 %) plant species each. The other 20 plant families had one (3.70 %) plant species each (Table 2).

Table 1: Sociodemographic data of the respondents in Ọdédá Local Government Area, Ogun State

Village	No of respondents	Age-group	Sex	Level of education	Acquisition of traditional knowledge
Fàamí	8	26-40 (0)	Male-7	Educated - 1	Inherited - 8
Lábùtà		41-59 (6)	Female-1	Not educated-7	Learned – 0
Ojo Olúwo		≥ 60 (2)			
Ijo àgbe	6	26-40 (0)	Male-6	Educated - 0	Inherited - 6
Tígbà		41-59 (1)	Female-0	Not educated-6	Learned – 0
		≥ 60 (5)			
Abulé Aké	6	26-40 (3)	Male-6	Educated - 5	Inherited - 5
Ìkerekú		41-60 (1)	Female-0	Not educated-1	Learned – 1
Ìwere		≥ 60 (2)			
Ìsólú,					
Odútólú					
Eweje	1	26-40 (1)	Male-1	Educated - 1	Inherited - 1
		41-60 (0)	Female-0	Not educated-0	Learned – 0
		≥ 60 (0)			

Table 2: Plant families and plant species used for management of specific ailments in Ọdédá Local Government Area, Ogun State

Arthritis					
Family	**Amaranthaceae**	**Sapotaceae**	**Zingiberaceae**		
Species	*Pupalia lappacea* (L.) Juss	*Vitellairia paradoxa* C.F.Gaertn.	*Aframomum melegueta* K. Schum.		
Convulsion					
Family	**Arecaceae**	**Curcubitaceae**			
Species	*Elaeis guineensis* Jacq.	***Lagenaria breviflora*** Benth			
Diarrhea/Helminthosis					
Family	**Anacardiaceae**	**Asteraceae**	**Menispermaceae**	**Solanaceae**	
Species	*Spondias mombin* L.	*Chromolaena odorata* (L.) R.M. King & H. Rob.	*Cissamepelos owariensis* P.Beauv. ex DC.	*Nicotiana tabacum* L.	
Epilepsy					
Family	**Fabaceae**	**Urticaceae**			
Species	*Bauhinia refescens* Lam.	*Urera obovata* Benth.			
Eye problem					
Family	**Fabaceae**	**Zingiberaceae**			
Species	*Parkia biglobosa* (Jacq.) R.Br. ex G.Don	*Aframomum melegueta* K.Schum.			
Fever (Malaria, Typhoid)					
Family	**Anacardiaceae**	**Apocynaceae**	**Bignoniaceae**	**Caricaceae**	**Euphorbiaceae**
Species	*Mangifera indica* L.	*Calotropis procera* (Aiton) W.T.Aiton	*Kigelia africana* (Lam.) Benth.	*Carica papaya* L	*Jatropha curcas* L.
Family	**Lamiaceae**	**Lythraceae**	**Malvaceae**	**Meliaceae**	**Moringaceae**
Species	*Ocimum americanum* L.	*Lawsonia inermis* L.	*Gossypium arboretum* L.	*Azadirachta indica* A.Juss.	*Moringa oleifera* Lam.
Family	**Poaceae**	**Rubiaceae**	**Rutaceae**		
Species	*Cymbopogon cuitratus* (DC.) Stapf	*Morinda lucida* Benth.	*Citrus aurantifolia* Swingle.		
Fibroid					
Family	**Euphorbiaceae**	**Poaceae**	**Zingiberaceae**		
Species	*Ricinus communis* L.	*Zea mays* L.	*Aframomum melegueta* K.Schum.		

Fetal repositioning					
Family	**Dioscoreaceae**	**Poaceae**			
Species	*Dioscrorea alata* L.	*Zea mays*.L.			
Gonorrhea					
Family	**Annonaceae**	**Apocynaceae**	**Cucurbitaceae**	**Fabaceae**	**Gutiferae**
Species	*Monodora myristica* (Gaertin.) Dunal	*Picralima nitida* (Stapf) T.Durand & H.Durand	*Citrullus colocynthis* (L.) Schrad.	*Pterocarpus osun* Craib.	*Garcinia kola* Heckel
Hematuria					
Family	**Rutaceae**	**Solanaceae**			
Species	*Citrus aurantifolia* Swingle.	*Nicotiana tabacum* L.			
Headache					
Family	**Anacardiaceae**	**Zingiberaceae**			
Species	*Spondias mombin* L.	*Aframomum melegueta* K.Schum.			
Hypertension					
Family	**Euphorbiaceae**				
Species	*Cnidoscolus aconitifolius* (Mill.) I.M. Johnst.				
Measles					
Family	**Apocynaceae**	**Caricaceae**	**Poaceae**	**Solanaceae**	
Species	*Calotropis procera* (Aiton) Dryand	*Carica papaya* L.	*Zea mays* L.	*Capsicum chinense* Jacq.	
Snake-bite					
Family	**Caricaceae**				
Species	*Carica papaya* L.				
Stroke/Ligament stiffness					
Family	**Moraceae**				
Species	*Ficus thonningii* Blume				
Vomiting					
Family	**Arecaceae**	**Rutaceae**			
Species	*Elaeis guineensis* Jacq.	*Citrus aurantifolia* Swingle.			

Sources: PUBMED, CAB Abstracts and Global Health, and Google Scholar

Relative frequency of citation of the plant species

Citrus aurantifolia and *Aframomum melegueta* had high RFC (0.24 and 0.19 respectively), followed by *Zea mays* (0.14). Nine plants had 0.10 RFC each while the remaining 24 plants had 0.05 RFC each (Table 3).

Table 3: Relative frequency of citation of the different plant species used in the management of specific ailments in Ọdédá Local Government Area, Ogun State

Plant species	Relative frequency of citation
Aframomum melegueta	0.19
Azadirachta indica	0.05
Bauhinia refescens	0.05
Calotropis procera	0.10
Capsicim chinense	0.05
Carica papaya	0.10
Cissamepelos owariensis	0.05
Citrus aurantifolia	0.24
Citrullus colocynthis	0.05
Chromolaena odorata	0.05
Cnidoscolus aconitifolius	0.05
Cymopogon citratus	0.05
Dioscorea alata	0.05
Elaeis guineensis	0.10
Ficus thonningii	0.10
Garcinia cola	0.05
Gossypium arboreum	0.10
Jatropha curcas	0.05
Kigellia africana	0.10
Lagenaria breviflora	0.05
Lawsonia inermis	0.10
Mangifera indica	0.10
Monodora myristica	0.05
Morinda lucida	0.05
Moringa oleifera	0.05
Nicotiana tabacum	0.05
Ocinum americanum	0.05
Parkia biglobosa	0.05
Picralima nitida	0.05
Pterocarpus osun	0.05
Pupalia lappaceae	0.05
Ricinus communis	0.05
Spondias mombin	0.10
Urera obovata	0.05
Vitellaria paradoxa	0.05
Zea mays	0.14

Sources: PubMed, CAB Abstracts and Global Health, and Google Scholar

Plant parts used, modes of preparation and routes of administration

The leaves (52.8 %), fruit (33.3 %), seeds (5.6 %), root, stem bark and tuber (2.8 %) were the plant parts commonly used (Fig. 2). The plant species were prepared mainly by soaking in cold water to make infusions (65.6 %) or boiling in water to make decoctions (34.4 %) -Table 4. Some preparations were used in combination e.g. grinding the stem bark and then boiling to make a decoction, burning leaves and then mixing with water to form paste amongst others (Table 4). All the respondents also mainly used the oral route in administering their medicines. However, a few additionally apply the herbal medicines topically on wounds or inflamed parts of the body (Table 4). There was no report of any side or adverse effects from the use of these plant species.

Reported literature

Of the plant species reported, approximately 99 % have been reported to be pharmacologically active in the literature. Approximately 83 % were found to have similar ethnomedicinal claims in some other regions of the world (Tables 4, 5).

DISCUSSION

In this study, the dominance by respondents above 60 years old age could be due to their consistent good track record of TMP over several years (Oran and Al-Eisawi, 2015) and the preference for western medicine by the younger generation. This result agrees with the result of other studies conducted in other parts of the World (Umair *et al*., 2017; Jima and Megersa, 2018; Alalwan *et al*., 2019). Lack of standardized curriculum and formal training in TMP in Nigeria and many other African countries could also be responsible for the few numbers of young respondents that participated in our study. The World Health Organisation has recognized the need to integrate traditional medicine into orthodox medicine when it defines it, as the total combination of knowledge and practices, whether explicable or not, used in diagnosing, preventing or eliminating physical, mental or social diseases (Isola *et al*., 2013). Several steps have been taken in some countries such as China and India to promote such medicine and integrate them into clinical practice (Sen and Charkraborty, 2017).

The Euphorbiaceae and Fabaceae families with three plant species each were more represented in our study. The diverse distribution of members of the Euphorbiaceae and Fabaceae families, their wide applications in traditional medicine and the ability to adapt to different climatic condition could be responsible for this higher representation (Kemboi *et al*., 2020). This is further supported by other studies conducted in northern Nigeria with different environmental and climatic conditions (Kankara *et al*., 2015; Abdulsalami *et al*., 2020). The plant species were used singly or in combination for the treatment of different diseases. Polyherbal combination is common in TMP as it offers a wider range of additive, synergistic or antagonizing biological effects (Bernardini *et al*., 2018).

The leaves and fruits were the plant parts most used across the villages. The preference for leaves may be because they are the main photosynthetic organs and therefore, contain secondary bioactive compounds that protect against external aggressions. It can also be speculated that the respondents are conservation conscious and thus mainly use leaves so they can sustain their supply of this herbal resource. The use of the leaves is con-

sistent with other reported studies (Gakuya *et al*, 2013; Agbodeka *et al.,* 2016; Kola *et al*., 2020). Conversely, use of leaves could also be a severe threat to some rare and slowly reproducing medicinal plants (Chen *et al*., 2016).

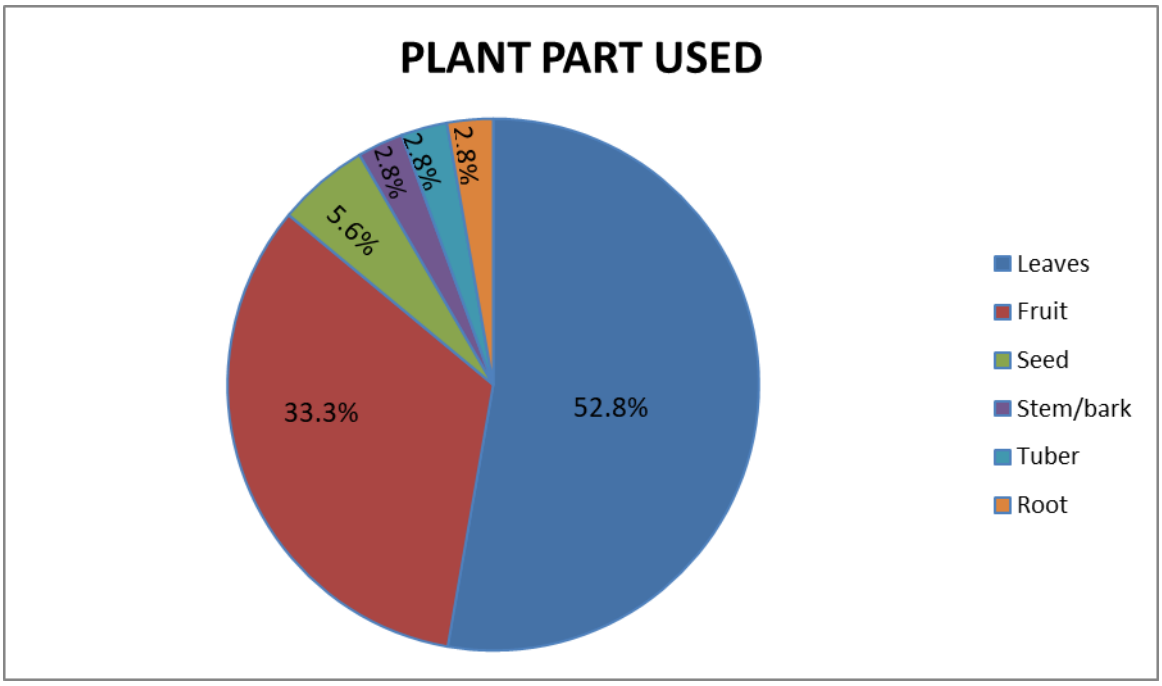

Figure 2: Plant parts used in the management of specific ailments by indigenous people of Ọdédá Local Government Area, Ogun State

Table 4: Medicinal plant species used for the management of specific ailments in Ọdédá Local Government Area, Ogun State

Species (Family)	Voucher specimen Number	Common names	Vernacular names	Part used	Disease	Mode of preparation and administration	Similar ethnobotanical claims reported
Aframomum melegueta K.Schum.	MPNH/2019/01291	Alligator pepper	Atare	Fruit	Eye problem	It is mixed with locust beans, burned together and applied on the eyelashes	Ogun, Nigeria - The seeds are used for the treatment of inflammatory diseases
					Fibroid	One alligator pepper is burnt with maize tassel. Six local eggs, pure honey and juice extract of castor leaf is mixed with it. Two tablespoon is taken twice daily	Ondo, Nigeria - Seed used for infertility
					Arthritis	The leaves of *Pupalia lappacea* are roasted with one alligator pepper, mixed with black soap and used to massage the affected joint. Water can also be added to the mixture to be taken orally	
Azadirachta indica A. Juss.	MPNH/2019/01292	Neem leaf	Ewé dógóyárò	Leaf	Fever/ Malaria	Neem leaf, key lime, lemon grass and pawpaw leaves are cooked and the decoction is taken orally	Southwest and Northcentral Nigeria - Decoction, infusion of bark and leaves for fever India; Sudan - Leaves infusion for malaria/fever
Bauhinia refescens Lam.	MPNH/2019/01293	Silver butterfly tree	Panumo abafe	Leaf	Epilepsy, Arthritis, Malaria Cancer	The bark is removed in strands to make ropes. The rope is used to tie tortoise (land type) round its body and then use black soap mixed with leaves to coat the tied tortoise body and the coated tortoise is put inside a container holding about 25liters of drinkable water. The water is then served to the diseased person continuously until the tied ropes loose by themselves	Burkina Faso - Leafy stem decoction for malaria Northern Nigeria - Leaves for arthritis and cancer

Calotropis procera (Aiton) Dryand	MPNH/2018/01265	Giant milkweed	Bomúbomú	Leaf	Measles	Leaves are cut inside a pot with maize and cooked together. The water from the cooked mixture is sprinkled on the affected body	Southwest Nigeria - The leaves are used in the treatment of viral infection such as measles India - Used for smallpox
Capsicum chinense Jacq	MPNH/2019/01312	Habanero type pepper	Ata rodo	Fruit	Snake bite	The head of pawpaw is cut and rubbed on bite site with habanero pepper	India - Root extract given orally, fruit powder applied tropically on snake bites
Carica papaya L.	MPNH/2018/01259	Pawpaw	Ìbepe	Fruit	Snake bite	The stump of pawpaw is sliced and the latex from the stem is placed on the bite site	Uganda - The plant is used for the treatment of snake bite because of its anti-venin properties
				Leaf	Malaria/ Fever	As for *A. indica*	Cameroon - The leaves, roots and fruits are used in the treatment of malaria
Chromolaena odorata (L.) R.M. King & H.E. Robins	MPNH/2018/01262	Siam weed Christmas bush	Ewé àgàtú Ewé Akíntolá	Leaf	Diarrhea (Helmint hosis) Wound healing	The leaves and English velvet leaf are squeezed and the juice is taken orally Juice extract applied topically to treat wound.	Lagos, Nigeria - The leaves are used in the treatment of dysentery
Cissampelos owariensis P.Beauv. ex DC.	MPNH/2019/01294	English velvet leaf	Ewe jókojé	Leaf	Diarrhea (Helmint hosis)	As for *C. odorata*	Angola; Mozambique; Sierra Leone; Uganda; Zambia - Infusion of the English velvet and bitter rhizome leaves. or stems are used in the treatment of gastrointestinal disorders
Citrullus colocynthis (L.) Schrad.	MPNH/2019/01295	Bitter cucumber Wild gourd Biiter apple	Egúsí bara	Fruit	Gonorrhea	The fruit of bitter cucumber, Akuamma plant, Africa nutmeg, potash, camwood and alcohol are made into an infusion. One teaspoon is taken twice daily	Akwa Ibom, Nigeria - The decoction or soup of the leaves is taken orally for the treatment of gonorrhea and syphilis

Citrus aurantifolia (Christm.) Swingle	MPNH/2018/01257	Key lime	Osàn wewe	Fruit	Fever/ Malaria Cough	As in *A. indica* Mix with pure honey to treat cough	Benin Republic; Southern Nigeria - Used for malaria
Cnidoscolus aconitifolius (Mill.) I.M. Johnst.	MPNH/2019/01296	Tree spinach Chaya leaf	ìyànà ìpájà	Leaf	Hypertension	The leaf is cooked with potash, mixed with milk and taken thrice daily	Southwest Nigeria - The leaves and shoots are squeezed with water with milk/tomato paste added. Believed to be blood boosting and taken commonly by pregnant women and anemic children Mexico- Hypertension
Cymbopogon citratus (DC.) Stapf	MPNH/2019/01297	Lemon grass	Kooko-obba	Leaf	Fever/ Malaria	As for *A. indica*	India - Used as traditional remedy against cough, malaria, pneumonia Ghana – Malaria
Dioscorea alata L.	MPNH/2019/01298	White yam	Ìsù fun-fun	Tuber	Foetal repositioning, Diabetes	As for *A. indica*	India - Used for treatment diabetes and pile
Elaeis guineensis Jacq.	MPNH/2019/01274	African oil palm	Ope	Seed	Vomiting	Roast yam and maize (still on cob) with naked flame and as each side is getting burnt, before turning, the burnt part is scraped and mixed thoroughly, then served with pap While turning pronouncements are made (ta ba fisu sina aayida, ti a ba fi agbado sina aayida, ki omo inu lagbaja maa yida) – meaning whie roasting yam, we must turn it, while roasting corn we must turn it, the fetus in womb should turn	Nigeria - Antidote for poisoning Cameroon; Ghana; Nigeria; Namibia - Treatment of malaria Togo - Taken orally to treat epilepsy

Ficus thonningii Blume	MPNH/2019/01299	Strangler fig	Odan-abaa	Leaf	Stroke/ Ligament pull, Malaria, Diabetes	The leaves are ground with python fat and used to massage the affected part	Kenya - Leaves used for treating diarrhea, gonorrhea and diabetes mellitus
Garcinia kola Heckel	MPNH/2019/01300	Bitter kola	Orógbó	Fruit	Gonorrhea	About 40 bitter kolas are sliced into two each, potash with pap water (omídún) mixed inside a container and cooked. The decoction is taken for seven days	West Africa - The latex is used in the treatment of gonorrhea infection
Gossypium arboretum L.	MPNH/2019/01301	Cotton leaf	òwú	Leaf	Fever/ Malaria	Solution of cotton leaf and lime is taken orally As iron/blood replenisher and anti-convulsion	India - Used as a nerve tonic in headache. The decoction of the seed is given for dysentery and intermittent fever
Jatropha curcas L.	MPNH/2018/01264	Physic nut	Bútúje, Ewé làpálàpá	Leaf	Fever/ Malaria Wound healing/ Anti-coagulant	Its leaves, Henna and African basil plants are cooked to make a decoction. The mixture is taken orally Latex on fresh wound coagulate and stop bleeding	Lagos, Nigeria - Used in the treatment of fever, smallpox, whitlow
Kigelia africana (Lam.) Benth.	MPNH/2019/01290	Sausage tree	Pańdoro	Fruit	Malaria	The fruit is sliced into small pieces, cooked along with fermented pap, water and potash. The decoction is taken for 4-5 days orally	Benin Republic - The fruit is used for the treatment of malaria
Lagenaria breviflora (Benth.) Roberty	MPNH/2019/01282	English wild colocynth	Tágìrì	Leaf	Convulsion, Measles	The leaves are squeezed, the juice obtained is mixed with the bile of cattle and salt.in a glass jar hanged in the cooking place for preservation. One teaspoon is taken daily	Southwest Nigeria – Used for the treatment of convulsion, measles

Lawsonia inermis L.	MPNH/2019/01301	Henna leaf	Ewe láàlì	Leaf	Fever/ Malaria	As for *J. curcas*	Southwest Nigeria - The leaves are infused with *Senna alata, Senna podocarpa* leaves and juice of *Citrus aurantifolia* for the treatment of malaria
Mangifera indica L.	MPNH/2019/01302	Mango	Mángòrò	Leaf	Malaria Typhoid	The leaves of the plant are cooked and taken orally The decoction of the bark, along with coconut fruit peel and small potash is taken orally	Uganda; Pakistan - Used for the treatment of malaria
Monodora myristica (Gaertin.) Dunal	MPNH/2019/01303	African nutmeg	Abo làkòse Ariwo	Seed	Gonorrhea	As for *C. colocynthis*	West Africa - The bark is used for the treatment of venereal diseases
Morinda lucida Benth.	MPNH/2019/01304	Brimstone tree	Oruwo	Root	Typhoid, Malaria	The root of the plant is crushed, the juice is mixed with gin and taken orally Stem bark decoction is used for malaria	Nigeria - Decoction and infusion of root, bark and leaves are used as remedy against fever caused yellow fever, malaria, typhoid and trypanosomiasis
Moringa oleifera Lam.	MPNH/2019/01305	Moringa	Ewé ile	Leaf	Fever/ Malaria	Moringa leaf, lime, cotton leaf and pap water are boiled and given orally	Asia - Moringa leaves are used for the treatment of fever, headache and sore throat
Nicotiana tabacum L.	MPNH/2018/01272	Tobacco	Ewé tábà	Leaf	Diarrhoea (Helminthosis) Hematuria	The leaves are squeezed and the juice given orally Tobacco leaf is squeezed with lime water and two teaspoon is given orally	India - Used for helminthosis Mexico - For diarrhea
Ocimum basilicum L.	MPNH/2019/01306	African basil	Efirin	Leaf	Fever/ Malaria	The leaves are cooked with Physic and Henna plant to make a decoction. The mixture is taken orally	India - Used for the treatment of fever, cough, flu, malaria fever, sore throat
Parkia biglobosa (Jacq.) G. Don	MPNH/2019/01307	Locust beans	Irú	Fruit	Eye problem	As for *A. melegueta* Un-mashed one can also be eaten as snacks for same purpose	Mali - The root and leaf pounded together in water to produce eye lotion

Picralima nitida (Stapf) T.Durand & H.Durand	MPNH/2019/01308	Akuamma plant	Abéèrè	Fruit	Gonorrhea	As for *A. melegueta*	West Africa - The bark is used for the treatment of venereal diseases
Pterocarpus osun Craib.	MPNH/2019/01309	Camwood	Osùn	Fruit	Gonorrhea	As for *A. melegueta*	Nigeria - Used for the treatment of candidiasis and fever
Pupalia lappacea (L.) Juss	MPNH/2019/01310	Forest Burr	Emo agbo	Leaf	Arthritis	As for *A. melegueta*	India - The leaf paste with cinnamon or carthamus oil is used for treatment of bone fracture and inflammation Nigeria - Decoction of the leaves is used for the treatment of urethra pain, endometritis, cystitis and other types of inflammation
Ricinus communis Linn.	MPNH/2019/01287	Castor oil plant	Ewé laa/ lara	Leaf	Fibroid	As in *A. melegueta*	Ogun, Osun, Nigeria- The fruit is made into an infusion with fermented maize water and salt for treatment of fibroid
Urera obovata Benth.	MPNH/2019/01288	Scratch-bush	Ewé esìsí	Leaf	Epilepsy, Laxative for pregnant women	Eight to nine leaves are rinsed and eaten raw	Côte D'Ivoire - Leaf decoction is used as an aphrodisiac
Vitellairia paradoxa C.F.Gaertin.	MPNH/2019/01311	Sheabutter	òrí	Seed	Arthritis	The bone marrow of the femur of cattle is crushed with sheabutter, mixed with camphor and placed under sunlight. The mixture is used to massage the joint every night after bath	Cameroon - Leaves and stem bark are used for the treatment of skin diseases, rheumatism, typhoid and microfilaria

Sources: PubMed, CAB Abstracts and Global Health, and Google Scholar

Table 5: Some reported pharmacological studies and isolated compounds present in plant species used for management of specific ailments in Ọdédá Local Government Area, Ogun State

Plant species	Some reported related pharmacological activities	Some isolated compounds
Aframomum melegueta	Anti-inflammatory	Alkaloids, tannins, sterols, flavonoids, triterpenes, glycosides, resins
Azadirachta indica	Antipyretic, antiviral, analgesic, antibacterial, contraceptive, hepatoprotective	Azadirachtin, nimbidin, nimbin, nimbinin, sodium nimbidate
Bauhinia rufescens	Anticancer, antitrypanosomal	Tannins, flavonoids, triterpenes, saponins, alkaloids
Calotropis procera	Anti-inflammatory, antimicrobial, antioxidant, anti-arthritic, analgesic	Cardenolides, terpenes, flavonoids
Capsicum chinense	Anti-inflammatory, antioxidant	Capsaicin, capsaicinoids
Carica papaya	Anti-inflammatory, ulcerogenic	Tannins, steroids, saponins, glycosides
Chromolaena odorata	Anthelminthic, analgesic, antioxidant, insecticidal, antipyretic	Protocatechulic, p-hydroxybenzoic, p-coumaric, ferlic, flavonoid
Cissampelos owariensis.	Anti-microbial, antidiabetic	Tannins, flavonoids, alkaloids, saponins
Citrullus colocynthis	Antibacterial, antifungal	Citrulline
Citrus aurantifolia	Acaricidal, anticholinesterase, antioxidant, antimicrobial	β-caryophyllene, citronellol, germacrene B, kaempferol, limonene, quercetin, rutin, sabinene
Cnidoscolus aconitifolius	Antibacterial, antioxidant	Steroids, phloatannins, tannins, alkaloids, terpenoids, saponins, cardiac glycoside
Cymbopogon citratus	Antimalarial, antifungal, antioxidant, anti-inflammatory, antimicrobial, antinociceptive, antihepatotoxic, antimutagenic, antiprotozoan	Myrcene, citronellol, citronellal, geraniol
Dioscrorea alata	Antioxidant, anticancer, antifungal, immunomodulatory, anti-inflammatory, diuretic	Diosgenin, dioscorin, discorin
Elaeis guineensis	Antibacterial, antioxidant	Alkaloids, terpenoids, phenolic compounds, steroids, flavonoids, carotenoids, catechins
Ficus thonningii	Analgesic, anti-inflammatory, antioxidant, anthelminthic	Alkaloids, terpenoids, tannins, flavonoids
Garcinia kola	Anti-inflammatory, antioxidant, anti-hepatotoxic antidiabetic	Kolaviron, garcinia, biflavonoid, (GB)-!a-glucoside, kolaflavonone, benzophenone, xanthone, coumarin, apigenin, garcinonic
Gossypium arboretum	Antioxidant, diuretic, hepatoprotective, anticovulsant, wound healing	Steroids, gossypol, tannins, resins, gossyfulvin, gossycaerulin, Vitamin A, D, E
Jatropha curcas	Anti-inflammatory, antioxidant, analgesic, anticancer, antimicrobial, antidiabetic	Jatrophine, jatropham, curcain, apigenin, vitexin, isovitexin

Kigelia Africana	Antimicrobial, antioxidant, wound healing	Alkaloids, saponins, flavonoids, carbohydrates, sapogenetic, glycosides
Lagenaria breviflora	Antioxidant, cardioprotecive, immunomodulatory, analgesic, anti-inflammatory, anti-stress	Phenyl alanine, valine, cucurbitacin B, D, E, saponin
Lawsonia inermis	Analgesic, anti-inflammatory, antibacterial, antimicrobial, antiparasitic, ant-oxidant	Lawsone, esculetin, fraxetin, scopoletin, botulin, lacoumarin, flavone glycosides, laxanthone, betulinic acid
Mangifera indica	Antimicrobial	Xanthonoid, mangiferin, tannins, gallic acid, catechins
Monodora myristica	Antimicrobial	Tannins, glycosides, saponins, flavonoids
Morinda lucida	Antimalarial, antibacterial, antidiabetic, trypanocidal, antifungal	Lucidin, morindin, soranjidiol, tannins, flavonoids
Moringa oleifera	Antii-inflammatory, antihypertensive, diuretic, anti-ulcer, antibacterial, antifungal	Moringine, moringinine, glucosinolates, isothiocyanates, flavonoids, carotenoids
Nicotiana tabacum	Antibacterial	Tabaisocoumarin A-C, phenolic compounds
Ocimum basilicum.	Anti-bacterial, anti-inflammatory, anti-ulcer, antioxidant, antifungal, wound healing	Flavonoids, triterpene, oxygenated sesquiterpene
Parkia biglobosa	Anti-inflammatory, analgesic	Trans-ferulic acid, lupeol, 4-0-methyl-epi-gallocatechin, epi-gallocatechin, epi-catechin 3-0-gallate, epi-gallocatechin 3-0 gallate
Picralima nitida	Antimicrobial, analgesic, antipyretic, anti-inflammatory, hypoglycemic, antioxidant, trypanocidal, antiulcer	Akuammine, psuedoakuammigine, akuammidine, akuammicine, Polyphenols
Pterocarpus osun	Antibacterial, antioxidant	Flavonoids, tannins, terpenoids, alkaloids, saponins, glycosides, saponins, tannins, cardiac glycosides, sterols, terpenes
Pupalia lappacea	Wound healing, antibacterial	1-docosa-nol, steric acid, syigamasterol, β-sitosterol-3-0-D-glucopyranoside, Stigmasterol-3-0- β-D-glucopyra-noside and 20-hydroxylecdysone
Urera obovata		
Vitellairia paradoxa	Anti-inflammatory, anti-arthritis, antibacterial, antifungal, antiviral	Alkaloids, tannins, saponins, flavonoid, phenols

NA- Not available

Sources: PubMed, CAB Abstracts and Global Health, and Google Scholar

Decoctions and infusions were cited as the most frequent form of herbal preparation used. Boiling is considered effective in extracting plant materials. It also preserves them longer due to destruction of heat labile pathogenic microorganisms that could have contaminated the plant material during collection and processing (Kamatenesi *et al.,* 2011). A drawback to this method of preparation is the likelihood of denaturing or altering heat labile active plant principles and the evaporation of volatile aromatic phytochemical ingredients present in the herbal preparation (Moshi *et al.,* 2012). Most of the plant species were ground to powder before use. Grinding enhances the rate of disintegration of the medicinal plant material and increases the rate of extraction of the active component into the solvent (Azmir *et al.*, 2013).

The most common route of administration in this study was the oral route. This route is safer, easier and does not require any specialized skills to administer. The oral route was also the most frequently used route in some other ethnobotanical studies reported (Salihu *et al.*, 2018; Wanjohi *et al.*, 2020). Topical route was also employed especially in cases of arthritis, wound and skin infection. This is in line with the study conducted by Tesfaye *et al.* (2020) in Ethiopia. Topical route is easier to administer and the tendency to cause toxic incidence is minimal because the bi-lipid skin layer is poorly vascularized.

Many of the plants documented in the study were found to have similar ethnomedicinal uses in other parts of the country and also in other countries of the World. This shared usage across ethnicity, cultures and regions may further corroborate their effectiveness (Nabatanzi *et al.*, 2020). Most of the plants documented have demonstrated similar pharmacological activity as reported by its ethnobotanical use. *Bauhinia refescens* reportedly used as an anticancer in our study demonstrated cytotoxic activities against MCF-7 human breast cancer cells (Garbi *et al.*, 2015a); *Morinda lucida* used as an antimalarial in our study exhibited antiplasmodial activity in mice infected with *Plasmodium berghei* and *Plasmodium falciparum* strain 3D7 (Chithambo *et al.*, 2017; Afolabi and Abejide, 2020). Methanolic leaf extract of *Citrus aurantifolia* exhibited antimalarial properties in Swiss albino mice at 320mg/kg (Ettebong *et al.*, 2019). *Ocimum basilicum* leaf extract exhibited antimalarial activity against *Plasmodium falciparum* (Inbaneson *et al.*, 2012). The flavonoid quercetin found in *A. indica* and *M. indica* is a strong inhibitor of the growth of the intraerythrocytic malaria parasite (Ganesh *et al.*, 2012, Ediriweera *et al.*, 2017). Methanolic leaf extract of *A. indica* has also been reported to show anti-inflammatory, pro-apoptotic and anti-proliferative effects *in vitro*, mediated via modulation of the nuclear factor-$\varkappa$B pathway (Schumacher *et al.*, 2011). *Nicotiana tabacum* used as an anthelmintic in this study demonstrated anthelmintic activity against the sheep nematode *Marshallagia marshalli* (Nouri *et al.*, 2016) and soil nematode *Caenorhabditis elegans* (Weber *et al.*, 2019). *Lagenaria breviflora* used for convulsion demonstrated anticonvulsant activity *in vitro* and the effect could be due to triterpenoids and saponins in the fruit (Elujoba *et al.*, 1990). The leaf back extract of the edible yam, *Dioscorea alata* is used for diabetes by the respondents in the study. The steroidal saponin, diosgenin, is one of the bioactive compounds responsible for its hypoglycemic activity (Amitani *et al.*, 2015). *Dioscorea* bulb extract has inhibitory activity against alpha-amylase and alpha-glycosidase, thus regulating hyperglycemia (Khiari *et al.*, 2014). *Bauhimia rufescencs* con-

tains a cyanoglycoside that inhibits cyclo-oxygenase-2 enzyme which may be responsible for its anti-inflammatory activity (Mohammed and Sirat, 2013).

The diseases frequently managed in the study area were malaria/fever, typhoid and arthritis. Malaria has been and continues to be one of the most widely spread health hazards in tropical and subtropical regions. It is the most important cause of human morbidity and mortality with enormous medical, emotional and economic impact in the world (Olasehinde *et al*., 2015). It is a major public health problem in Nigeria, contributing a quarter of the malaria burden in Africa (Olasehinde *et al*., 2015). According to the 2016 World Health Organization report, there were 212 million malaria cases worldwide, accounting for nearly 4 290 000 deaths, of which 92% were in Africa (Aschale *et al.,* 2018). Growing medicinal plants in a "green pharmacy", for preparation at the local level (usually as herbal teas), can empower poor communities to become more self-reliant. They could serve as alternative medicine to conventional drugs used for chronic diseases such as arthritis. The unpleasant adverse effects associated with these conventional drugs (cardiovascular, gastrointestinal and renal adverse effects) and the inability of the drugs to provide long-term remission is problematic (Crofford, 2013).

CONCLUSIONS

The rich Nigeria flora and traditional medicine practice could provide leads for new drug molecules which may proffer solution to the increase number of emerging and re-emerging diseases ravaging the world. There is an urgent need to standardize traditional medical practice and also develop a standardize curriculum and formal training in this practice in Nigeria. This will also have help to preserve cultural heritage that has been in use over many generations.

Conflict of interest

The authors declare no conflict of interest.

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Authors' contributions

OTA conceptualized the study and organized the visit to the study site. DBO and TS wrote the drafts of the manuscript. DBO, RAA, KOA and OAA interviewed the respondents, compiled and analyzed the data. OTA revised the manuscript critically for important intellectual content. All authors read and approved the final version of the manuscript to be published and agreed to be accountable for all aspects of the work.

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