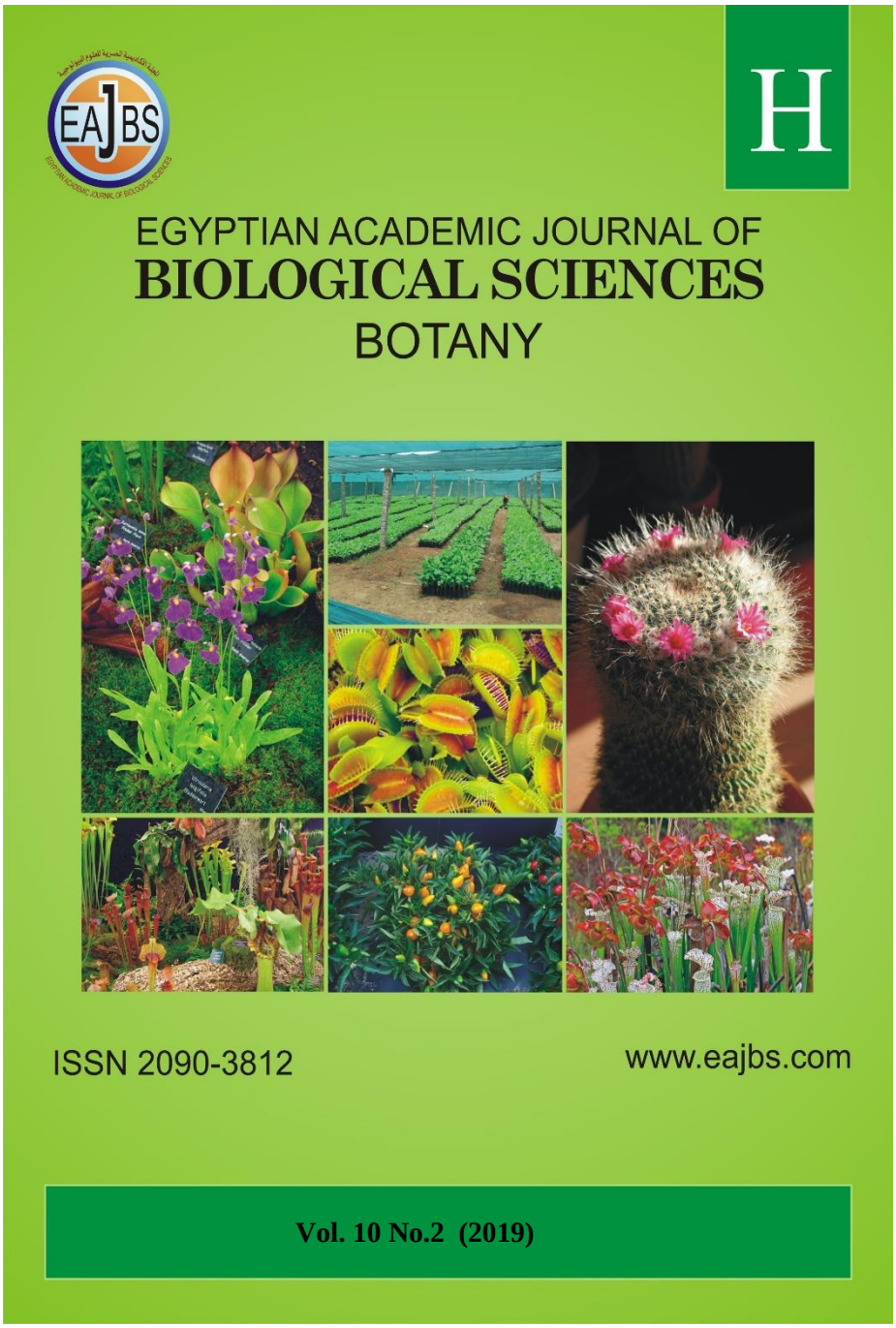

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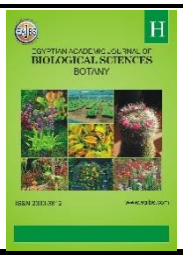

Management of Malaria: An Account by the Indigenous People of Kashere and Its Environs, Gombe State, Nigeria.

Gani, A. M.[1]; Kolawole O. S.[1*]; Dahiru, M.[1] and Isyaka, M.S.[2]
1-Department of Biological Sciences, Federal University of Kashere, Gombe State.
2-Department of Chemical Sciences, Federal University of Kashere, Gombe State.
E-Mail : kolawolesaheed@fukashere.edu.ng;

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ABSTRACT

Malaria still remains a major health concern that affects the poor and marginalised populations. Most of indigenous knowledge about plants used for the management of malaria is undocumented and the risks of being lost are on the high. The ethnobotanical study documents the different types of medicinal plants used for the treatment of malaria in Kashere and its environs of Akko L.G.A. of Gombe State. Information was collected by interviewing 84 informants, using a semi-structured questionnaire, which included Traditional Medical Practioneers, farmers and other inhabitants who have experience in the management of malaria. Collected plant samples were identified and authenticated at the Federal University of Kashere Herbarium (FUKH). Data was analysed using frequency and percentages. In this study, 81% of the informants are males and 19% are females. A total of 63% of the informants have attended primary school/Islamia education, and 76% of the respondents are aged above 40 years of age. A total of 41 plants species belonging to 28 families were identified. Most plants used in the management of malaria in Kashere community belong to Fabaceae (12%), Rutaceae (7%), Asteraceae (7%) and Malvaceae (7%) plant families. *Azadirachta indica* A. Juss is with the highest relative frequency of citation (RFC- 0.74) among the plants surveyed. The main method of preparation is decoction and dominant plant parts used in the preparation of remedies were leaves. The diversity of medicinal plants species used and associated indigenous knowledge are of great value to Kashere community and their conservation and preservation is paramount.

INTRODUCTION

Plants are the principal source of drugs for the treatment and prevention of diseases and also for the manufacture of some drugs used in orthodox medicine (Mowobi *et al.*, 2016). Soladoye *et al.* (2010) opined that about 80% of Western Pharmaceuticals have their origin in plants. Recently there is an increase in the screening of plants for novel chemicals by pharmaceutical companies and natural product researchers. Ethnobotany is the study of the interaction between plants and people, with a particular emphasis on traditional tribal cultures. It is based on the knowledge of plants by the local people and their usefulness as understood by the people of a particular ethnic group since information

concerning a particular plant varies from one ethnic group to another (Tor-Anyiin *et al*., 2003; Igoli *et al*., 2005).

According to the World Health Organization (WHO), about 65-80% of the world's population in developing countries depend essentially on plants for their primary healthcare due to poverty and lack of access to modern medicine (Awoyemi *et al*., 2012). Many attempts have been made to define Indigenous Knowledge Systems (IKS). IKS is defined as local knowledge that is unique to a given culture or society. It is the knowledge by which food security, animal and human health and sustainability are achieved, this knowledge is the local people's capital (UNESCO, 1999; Mapaure and Hatuikulipi, 2007; Dan *et al*., 2010).

Plants have been used in traditional medicinal practice for several thousand years (Abu-Rabia, 2005). Medicinal plants are used to treat the spiritual origins of disease as well as the physical symptoms. The vast knowledge of such plants is now beginning to be acknowledged by the rest of the world; so is the role played by indigenous people as custodians of the world's genetic heritage (Idu and Onyibe, 2007). It also provides leads towards therapeutic concept thereby accelerating drug discovery; this is now being called reverse pharmacology (Chinsembu, 2009; Kaya, 2009).

Africa is endowed with an enormous wealth of plant resources (Lawal *et al.*, 2009). Medicinal plants serve an important role to the health of individuals and communities. The medicinal importance of these plants lies in some chemical substances that produce a definite physiological action in the human body (Edeoga *et al.,* 2005; Kolawole *et al*., 2014). In human beings, some phytochemicals have been found to be protective and preventive against many degenerative diseases and pathological processes such as ageing (Burns *et al.*, 2001; Adeyemi *et al*., 2014). The most important of these bioactive constituents of plants are alkaloids, tannins, flavonoids, and phenolic compounds (Adeyemi *et al*., 2015). In addition to treating infectious diseases, phytomedicines have been reported to limit the side effects associated with synthetic antimicrobial drugs (Iwu *et al*., 1999).

Malaria is a common and life-threatening disease in many tropical and sub-tropical areas caused by the protozoan parasite *Plasmodium* and transmitted by female *Anopheles* mosquitoes, which bite mainly between dusk and dawn (WHO, 2013). Malaria is one of the tropical parasitic diseases responsible for significant morbidity and mortality especially among children and pregnant women (Idowu *et. al*., 2010). The most severe form of malaria is caused by *P. falciparum*; variable clinical features include fever, chills, headache, muscular aching and weakness, vomiting and cough, diarrhoea and abdominal pain (WHO, 2013). Malaria related death is estimated at 1-2 million people annually (Idowu *et. al*., 2010; Sudhanshu *et al*., 2003).

The continuous search for natural plant products for use as medicines is encouraged by ethnobotanical survey; Igoli *et al.* (2005) recognized ethnobotanical survey as one of the major approaches for selecting plants for pharmacological screening. Several workers have conducted ethnobotanical surveys among various tribes of the African continent and the rest part of the world, (Adjanohoun *et al*., 1991; Gbolade and Soremekun, 1998; Rashid, 2001; Gbolade 2000; Ajaiyeoba *et al*., 2002; Osowole *et al*., 2005; Ebong *et al*., 2005; Adeyemi *et al*., 2015). The objective of the present study was to add to the existing knowledge of medicinal plants by documenting information on the use of plants in the management of malaria.

MATERIALS AND METHODS

Ethnobotanical Study:

An ethnobotanical survey was carried out between January and October 2017 in Kashere and its environs of Akko LGA of Gombe State. Interviews were conducted using semi-structured questionnaires which were administered to local populations, to obtain information about their knowledge of plants used in the treatment of malaria. The participants in this study were provided with information on the nature of the study, benefits, and risks involved. Those who agreed to participate signed or thumb printed written consent at the beginning of the study.

With the help of an interpreter/research assistant which is well known to the respondents, all interviews and discussions were conducted in Hausa and Fulfulde, the prominent languages of the study area.

Collection and Taxonomic identification of Plants Specimens:

A series of field trip was conducted to collect specimens of the reported plants from the natural vegetation and home gardens with the help of some guides selected among the respondents. The identification of the sampled plants was achieved with the aid of herbarium specimens and literature on Nigerian plants. The online plant diversity resources further confirmed the identity of the surveyed plants. Voucher specimens were collected, pressed and deposited in the herbarium of Federal University of Kashere Herbarium (FUKH), Nigeria.

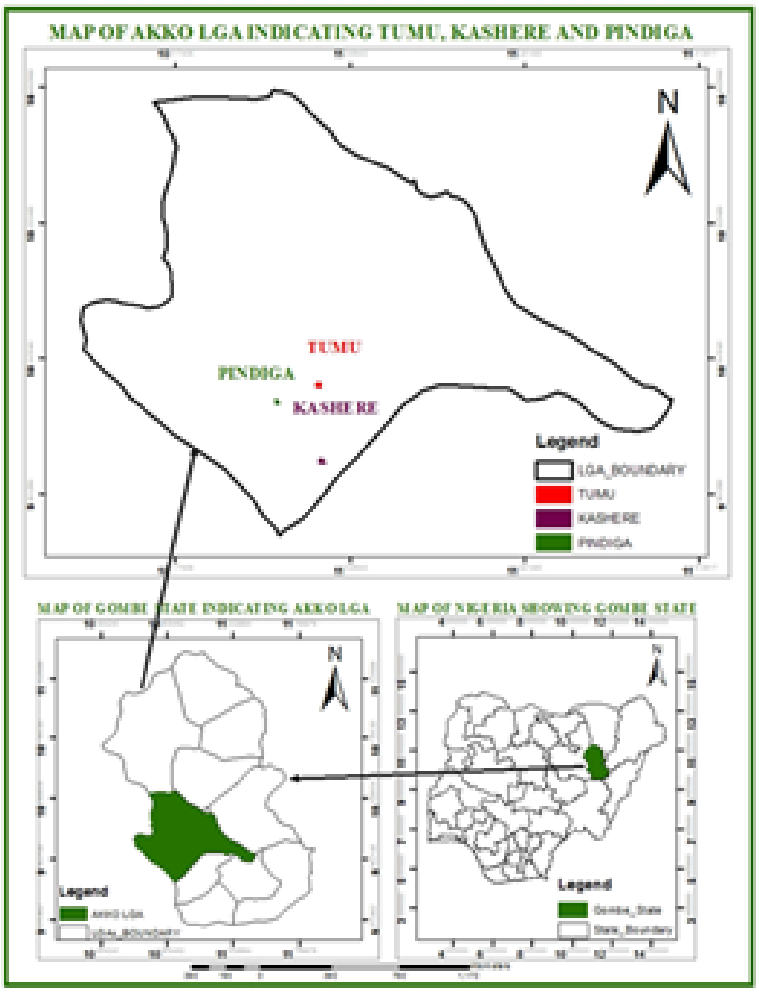

Fig. 1: Map of Kashere and its environs showing the study area

Data Analysis:

A descriptive statistical method using frequencies and percentages was used to analyze the socio-demographic data of the respondents, and the results of the ethnobotanical survey were analyzed using the Relative Frequency of Citation (RFC).

Relative Frequency of Citation (RFC):

This measure was calculated to determine the relative importance of a particular species. This value was determined using the relation RFC = Fc / N (Tard and Pardo-de-Santayana, 2008), where Fc is the number of respondents who cited a particular species and N is the total number of the respondents.

RESULTS AND DISCUSSION

Social Demography of Respondents:

It was observed that among the 84 respondents who were interviewed, the majority (81%) were male (Figure 2), and the age ranged between 20 and 75 years. It is usually believed that older members of the society have experience in the practice of traditional medicine and pass it on to the younger generation (Mukungu *et al*; 2016). Contrary to that, Tugume *et al*. (2016) opined that younger generations have little interest in traditional medicine in general and this will be a risk of knowledge loss if nothing is done to motivate them. Younger people are exposed to modern education and are not usually interested in learning and practicing ethnomedicinal wisdom that would preserve indigenous knowledge. Lambert *et al*. (2011) and Mukungu *et al*. (2016) observed in separate studies in Kenya and asserted that the younger generation is not readily accepted by the community as traditional medical practitioners, as they are considered inexperienced. These explained the reasons why more than half of the respondents were of 40 years and above (Figure 5).

The further result revealed that 63% of the informants have primary /Islamic education (Figure 4). A similar trend has earlier been observed by Mukungu *et al*. (2016) who stated that practice of traditional medicine has been for a long time been restricted to the less educated in the society since the most literate people view traditional medicine as primitive and inappropriate.

Plant Information and Taxonomic Diversity:

The survey revealed that a total of 41 species distributed among 28 families are used in the management of malaria in Kashere and its environs. The scientific names and authority of each species together with the family name, local name (Hausa), common name (English), plant parts used, relative frequency citation and mode of preparation are presented in Table 1. Most of the plants used in the management of malaria in Kashere community belonged to Fabaceae (12%), followed by Rutaceae (7%), and Asteraceae (7%) (Figure 3). Of the plants identified during the ethnobotanical survey, *Azadirachta indica* (0.74), *Cymbopogon citratus* (0.50), *Vernonica amygdalina* (0.46), *Hibiscus sabdariffa* (0.45) and *Mangifera indica* (0.60) have the highest relative frequency of citation (RFC) whereas *Cassia fistula* (0.10), *Acacia polyacantha* (0.10), *Ximenia americana* (0.10), *Aloe barbadensis* (0.11), *Phyllanthus amarus* (0.12) and *Vitex doniana* (0.12) have the lowest relative frequency of citation (Table 1).

Frequency of Parts Used:

The study revealed that traditional medical practitioners utilized various parts of the medicinal plant in the preparation of the antimalarial remedies. The most common plant parts used were leaves (36%), stembark (17%), fruits (17%), roots (13%), seed (9%) and whole plants (8%) (Table 2). From the results the dominant plant parts usage were leaves followed by stembark and fruits which is in consonance with earlier reports from several studies of other researchers (Idowu *et al*., 2010; Asase *et al*., 2010; Ighere *et al*.,

Olorunosola *et al*., 2013; Traore *et al*., 2013; Mahwasane *et al*., 2013; Iyamah and Idu, 2015).

Iyamah and Idu (2015) are of the opinion that the preference towards leaves may be linked to the fact that leaves are the main photosynthetic organs of the plants, and they also act as reservoirs for the products of photosynthesis or exudates which contains more bioactive secondary metabolites. However, the use of leaves is less dangerous to the existence of the plant species from the conservation point of view as compared to the use of underground parts like roots and stembark or the use of whole plants (Giday *et al*., 2003; Zheng and Xing, 2009; Nguta *et al*., 2010, Yetein *et al*., 2013). Conservationists are of the opinion that overexploitation of medicinal plants which are valued for their root parts and stem barks (Maroyi, 2013; Mukungu *et al*., 2016). Leaves and fruits are most preferred parts of sustainable plant use (Mukungu *et al*., 2016) since they are the least destructive to the plants and the accounted for 53% in this study.

Mode of Preparation of Herbal Remedies:

The results obtained in this study show that different methods of preparation are employed by the traditional medical practitioners in the use of these plants included decoction, infusion/tincture, juice extracts and maceration (Table 1). The decoction method was frequently used. This is also in accordance with the results of Yetein *et al*. (2013) and Iyamah and Idu (2015). Also some traditional medical practitioners reported single plant in their treatment of malaria while others reported two or multiple plant species that may be combined and used. Throughout this study none of the respondents reported the use of fermented maize as solvent in the extraction or preparation of the herbal remedies as earlier reported by Idowu *et al*. (2010) and Olorunnisola *et al*. (2013) in their studies on management of malaria. The herbal remedies can be chewed/consumed orally, inhaled or used in a bath. However, majority of the herbal preparations identified in this study involved boiling the plant material and then drinking the extract.

Previous Studies and Documentation:

Of the 41 plants documented in this study, 11 (*Aloe barbadensis, Ananas comosus, Azadirachta indica, Capsicum annum, Carica papaya, Citrus aurantifolia, Cymbopogon citratus, Mangifera indica, Psidium guajava, Senna occidentalis, Vernonica amygdalina*) plants were reported to have been previously investigated and phytochemicals isolated.

Data on the antimalarial plants previously investigated and their other medicinal uses are documented in Table 3.

Table 1. Plants used in the management of malaria in Kashere and its environs

S/N	Name of Plants	Family	Local name	Common name	RFC	Plants parts used	Mode of preparation
1	*Acacia polyacantha* Willd.	Mimosaceae	Kak kara, Kamboorin shaahoo	White thorn	0.10	Bark	Decoction
2	*Adansonia digitata* L.	Malvaceae	Kuka	Baobab	0.24	Leaves, barks, seeds and roots	Decoction
3	*Allium sativum* L.	Liliaceae	Tafarunwa	Garlic	0.30	Fruits	Infusion/tincture
4	*Aloe barbadensis* Mill.		Tinya	Aloe vera	0.11	Leaves	Decoction
5	*Ananas comosus* (L.) Merr.	Bromeliaceae	Abaraba, Nkwu aba	Pineapple	0.15	Fruits	Decoction
6	*Anogeisus leiocarpus* (DC) Guill. & Perr.	Combretaceae	Marke	African birch	0.36	Roots	Decoction
7	*Azadirachta indica* A. Juss	Meliaceae	Dongoyaro, darbejiya	Neem	0.73	Whole plants	Decoction
8	*Balanite aegyptiaca* (L.) Del.	Zygophylaceae	Adua	Desert date	0.19	Roots	Decoction
9	*Capsicum annum* L.	Solanaceae	Barkoonoo, Tasshii	Pepper	0.15	Fruits	Decoction
10	*Capsicum frutescens* L.	Solanaceae	Barkoonoo	Africa/Guinea pepper	0.18	Fruits	Decoction
11	*Carica papaya* L.	Caricaceae	Gwanda	Pawpaw	0.42	Leaves and unripe seeds	Decoction
12	*Cassia fistula* L.	Fabaceae		Indian Laburnum, pudding stick, Golden shower	0.10	Roots	Decoction
13	*Cenaurea perrottetti* DC	Asteraceae	Dayi	Common knapseed	0.12	Leaves	Decoction
14	*Citrullus lanatus* (Thumb.) Matsum. & Nakai	Curcubitaceae	Kankana	Water melon	0.35	Fruits, Seeds	Juice extracts
15	*Citrus aurantifolia* (Chrism.) Swingle	Rutaceae	Lemu	Lime	0.26	Fruits	Decoction
16	*Citrus limon* (L.) Burm.f	Rutaceae	Lemunoisami	Lemon	0.26	Fruits	Decoction
17	*Citrus sinensis* (L.) Osbeck	Rutaceae	Lemun zaki	Orange	0.24	Leaves	Decoction
18	*Cymbopogon citratus* (DC.) Stapf.	Poaceae	Tsauri	Lemon grass	0.50	Leaves	Decoction
19	*Eucalyptus camaldulensis* Dehn	Myrtaceae		Eucalyptus	0.25	Leaves, Stembark	Decoction
20	*Garcinia kola* Heckel	Clusiaceae	Cida goro	Bitter kola	0.26	Leaves and fruits	Decoction

21	*Hibiscus sabdariffa* L.	Malvaceae	Yakuwa	Roselle	0.45	Leaves and outer seed covering	Decoction
22	*Kigelia africana* (Lam.) Benth.	Bignoniaceae	Rahaina	Sausage tree	0.14	Seeds	Decoction
23	*Lawsonia inermis* L.	Lythraceae	Lalle	Henna	0.27	Leaves	Decoction
24	*Mangifera indica* L.	Anacardiaceae	Mangoro	Mango	0.60	Leaves and stem bark	Decoction
25	*Moringa oleifera* Lam.	Moringaceae	Zogale	Drum stick	0.26	Leaves	Decoction/Maceration
26	*Musa paradisiaca* L.	Musaceae	Aya ban, turawa	Plantain	0.33	Leaves	Decoction
27	*Musa sapientum* L.	Musaceae	Kwadan	Banana	0.36	Leaves	Decoction
28	*Ocimum gratissimum* L.	Labiateae	Kafi amarya	Wild basil	0.26	Whole plants	Decoction
29	*Parinari curatellifolia* Planch ex Benth.	Rosaceae	Farin ruwa	Cork tree, Hissing tree	0.19	Leaves and roots	Decoction
30	*Persicaria senegalensis* (Meisn.) Soják	Polygonaceae	Binii da zugu	Fulaf	0.20	Leaves	Decoction
31	*Phyllanthus amarus* Schum et Thonn	Euphorbiaceae	Geeron-tsuutsaayee	Gale-o-wind, Hurricane wind	0.12	Leaves or whole plant	Infusion/Decoction
32	*Psidium guajava* L.	Mytraceae	Gwaba	Guava	0.21	Stem bark and fruits	Decoction
33	*Senna occidentalis* (L.) Link	Fabaceae	Raydore	Coffee senna	0.29	Roots	Decoction
34	*Senna siamea* (Lam.) Irwin & Barneby	Fabaceae	Cassod tree, siamesse cassia	Raiidor	0.24	Leaves and stem bark	Decoction
35	*Sorghum bicolor* (L.) Moench	Poaceae	Daawaa	Sorghum	0.14	Leaves	Decoction
36	*Tamarindus indica* L.	Fabaceae	Tsamiya	Tamarind	0.33	Barks	Decoction
37	*Tridax procumbens* L.	Asteraceae		Tridax	0.20	Leaves	Decoction
38	*Vernonica amygdalina* L.	Asteraceae	Chusar-doki, shakwa shuwaka	Bitter leaf	0.46	Leaves	Decoction/Juice extract
39	*Vitex doniana* Sweet	Verbanaceae	Bursun dinyaa	Blackplum	0.12	Leaves, barks, seeds	Decoction
40	*Ximenia americana* L.	Olacaceae	Tsada	Spiny plum	0.10	Stem bark and roots	Decoction
41	*Zingiber officinale* Roscoe	Zingiberaceae	Cittaa mai kwaayaa	Ginger	0.29	Rhizome	Decoction

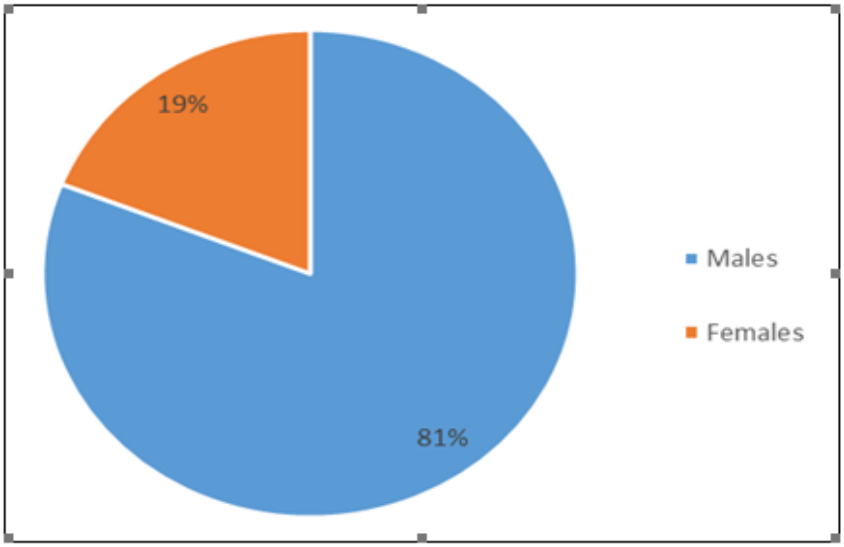

Fig. 2: Sex distribution of respondents

Table 2: Frequency of Plant parts commonly used for the treatment of malaria

Plant part	Frequency
Leaf	19 (37.0)
Fruits	9 (17.0)
Stembark	9 (17.0)
Root	7 (13.0)
Seeds	5 (9.0)
Whole plant	4 (8.0)
Total	**53 (100.0)**

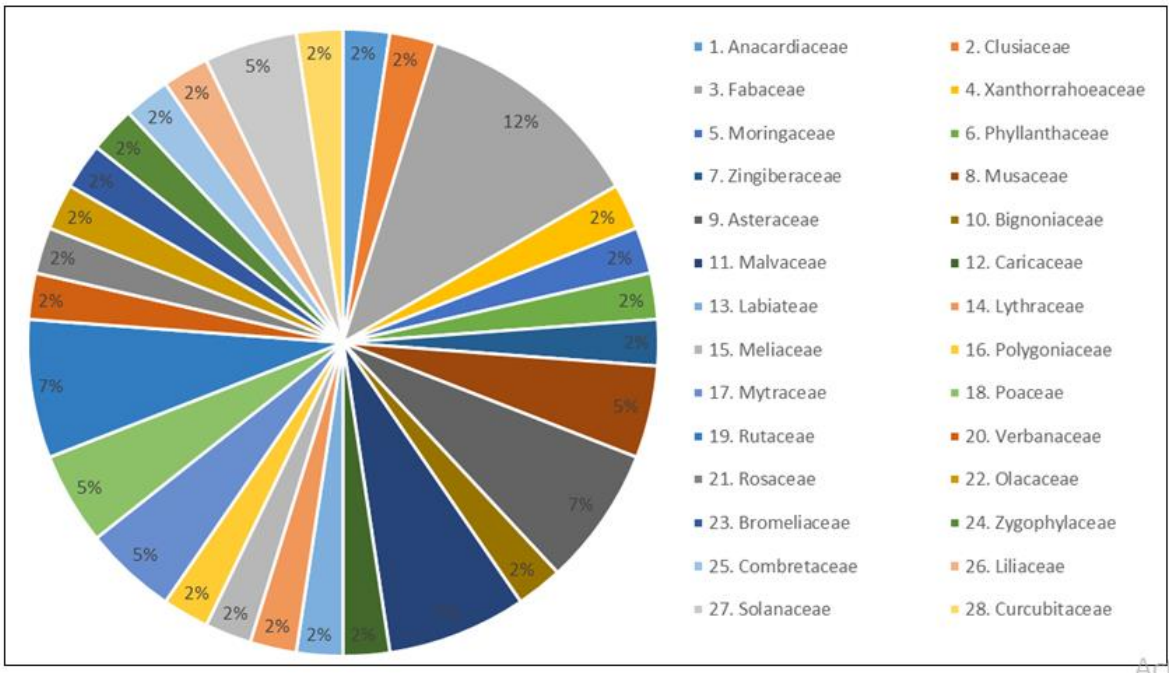

Fig. 3: Frequency of use of families in the management of malaria in Kashere and its environs.

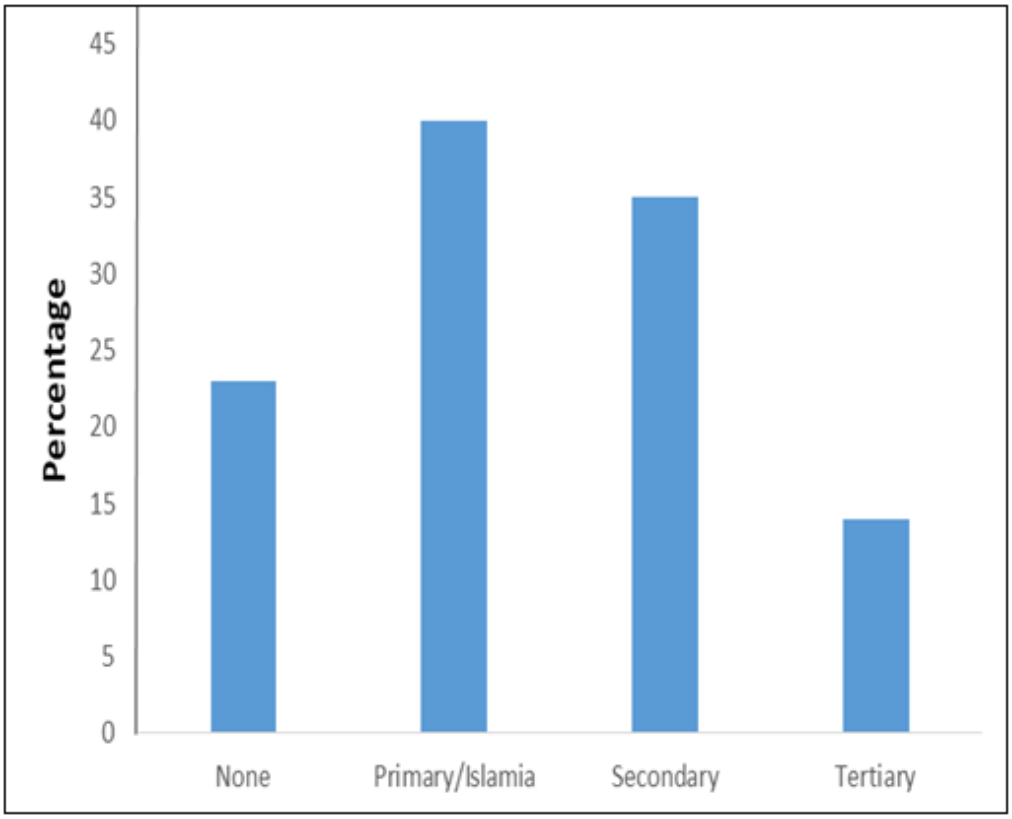

Fig. 4: Education level of Respondents

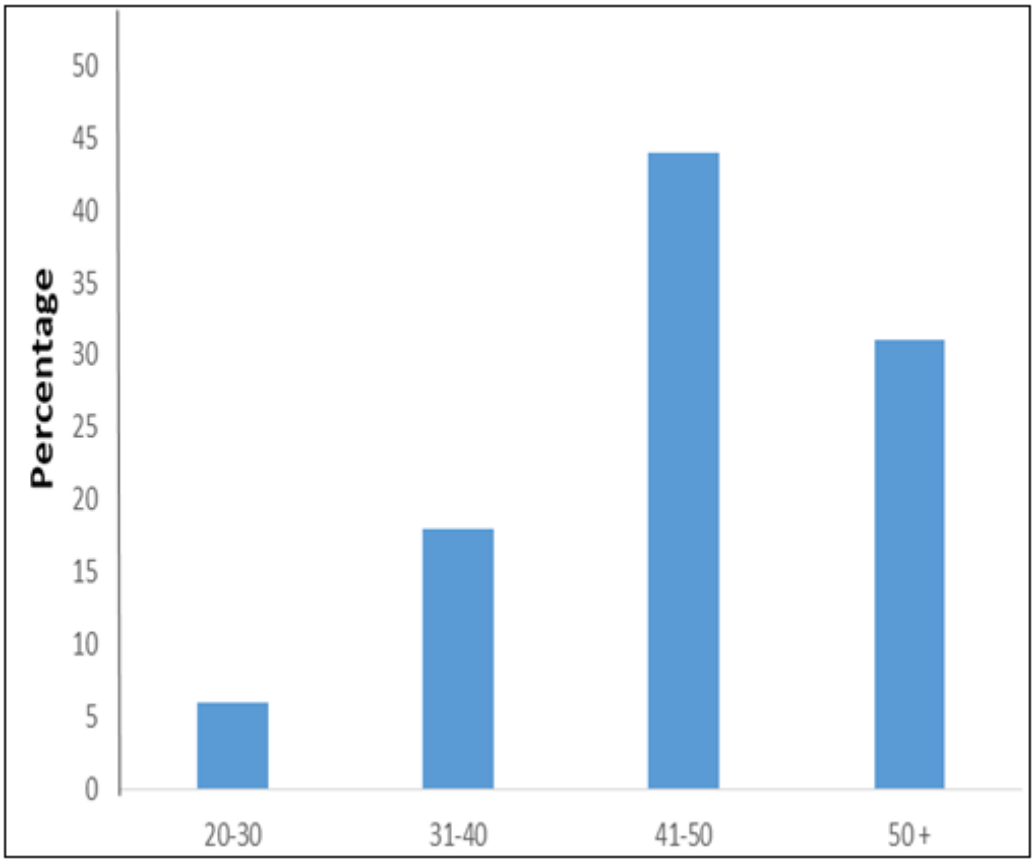

Fig. 5: Age group of Respondents

Table 3: Anti-malarial plants that have been previously investigated that are used in Kashere and its environs

S/N	Name of Plants	Other medicinal uses	Previous phytochemicals isolated	References
1	*Aloe barbadensis* Mill.	Malaria, wounds	Aloe-erriodin, aloetic acid, anthranol, alotu A and B	Hamman (2008); Kipkore *et al.*, 2014
2	*Ananas comosus* (L.) Merr.	Malaria, typhoid fever, cough, anthelminthics, fibrinolytications, digestive problems	Bromelain	Oloruniyi and Morenikeji (2013); Iyamah and Idu (2015)
3	*Azadirachta indica* A. Juss	Hepatoprotective, malaria, skin diseases, ulcers, fever, asthma	Isoprenoids, gedunin	Dhara *et al.* (1999); Adesegun and Cooker (2001); Qureshi *et al*. (2016)
4	*Capsicum frutescens* L.	Prostate cancer, throat, breast and squamous cell carcinoma	capsacin	Kisangau et al. (2007); Tugume *et al.* (2016)
5	*Carica papaya* L.	Malaria, mental disorder, convulsion, diabetes, abortifacients, hermia, gonorrhoea, syphilis, dysentry	Papain	Bhat and Sorolia (2001); Odugbemi (2008); Avwioro (2010)
6	*Citrus aurantifolia* (Chrism.) Swingle	Jaundice, stomach ache, antimicrobials, abdominal ulcer, carminative, hypertensive, measles, cough, scurvy, insecticides	Alkaloids, saponins, flavonoids and glycosides	Obule (2006); NNMDA (2013); Bapna (2014)
7	*Cymbopogon citratus* (DC.) Stapf.	Malaria, cough, sprains, stomach tonic, chest pains, rheumatic joints, refrigerant, ringworm	Terpenoids, aldehydes, essentials oils geranial	Bidla *et al.* (2004); Odugbemi (2008); Iyamah and Idu (2015)
8	*Mangifera indica* L.	Malaria, insanity, insomnia, anthelminthic, high blood pressure, liver diseases, diarrhea, diabetes, haemorrhage, antimicrobials	Xanthone, Glycosides-mangiferin, saponins, steroids and tannins	Ayeloja and Bello (2006); Odugbemi (2008); Iyamah and Idu (2015)
9	*Psidium guajava* L.	Stomach ache, diarrhea, laxative, laryngitis, skin ulcers, rheumatism, cholera, mouth swelling, convulsions, dysentry	Flavonoids, saponin, cabohydrates, terpenoids, anthraquinones	Mundkumar and Ojewole (2002); Obute (2006); NNMDA (2005, 2008)
10	*Senna occidentalis* (L.) Link	Malaria, laxative, hepatoprotective, diuretic, vermifuge	Quinones	Silva *et al*. (2011); Mukungu *et al.* (2016)
11	*Vernonica amygdalina* L.	Malaria, ringworms, weak erections, tonic astringent, nervous diseases, gingivitis, diarrhea, antimicrobials, impotency, acute joint pains, piles	Sesquiterpenes, lactones compounds such as vernolide, vernodalin; hydroxyvernolide as steroids	Tona *et al.* (2004); Omoregie *et al*. (2011); Iyamah and Idu (2015)

Conclusion

This study documents the diversity of medicinal plants used in the management of malaria in Kashere and its environs, 41 plants are reported to be used in the management of malaria. This is indicative of the rich nature of ethnomedicinal knowledge and therefore calls for preservation of the knowledge and conservation of the forests to secure the future of traditional medicine practice in Kashere community. The documented plant has potential of being used in drug development.

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