European Journal of Medicinal Plants

21(4): 1-22, 2017; Article no.EJMP.35368
ISSN: 2231-0894, NLM ID: 101583475

Ethnobotanical Survey of Antimalarial Medicinal Plants Used in Butebo County, Eastern Uganda

Kodi Philip[1*], Mwangi Muthoni Elizabeth[1], Peter Kiplagat Cheplogoi[1] and Kariuki T. Samuel[2]

[1]*Department of Chemistry, Egerton University, P.O.Box 536-20115, Njoro, Kenya.*
[2]*Department of Biological Sciences, Egerton University, P.O.Box 536-20115, Egerton, Njoro, Kenya.*

Authors' contributions

There was collaboration between the authors during the carrying out of the research. Author KP designed the research project, carried out the survey work and wrote the first draft of the manuscript. Authors PKC and MME assisted in the designing and drafting the questionnaire. Author KTS helped in the identification and naming of some of the medicinal plants. Authors KP, PKC, MME and KTS carried out the literature searches, data analysis and prepared the final draft of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJMP/2017/35368
Editor(s):
(1) Mohamed L. Ashour, Professor, Department of Pharmacognosy, Faculty of Pharmacy, Ain Shams University, Organization of African Unity Street, Abbasia, Egypt.
(2) Marcello Iriti, Professor, Plant Biology and Pathology, Department of Agricultural and Environmental Sciences, Milan State University, Italy.
Reviewers:
(1) Ogundolie Olubusola Omolara, Federal University of Technology, Nigeria.
(2) Luk Bahadur Chetry, Rajiv Gandhi University, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/22425

Original Research Article

Received 10th July 2017
Accepted 17th August 2017
Published 22nd December 2017

ABSTRACT

Aims: The ethno botanical survey conducted was aimed at collecting, identifying ant malarial plants and documenting ethno botanical information on traditional herbal medicines used to treat malaria in Butebo County in Eastern Uganda.
Study Design: The ethno botanical survey was conducted using a questionnaire in five Sub Counties each consisting of 10 respondents.
Place and Duration of Study: The ethno botanical survey was carried out in Eastern Uganda, in Butebo County, in 2014.
Methodology: The plants collected and information documented was got by interviewing respondents using semi–structured, open and closed ended questionnaire that were administered to traditional healers and herb sellers using Snowball sampling method. The most important

**Corresponding author: E-mail: kodiphilip@yahoo.com;*

information collected included knowledge on the use of medicinal plant species, the local names of plant species, parts of plant used, dosage, methods of herbal preparation and drying, mode of administration, duration of treatment and traditional uses. A total of 50 households were interviewed using questionnaires, ten respondents were selected from each Sub County. Medicinal plants collected were identified and their Voucher specimens deposited at the Department of Botany herbarium Makerere University for future specifications.

Results: Thirty three plant species from 30 genera that consisted of (*Flueggea virosa* (wild) Voigt, *Securidaca longipedunculata*, *Erythrina abyssinica*, *Melia azedarach*, *Carrisa edulis* Fork, *Harrisonia abyssinica* Olive., *Zanthoxylum chalybeum* Engl., *Psidium guajava*, *Citrus sinensis*, *Schkuhria pinnata* (lam.), *Lantana camara*, *Carica papaya*, *Mangifera indica* L., *Azadirachta indica*., *Persea americana* Mill., *Bidens pilosa*, *Cymbopogon citratus* (DC), *Plectranthus barbatus*, *Maytenus senegalensis*, *Citrus reticulate*, *Ocimum gratssiumum*, *Ocimum basilicum*, *Croton macrostachyus* Olive, *Oncoba spinosa* Forssk, *Steganotania araliacea*, *Acacia sieberiana*, *Ormocarpum trachycarpum*, *Acacia hockii* De willd, *Euclea latideus* Staff, *Cassia hirsuta*, *Chamaecrista nigricans* Greene, *Butyrospermuum paradoxum*, and *Aristolochia tomentosa* (Sims) were identified as being used by communities as antimalarial plants. These belong to 23 families of: Rutaceae, Lamiaceae, Euphorbiaceae, Mimosaceae, Celastraceae, Meliaceae, Asteraceae, Papillionaceae, Polygalaceae, Flacourtiaceae, Umbelliferae, Sapotaceae, Apocynaceae, Simaroubaceae, Ebenaceae, Aristolochiaceae, Anacardiaceae, Caricaceae, Lauranceae, Myrtaceae, Verbenaceae, Poaceae and Celastraceae. The most frequently used medicinal plants were from the families; Rutaceae and Lamiaceae (13.0% each) that had three plant species each. Ten species (30.3%) were identified and documented for the first time in Uganda to treat malaria including: *O. spinosa*, *S. araliacea*, *A. sieberiana*, *O. trachycarpum*, *A. hockii*, *E. latideus*, *C. hirsuta*, *C. nigricans*, *A. tomentosa* and *B. paradoxum*. The most commonly used plant part was the root (44.68%), followed by leaves (38.30%), stem (6.38%) each, bark and whole plant (4.30%) each and the least was the seeds with 2.13%. The growth habits included; trees (48.48%), shrubs and herbs (24.24% each) and the climbers with the least percentage of (3.03%). The largest habitant of the medicinal plants was found in the homesteads (21.10%), followed by wooded grassland and garden with (18.20%), grasslands (15.20%), open grassland (9.10%), cultivated and road side (6.10% each), garden edge and forest had the lowest value of 3.0% each. Most of the plant materials were dried in the shade, pounded into a powder and taken orally as water decoctions (76.50%) and infusions (23.50%).

Conclusion: Many plants used traditionally for the treatment of malaria were identified and claims of some of the medicinal plants documented in the survey are supported by literature. However the scientific validation of the traditional claims of antimalarial activity of some of these plants not researched on is needed. This includes testing for efficacy, safety (toxicity), antiplasmodial screening and structure elucidation to find out the identity of active compounds present. This would make them considered for future research for active compounds and the possible synthesis of new, cheaper and more effective ant malarial drugs. This would help in conserving and sustainable use of the ant malarial plants. Therefore it is necessary to carry out research to solve these problems so that the lives of people are not at risk.

Keywords: Ethnobotanical; antimalarial; medicinal plants; Uganda; Butebo; survey.

1. INTRODUCTION

Ethnobotanical survey is an important step in the identification, selection and development of the therapeutic agents from medicinal plants. In Ethnobotany and natural products chemistry, the mode of preparation and administration of herbal preparations are often crucial variables in determining efficacy in pharmacological evaluation. Use of phytomedicines for treatment of fevers and malaria is a known practice in many rural communities in Africa. However these plants are taken orally by the people without any consideration of possible toxic effect of components in such plants. The surveys have shown that these traditional medicines have been found to be effective especially in the treatment of malaria which is of great concern to any African nation [1]. The constant evolution of the malaria parasite has rendered the cheapest and most widely available antimalarial treatments ineffective, more so with the recent reports about the increasing resistance of *Plasmodium falciparum* to artemisinin based compounds [2].

Accordingly, there is deep concern that this parasite will soon develop total resistance to such orthodox treatments. Therefore, the search for newer more effective malaria cures is a major force of global research to day. This calls for an urgent need to explore and utilize the naturally rich biodiversity of indigenous communities through research that could translate to benefits for mankind. Such investigations on medicinal and beneficial plants could provide useful leads for the synthesis of important active compounds. Various studies have been documented with over 1200 plant species from 160 families used in the treatment of malaria or fever [3]. Similar investigations have been carried out in many African nations like Kenya [4], Ghana [5], Nigeria [6], Zimbabwe [7] and many others. According to literature there is no record of indigenous antimalarial herbs commonly used in Butebo County in Eastern Uganda. However a number of surveys have been carried out in Uganda to document the use of antimalarial herbal medicines [8,9]. It is assumed that these studies can help in complying data that will assist policy makers. But few studies have been undertaken to investigate the antiplasmodial efficacy and safety of plants claimed to have antimalarial therapeutic value. Ethnobotanical surveys done in Uganda have indicated that the plants, *Vernonia amygdalina* Del., *B. pilosa*, *Justicia betonica*, *S. pinnata*, *Secamone africana* (Olive.) Bullocks, *Cissus integrifolia* (Baker) among others are used to treat fever, sore throat, pelvic pain and intestinal parasitosis [10]. The documented information will be used as a basis of: selection of ant malarial plant species for pharmacological, toxicological, and phytochemical studies. It will also be used in both in-situ and ex-situ conservation of ant malarial potent plants. The information will also be used to establish comparisons with other Countries sharing similar characteristics, selection of plants for isolation of new and novel molecules for development as ant malarial drugs. This will assist in setting up health policies in regard to prevention and treatment of malaria.

2. MATERIALS AND METHODS

2.1 Study Site

An ethno botanical study was carried out in Butebo County composed of five sub-Counties of; Kakoro, Kabwangasi, Petete, Butebo and Kibale in Pallisa District, located in Eastern Uganda (Fig. 1). The study was aimed at documenting medicinal plant species used in treating malaria and fever among the local people. The study was conducted during dry and rain seasons in December - January and April-August respectively in 2014. This was aimed at targeting plants that grow in dry and wet seasons.

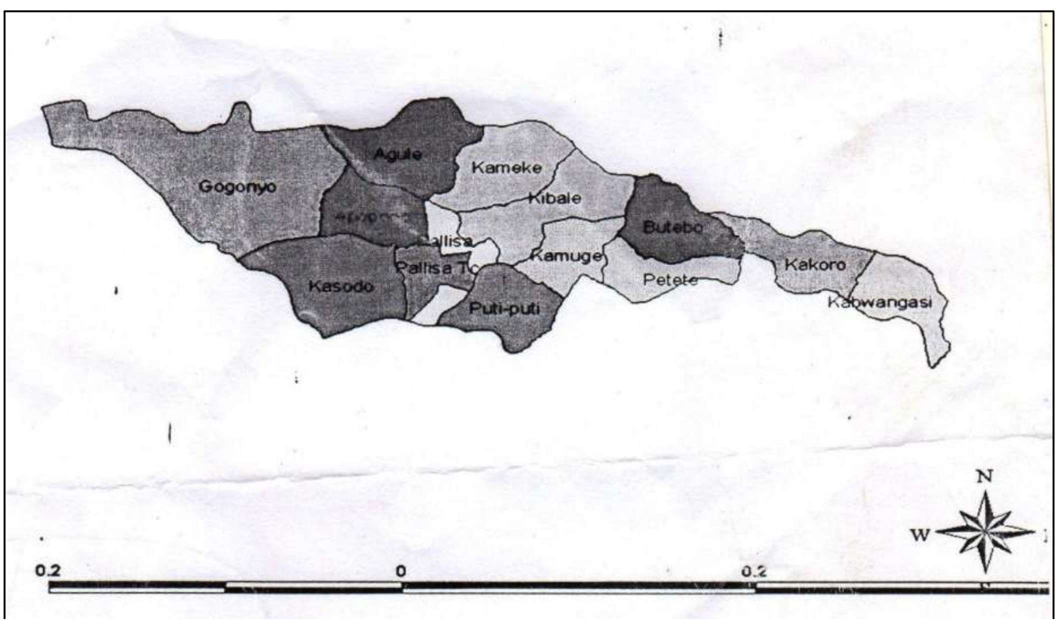

Fig. 1. Map of Pallisa District showing the five Sub-counties of Butebo County

2.2 Collection of Ethnobotanical Information and Plant Identification

Semi–structured, open and closed ended questionnaire were administered to traditional healers and herb sellers. These were selected by specific practitioners who knew those that are genuine to obtain information on commonly used herbs for antimalarial remedies. The questions in the questionnaire were translated in the two local languages used, Ateso and Lugwere for better understanding by the respondents. Information collected included knowledge on the use of medicinal plant species, the local names of important plant species, parts of plant used, dosage, methods of herbal preparation, mode of administration, and duration of treatment, traditional uses and other questions. A total of 50 households were interviewed comprising of ten respondents from each sub County. Field surveys were done on farm land, in forest reserves to identify the plants, area of collection and also to study the general status of the plants. Medicinal plants were photographed, collected, dried and taken for identification by a taxonomist. The voucher specimens were deposited at the Department of Botany herbarium for future specifications.

2.3 Data Analysis

In order to analyze ethno botanical information, Microsoft Excel package 2013 was used where descriptive statistical methods were employed. The information obtained through the ethno botanical interviews was analyzed and expressed as percentages. Pie charts and bar graphs were used to express the following parameters: Taxonomic diversity, growth forms, habitants, modes of preparation, parts of the plant used to treat malaria. The percentage of people who have knowledge about the use of a species in the treatment of malaria was evaluated using the formula: $PPK = \frac{NPICP}{TNPI} \times 100$; where: PPK = percentage of people who have knowledge about the use of a species in the treatment of malaria, NPICP = number of people interviewed citing species, TNPI = Total number of people interviewed. Preference ranking (PR) method was also employed, where plants are ranked according to their level of effectiveness in the treatment of malaria by the local people. Each rank was given an integer (1, 2 or 3) with the most effective plants assigned a value of 3 [5]. Availability of literature of previous studies on the plants identified e.g., as ant malarial plants, antiplasmodial and toxicity activity tests, clinical trials, extraction solvents utilized was also done. Phytochemical compounds isolated from the antimalarial plants were used to find out the previous research that had been investigated.

3. RESULTS AND DISCUSSION

3.1 Plant Information and Taxonomic Diversity

Thirty three plant species from 30 genera that consisted of (*F. virosa, S. longipedunculata, E. abyssinica, M. azedarach, C. edulis, H. abyssinica, Z. chalybeum, P. guajava, C. sinensis, S. pinnata, L. camara, C. papaya, M. indica, A. indica, P. americana, B. pilosa, C. citratus, P. barbatus, M. senegalensis, C. reticulate, O. gratssiumum, O. basilicum, C. macrostachyus, O. spinosa*, *S. araliacea, A. sieberiana, O. trachycarpum, A. hockii, E. latideus, C. hirsuta* and *C. nigricans, B. paradoxum, A. tomentosa*) were identified as being used by communities as antimalarial plants. Twenty three plants have been already document in literature as antimalarial medicinal plants in Uganda and other Countries. The 33 medicinal plants belong to 23 families of: Rutaceae, Lamiaceae, Euphorbiaceae, Mimosaceae, Celastraceae, Meliaceae, Asteraceae, Papillionaceae, Polygalaceae, Flacourtiaceae, Umbelliferae, Sapotaceae, Apocynaceae, Simaroubaceae, Ebenaceae, Aristolochiaceae, Anacardiaceae, Caricaceae, Lauranceae, Myrtaceae, Verbenaceae, Poaceae and Celastraceae. All the medicinal plants were reported in the two local languages used which included Ateso and Lugwere. The most frequently used medicinal plants were from the families; Rutaceae and Lamiaceae (13.0% each) that had three plant species each. This was followed by Euphorbiaceae, Mimosaceae, Celastraceae, Meliaceae, Asteraceae and Papillionaceae (8.7% each) with two plant species each. The remaining fifteen families Polygalaceae, Flacourtiaceae, Umbelliferae, Sapotaceae, Apocynaceae, Simaroubaceae, Ebenaceae, Aristolochiaceae, Anacardiaceae, Caricaceae, Lauranceae, Myrtaceae, Verbenaceae, Poaceae and Celastraceae with 4.3% had one plant species each (Fig. 2). Ten species (30.3%) were identified and documented for the first time in Uganda to treat malaria these included: *O. spinosa, S. araliacea, A. sieberiana, O. trachycarpum, A. hockii, E. latideus, C. hirsuta*, *C. nigricans*, *A. tomentosa* and *B.*

paradoxum. Information on the correct identification of these medicinal plants that include the species name, families, local names, plant parts used, preference ranking and other diseases treated including malaria are shown in Table 1. Among the plants identified: *C. nigricans* (90%), *Z. chalybeum* (84%), *S. pinnata* (80%), *O. basilicum* (78%), *E. latideus* (74%), *E. abyssinica* (72%), *A. indica. and O. spinosa* (70%) had the highest PPK values with corresponding PR values of 3, 3, 3, 2, 3, 2, 3 and 3 respectively. *A. hockii* (28%), *C. papaya* (26%), *C. reticulate, M. indica. and C. macrostachyus* (24%) each *and A. tomentosa* (8%) had the lowest PPK values with PR values of 2, 2, 2, 1, 2, 2 respectively (Table 3). The high PR values are in agreement with the plants that had high PPR values (Table 3) used in treating malaria. An ethnobotanical survey in Ghana by [5] and in Nigeria by [6] identified that *A. indica* had the highest PPK values of 29.3%, 12.8% and PR values of 2, 3 respectively. *C. citratus* was documented as one of the plants with the highest value of PPR and PR of 11.3 and 3 respectively second to *A. indica* [6]. The information on frequently used antimalarial plant species is also an important lead to the species that can be targeted for antiplasmodial tests, toxicological tests, and phytochemical analysis. This was also noted [11] that plant species with high fidelity level values are considered potential candidates for further pharmacological investigations and deserve priority investigations.

The antimalarial plants that have been documented in Uganda and other Countries and cited in this study are: *F. virosa, S. longipedunculata, E. abyssinica, M. azedarach, C. edulis, H. abyssinica, Z. chalybeum, P. guajava, C. sinensis, S. pinnata, L. camara, C. papaya, M. indica, A. indica, P. americana, B. pilosa, C. citratus, P. barbatus, M, senegalensis, C. reticulate, O. gratssiumum, O. basilicum, C. macrostachyus*.

The families of Lamiaceae and Rutaceae had the highest number of species documented, this information is in agreement with results from other researchers [12] which showed the same trend. The 23 antimalarial documented plant species in this study are high compared to other similar ethnobotanical surveys done in Uganda. For example only 20 were documented in Cegere Sub-county [13], 20 medicinal plants in Kibale [8], 20 species in Mbarara District [14]. However the number was lower compared to surveys in other regions in Uganda that include: Twenty three species in the Sango bay area [15], 27 plant species Budiope county [16], 48 in Nyakayojo, Mbarara District in Western Uganda [17] and 86 species in Mpigi District, Central Uganda [18].

3.2 Respondent Details

A total of 50 respondents interviewed comprising of females (34%) and males (66%) with age groups of 20 or less (0%), 21-30 (8%), 31-40 (14%), 41-50 (16%), 51-60 (24%), and above 60 (38%) with the highest number of people interviewed. They consisted of mainly Bateso (68%) and Bagwere (32%) whose main occupation is farming. The educational background consisted of 34% with no formal education, 20% had reached Primary level, 44% had Secondary education and those with tertiary education were 2% (Table 2).

The females (34%) had the least number while males (66%) the highest. This was in agreement with other ethnobotanical studies carried out [13] who had the highest value (53.3%) of the respondents as males while the rest were females. In an ethnobotanical survey conducted [19] had the highest number of males compared to females (41.8% females and 58.2% males). In the African culture the belief is that traditional healers should be male [20]. In society older people aged between 51-80 years for example in this study (62%) had more knowledge on medicinal plants and their uses. This is due to long direct contact with plant resources than young people. On the other hand, younger people have little interest in traditional medicine in general and there appears to be a risk of knowledge loss if nothing is done to motivate them. Younger people are exposed to modern education and therefore not interested in learning and practicing ethnomedicinal wisdom that would give them indigenous knowledge. Differences in medicinal plants knowledge among age groups was also reported in other studies investigated [21] in Ethiopia. The respondents were dominated by the Ateso (68%) who had a strong background in knowledge on medicinal plants than the Bagwere (32%). The highest level of education attained was that of tertiary institution. Most of the respondents were educated up to the level of Secondary education (98%).

Table 1. Taxonomic diversity, growth forms, plant parts, local names, habitats of medicinal plants and diseases

	Botanical name	Family name	Local name(s)	Parts used	Growth habit	Habitat	Other Diseases treated
1	*Croton macrostachyus Olive* KP 900	Euphorbiaceae	Ookota	R & S	T	GL	Stomach ache, TB, coughs, fever, asthma, skin diseases
2	*Flueggea virosa (wild) Voigt* KP 901	Euphorbiaceae	Alakasi	R & L	SH	WG	Chest pains, miscarriage,
3	*Ocimum basilicum* KP 902	Lamiaceae	Emopim	L	H	G	Fever, eye cataract, headache
4	*Securidaca longipedunculata Fresen./* KP 903	Polygalaceae	Eliloi	R	SH	OG	Measles, Body pains, cough hernia, Snake bite, ticks control skin disease, Infertility, Diarrhoea, tooth ache
5	*Ocoba spinosa Forrsk* KP 904	Flacourtiaceae	Ekalepulepu	R	SH	GL	Epilepsy, syphilis, wounds, skin disease, Headaches Sexual impotence, Stomach ache
6	*Steganotania araliacea* KP 905	Umbelliferae	Ematule	R & L	T	OG	Swollen body, measles
7	*Erythrina abyssinica* KP 906	Papilionaceae	Engosorot	R	T	GL	TB, Stomach ache, tooth ache, Deafness, sterility, Uterine fibroids Fever, Leprosy, arthritis, body swellings, burns Syphilis
8	*Acacia sieberiana.* KP 907	Mimosaceae	Etiriri	R	T	WG	Cough, epilepsy, dysentery
9	*Ormocarpum trachycarpum* KP 908	Papillionaceae	Ederut	R	SH	GL	Snake bite, pneumonia
10	*Melia azedarach* KP 909	Meliaceae	Elira	L	T	HS	Parasitic worms, Fever, skin disease & itching Wounds, Body pains
11	*Butyrospermuum paradoxum* KP 910	Sapotaceae	Ekunguri	R	T	WG	Labour pains, headaches
12	*Carrisa edulis*	Apocynaceae	Ekamuriei	R	SH	WG	Cough, epilepsy, syphilis,

	Botanical name	Family name	Local name(s)	Parts used	Growth habit	Habitat	Other Diseases treated
	KP 911						Diarrhoea, snake bite, measles dysentery, fever, chest pain, headaches, TB, Polio
13	*Harrisonia abyssinica Olive.* KP 912	Simaroubaceae	Ekeroi	R & L	SH	WG	Syphilis, snake bite, Fever, wounds, abdominal pains (menstruation)
14	*Acacia hockii De willd* KP 913	Mimosaceae	Ekisim	R	T	OG	Diarrhoea, dysentery, syphilis
15	*Euclea latideus Staff* KP 914	Ebenaceae	Emusi	R	SH	GL	Swelling of legs, ringworms
16	Cassia hirsuta. KP 915	Caesalpinioideae	Kasagalansansi	R	H	RS	stomach ache
17	*Zanthoxylum chalybeum* KP 916	Rutaceae	Eusuk	R & L	T	WG	Fever, Coughs, Colds, Chest Body swellings, Stomachaches
18	*Chamaecrista nigricans Greene./* KP 917	Caesalpiniaceae	Epeduru lo didi	L	H	G	Hypertension, labour promotion, retained placenta
19	*Schkuhria pinnata* KP 918	Asteraceae	Apunait	L	H	G	chest pains, treatment of ears, wounds, skin diseases, diabetes
20	*Aristolochia tomentosa Sims* KP 919	Aristolochiaceae	Kankapu	S	C	GE	Wounds, snakebites, skin diseases
21	*Mangifera indica.* KP 920	Anacardiaceae	Omuyembe	L	T	HS	Venereal diseases, pain killers Diarrhea, dysentery, cough fever, cough, syphilis
22	*Carica papaya.* KP 921	Caricaceae	Papali	L	T	HS	Cough, cancer, snake bite sterility, pain killers, antidotes promotes labour,
23	*Persea americana Mill.* KP 922	Lauranceae	Ovakedo	L	T	HS	Antibacterial, antifungal, worms & parasites, high blood pressure, wounds, cough
24	*Azadirachta indica.* KP 923	Meliaceae	Neem	L, R, SD & RB	T	HS	Cough, syphilis, skin disease chicken pox, vomiting, fever, lice, diabetes, obesity, Nausea
25	*Psidium guajava* KP 924	Myrtaceae	Mapera	L & RB	T	HS	Cough, wounds, typhoid, measles, diarrhoea, dysentery,

	Botanical name	Family name	Local name(s)	Parts used	Growth habit	Habitat	Other Diseases treated
							fever, diabetes, small pox
26	*Lantana camara* KP 925	Verbenaceae	Kanpanga	L	SH	RS	TB, pneumonia, chest pain, snake bite, wounds, measles, ringworms
27	*Citrus sinensis.* KP 926	Rutaceae	Omucungwa	R	T	HS	Cough, reduce vomiting, diabetes
28	*Cymbopogon citratus* KP 927	Poaceae	Akisube	L	H	C	Cough, cancer, fever, indigestion
29	*Bidens pilosa* KP 928	Asteraceae	Kalala	L, WP & R	H	G	Wounds, skin diseases, diabetes
30	*Plectranthus barbatus* KP 929	Lamiaceae	Ebiriri omutano	L, S, R & WP	H	G	Snakebites, fever, heart diseases,
31	*Maytenus senegalensis* KP 930	Celastraceae	Echomai	R	T	F	Toothaches, wound healing, skin diseases, respiratory treat-ment, chest pain, fever
32	*Citrus reticulata.* KP 931	Rutaceae	Omuqugwa	R	T	C	weight reduction, cancer skin diseases
33	*Ocimum gratissimum* KP 932	Lamiaceae	Omujaja	L	H	G	Chest pain, treatment of ears

Stem (S), Root (R), Leaves (L), Root bark (RB), Seeds (SD), Whole plant (WP), Tree (T), Shrub (SH), Herb (H), Climber (C), Grassland (GL), Wooded grassland (WG), Open grassland (OG), HS- homestead (HS), Road side (RS), Garden edge (GE), Garden (G)

3.3 Indigenous Knowledge on the Antimalarial Medicinal Plants

The local communities in Butebo County use also the antimalarial medicinal plants for the treatment of other different diseases. These include: gynecological issues, digestive disorders, skin infections, respiratory tract infections, arthritis and inflammation, neurological and nervous system disorders, erectile dysfunction and impotence, poisonous animal bites, hypertension, painful body parts, body odour, headaches and fatigues, diabetes, STDs and venereal diseases and others as shown in Table 1.

The use of one plant to treat several ailments is probably attributed to presence of many metabolites in one particular plant. Also the same molecule can be active against different pathogens. Most of the medicinal plant species collected and identified in the study area were also used in other regions of Uganda and other parts of Africa to treat the same or different ailments. The use of the same plant species for similar or different ethnomedicinal uses in different countries is a reliable indication of the bioactivity potential of the documented plant species [22]. Using the same species in different cultures over a long period suggests strongly that these species may be effective in the treatment of malaria [23]. It is however, important to validate all claims of therapeutic efficacy and safety. This should be done by undertaking pharmacological, toxicological, and controlled clinical studies. Validation of traditional medicinal practices is important because it may generate higher confidence and therefore wider use of such species. Wider acceptance of traditional herbal remedies can yield significant benefits for primary health care. They can also extend the market and create value addition for the herbal medicines.

All the respondents reported that the patients received included both men and women of different age groups ranging from children to elder people. The number of patients received on daily basis ranged between an averages of 6-10. These were diagnosed using symptoms of the disease and interviewing the patient. The patient's preferred decoctions and infusions (Table 3), which were prepared from either boiling water or hot water. Some diseases were reported to have been treated successfully after failing to be treated in clinics or hospitals. The sources of information about the medicinal plants were got from parents, grandparents, in laws and through dreams. This information included the dose of the medicinal plants and part of the plant used to treat the diseases. The information was kept from being lost by passing it on to next chosen person in the clan especially those who were still energetic. This explains the reason why the plants were collected and prepared by only the family members so that the information could not be passed on to other families. Most of the respondents reported that they were not willing to share the information about the medicinal plants. This was because the medicinal plants generate income to specific families. Poverty, availability, being cheap and effective, lack of medicine in hospitals and distant medical facilities were cited by respondents as reasons for preferring medicinal plants to modern synthetic medicine. The same reasons were also noted [13] in their study of antimalarial plants in Cegere Sub-County, Northern Uganda in an ethnobotanical survey that they conducted. Some healers cited that some plants were effective but not used because of being poisonous. There were also side effects caused by some medicines that were over came by reducing the dose or stopping the medication. The expiry date was determined by the formation of moulds, acquiring bad smell, change of colour and fermentation of the medicinal preparations. The old and expired medicines were either thrown away or destroyed by burning.

Table 2. Demographic data of the respondents

Age (years)	**N (%)**
0-20	0(0)
21-30	4 (8)
31-40	7 (14)
41-50	8 (16)
51-60	12 (24)
61-90	19 (38)
Sex	**N (%)**
Male	33 (66)
Female	17 (34)
Tribe	**N (%)**
Bateso	34 (68)
Bagwere	16 (32)
Education status	**N (%)**
No formal education	17 (34)
Primary education	10 (20)
Secondary education	22 (44)
Tertiary education	1 (2)

Table 3. Species names, mode of preparation, administration, PPK and PR values

	Botanical name	Mode of preparation	Administration	PPK	PR
1	*Croton macrostachyus Olive*	Decoction	Drinking	24	2
2	*Flueggea virosa (wild) Voigt*	decoction	Drinking	54	2
3	*Ocimum basilicum*	Infusion	Drinking	78	2
4	*Securidaca longipedunculata*	decoction	Drinking	34	3
5	*Ocoba spinosa Forrsk*	decoction	Drinking	70	3
6	*Steganotania araliacea Hoeshst*	decoction	Drinking	58	2
7	*Erythrina abyssinica DC*	decoction	Drinking	72	2
8	*Acacia sieberiana DC Var A.*	decoction	Drinking	66	3
9	*Ormocarpum trachycarpum*	decoction	Drinking	48	2
10	*Melia azedarach L.*	decoction	Drinking	56	1
11	*Butyrospermuum paradoxum*	decoction	Drinking	52	2
12	*Carrisa edulis*	decoction	Drinking	68	2
13	*Harrisonia abyssinica Olive.*	decoction	Drinking	42	3
14	*Acacia hockii De willd*	decoction	Drinking	28	2
15	*Euclea latideus Staff*	decoction	Drinking	74	3
16	*Cassia hirsuta L.*	Infusion	Drinking	38	2
17	*Cymbopogon citratus (DC)*	decoction	Drinking	56	3
18	*Zanthoxylum chalybeum Engl.*	decoction	Drinking	84	3
19	*Chamaecrista nigricans Greene*	Infusion	Drinking	90	3
20	*Schkuhria pinnata (lam.)*	Infusion	Drinking	80	3
21	*Citrus sinensis (L) Osb.*	decoction	Drinking	34	1
22	*Aristolochia tomentosa Sims*	Infusion	Drinking	8	2
23	*Mangifera indica L.*	decoction	Drinking	24	1
24	*Carica papaya L.*	decoction	Drinking	26	2
25	*Lantana camara*	decoction	Drinking	40	2
26	*Persea americana Mill.*	decoction	Drinking	44	2
27	*Azadirachta indica A. Juss.*	decoction & infusion	Drinking	70	3
28	*Psidium guajava*	decoction	Drinking	52	2
29	*Bidens pilosa*	Infusion	Drinking	36	2
30	*Plectranthus barbatus*	Infusion	Drinking	30	2
31	*Maytenus senegalensis*	Decoction	Drinking	60	3
32	*Citrus reticulata*	decoction	Drinking	24	2
33	*Ocimum gratissimum*	decoction	Drinking	50	2

In order to promote the herbal medicines in future the respondents reported that there should be registration of all the people involved in herbal medicinal practice for recognition. They also recommended the legislation of a policy to stream line the herbal medicine treatment. This was to assist them know each other in to order to form associations that would assist them to look for funding and training in standard practices to improve on the quality of the medicines. They also cited lack of scientific testing (efficacy and safety), deforestation and storage as major challenges in the practice of the herbal medicine. They could not determine the correct dose of the preparations and it was becoming difficult to find the raw materials (plants) for the medicines.

3.4 Growth Forms of Plants, Habitats and Plant Parts Used

The most commonly used plant part was the roots (44.68%), followed by leaves (38.30%), stem (6.38%) each, root bark and whole plant (4.30%) each, the least was the seeds with 2.13% (Fig. 3). The growth habits included; trees (48.48%) with the highest value, followed by shrubs and herbs (24.24% each) and the climbers with the least percentage of (3.03%) (Fig. 4). The largest habitat of the medicinal plants was found in the homesteads (21.10%), followed by wooded grassland and garden with (18.20%), grasslands (15.20%), open grassland (9.10%), cultivated and roadside (6.10%), garden edge and forest had the lowest value of 3.0% each (Fig. 5). Information on growth forms, habitats and plant parts used is summarized in Table 1. Other ethnobotanical surveys [14,4,19] also showed that roots had the highest percentage of the plant parts used followed by leaves. The results got from the growth habits above had the same findings as cited by [5,4] in their ethnobotanical surveys of antimalarial plants. The homesteads that occupied the largest habitat was also cited [13] in their survey of antimalarial medicinal plants in Uganda.

Collection of the bark and root is damaging and makes species vulnerable to over exploitation. Harvesting the bark in large quantities can destroy the plant because the protective role of the bark to the plant will be destroyed. On the other hand uprooting plants especially in case of herbs and shrubs causes total destruction of the plant. Debarking and uprooting of medicinal plant species negatively affects the sustainability of the species in use. Harvesting of roots on the other hand is more destructive as it often involves uprooting whole plants which consequently affects regeneration for sustainable use.

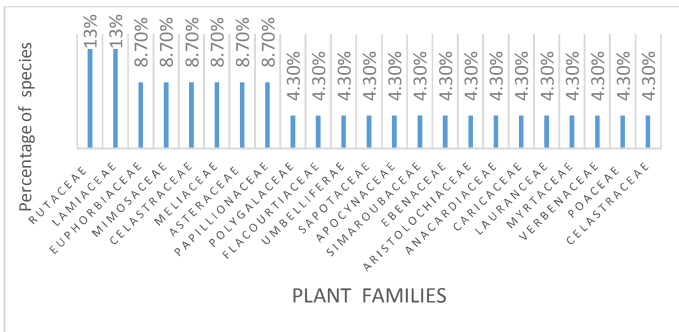

Fig. 2. Plant families

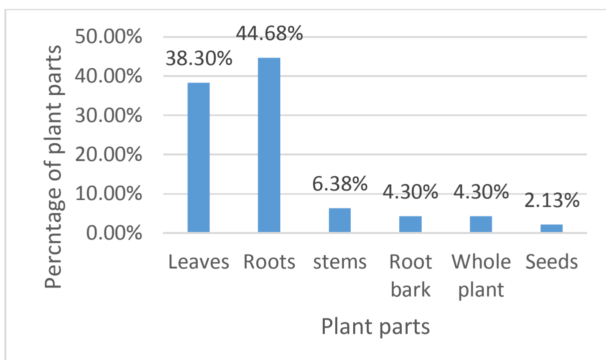

Fig. 3. Medicinal plant parts used

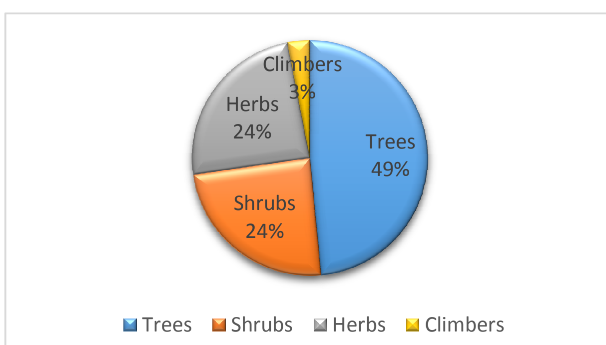

Fig. 4. Growth habits of medicinal plants

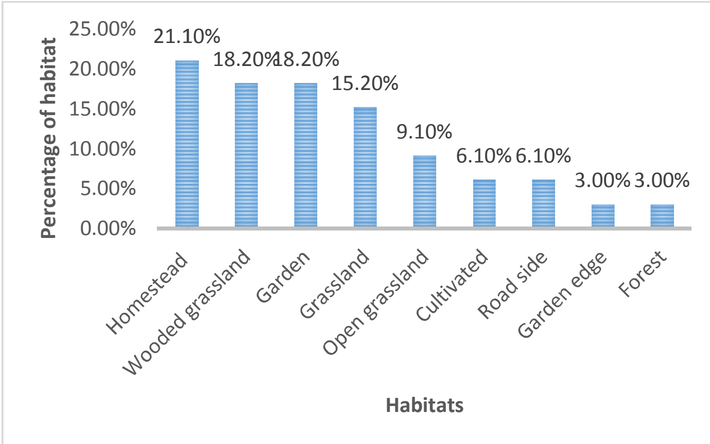

Fig. 5. Habitats occupied by the plant

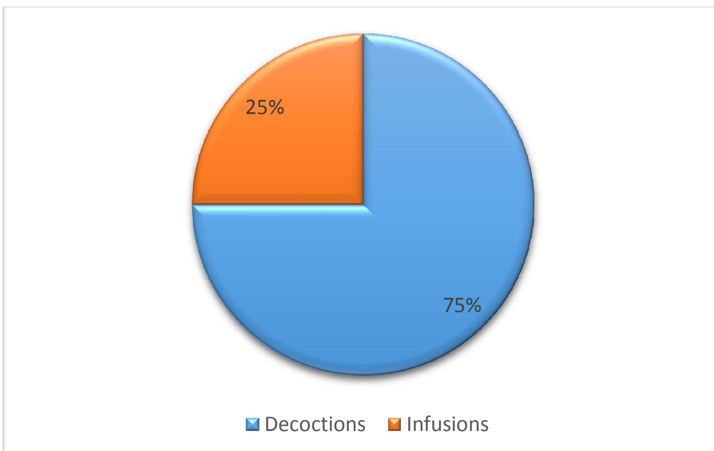

Fig. 6. Modes of preparation of herbal medicines

F. virosa, S. araliacea, H. abyssinica, Z. chalybeum, P. guajava, B. pilosa, P. barbatus, A. indica A. Juss. and *C. macrostachyus* (Table 1), have more than one plant part that is used. Preserving of these plants may be achieved if the harvesting of bark and root is avoided and harvesting of leaves which is less destructive is promoted. The use of leaves is less destructive if small quantities are collected but not so if large quantities are harvested. Most studies have shown that leaves of different plants possess bioactive ingredients against different diseases and pathogen [24,25]. Since harvesting of leaves is less destructive than harvesting roots or barks, it is necessary to test leaves for efficacy against different diseases.

This should be for those plants where roots and barks are mostly harvested to minimize dangers of over exploitation. Leaves of *A. indica* [26], *S. longipedunculata* [27], *L. camara* [28], *C. papaya* [29], *and P. guajava* [29] have been found to be effective against malaria therefore the harvesting roots of this plants can be avoided. Since shrubs are slightly draught resistant and available in all seasons of the year they are preferred because they are not affected by the changes in the season. Therefore in order to preserve the medicinal plants it better to harvest plant parts that do not destroy the whole plant or the harvesting should not be done continuously and in large quantities.

3.5 Herbal Preparation and Administration

Most of the plant materials were dried in the shade, pulverized into a powder and taken orally as water decoctions (76.50%) with the highest percentage and infusions (23.50%) as shown in Fig. 6. The decoctions and infusions were taken as single monotherapy preparations. However the some respondents reported mixing more than one plant in their preparations in the treatment of other diseases. A summary of the species name, mode of preparation, method of administration, PPK and PR values is shown in Table 3. The preparations were made by boiling the medicinal plant powder in water and adding 2-5 spoons of the powder to a half a liter of hot or cold water taken twice daily for about a week. The dose taken depended on the age of patient, but some respondents reported that sometimes weight was considered to determine the dose. This was also cited in other antimalarial ethnobotanical surveys [16,13]. This explains why some medicines have to be taken for a longer period of time and also it may lead to under dose or over dose. Therefore the posology of these herbal medicines has to be determined for effective treatment of malaria in the communities. Some preparations were always prepared instantly to increase their effectiveness while others were available in stored form. The stored medicines were kept in closed containers and in the dark to avoid contamination and degradation by sunlight respectively. The storage containers consisted of; plastic papers, plastic bottles and glass bottles that were labelled by names and part of the plant used. Most of the respondents reported that the stored medicines were used within a period of not more than 6 months to avoid changing into poisonous substances. This was done to avoid the decrease in the effectiveness and fermentation which is caused due long periods of storage.

Decoctions and infusions been cited elsewhere as the most common method of preparation of herbal remedies. Other ethnobotanical surveys have also cited that most herbal preparations are taken orally as decoctions and infusions [14,15]. The choice of oral administration may be related to the use of some solvents such as water that are commonly believed to serve as a vehicle to transport the medicine. Boiling is effective in extracting plant materials and at the same time preserves the herbal remedies for a longer period compared to cold extraction. However, both decoctions and cold extracts do not offer long shelf life for the preparations. This implies the herbalist continuously harvest medicinal plants which puts them under a lot of pressure that may lead to over exploitation.

3.6 Antiplasmodial and Toxicity Activities done on Some Medicinal Plants

Twenty three species (69.70%) have been documented as antimalarial medicinal in Uganda and other parts of the world mainly East Africa and other regions of Africa. Extraction solvents of different polarity included; water, ethanol, dichloromethane, ethyl acetate, methanol, petroleum ether, chloroform, acetone and n-hexane. A wide range of phytochemical compounds have been isolated and screened from these medicinal plants that are responsible for different biological activity. Antiplasmodial bioassay activity screening was tested using the *in vitro* and *in vivo* models against different strains of parasite to test for the efficacy of the plants.

In their review of potential antimalarials from African natural products [30] found out that a total of 652 plant species from 146 families and 4 insects/products were documented. The activities of 558 plants were found to be reported *in vitro,* while 94 were reported *in vivo*. Plants species from family Asteraceae (11.04%), Mimosaceae (8.128%), Euphorbiaceae (5.52%), Rubiaceae (5.52%), Apocyanaceae (5.214%), Rutaceae (4.90%), Anonaceae (3.844%), Meliaceae (3.844%), Lamiaceae (3.52%), Combrataceae (2.76%), and Poaceae (2.60%) have received more scientific validation than others. About 36.80% of plants reviewed were grown in West Africa especially Nigeria, Benin, 31.90% from South Africa, 13.03% from North Africa, 10.88% from Central Africa while 7.36% of the plants were grown in East Africa. Findings from their review show that East Africa as a region still has many antimalarial plants that have not been documented and investigated. Some of the families reviewed in their study were also cited in this study these included; Asteraceae, Euphorbiaceae, Meliaceae, Lamiaceae, Poaceae, Apocyanaceae, Rutaceae and Mimosaceae.

Studies on antiplasmodial screening and toxicity tests have been carried out to support the ethnobotanical use and therapeutic claims of the communities in Butebo County. These scientific studies include that of the 23 plant species that have been cited in this study. These plants have been reported to contain antiplasmodial activity against different strains of *P. falciparum* parasites. Among the plants from South Africa screened against *Plasmodium falciparum* on chloroquine (CQ) sensitive strain D10 included

Flueggea virosa leaves (IC_{50}, 19 µg/ml) [31]. In Kajiado district, Kenya, [32] reported some of the species as having antiplasmodial activity against sensitive *P. falciparum* clone D6 which was rather high this included *C. edulis* root bark (IC_{50}, 6.41 µg/mL). while screening CQ resistant *P. falciparum* strain KI against plant extracts from Tanzania [33] found *M. senegalensis* root bark (IC_{50}, 0.62 µg/mL), *Z. chalybeum* root bark (IC_{50}, 4.2 µg/mL) to have the strongest antiplasmodial activity among the plant species tested. Some pure compounds have been isolated in Rwanda from *Z. chalybeum* root bark EtOH crude extract. These compounds include; chelerythine; methyl canadine and nitidine. These compounds when screened against chloroquine resistive *P. falciparum* 3D7 strain gave IC_{50} values of 1.35, 2.01 and 0.17 µg/mL respectively [34].

A study in Kenya screened CQ sensitive *P. falciparum* NF54 and CQ resistant ENT30 strains against crude plant extracts from Meru and Kilifi districts [35]. Their investigation found that *H. abyssinica* root bark (IC_{50}, 72.66 µg/mL) was active. In a study that screened some medicinal plants from Sudan against CQ sensitive *P. falciparum* 3D7 and resistant Dd2 strains [26] found *A. indica* leaves (IC_{50}, 5.8 and 1.7 µg/mL, for 3D7 and Dd2, respectively). In Nigeria *in vivo* studies have been investigated on *A. indica* leaves and bark to support the *in vitro* finding above. Aqueous extracts at a dose of 800 mg/kg were tested on mice infected with *P. y*eolii. The results showed a high inhibition of 79.6 and 68.2% for the suppressive and curative model tests [36]. One of the pure compounds isolated from *A. indica* in a study from Nigeria was a triterpenoid called Gedunin from a methanol crude extract of the leaves. Antiplasmodial activity was screened on this compound against chloroquine resistant *P. falciparum* W2 parasite and found to have IC_{50} of *0.02* µg/mL [37].

Aqueous extracts of *S. pinnata* administered intra-peritoneally have been observed to suppress the growth of parasites *in vivo* in mice by 64%, with no observed toxicity [4]. *S. pinnata* is widely used and believed to be an efficacious antimalarial medicinal plant. Preliminary information from literature suggests it is safe and bioactive, with low toxicity values (LC_{50}) below 1000 µg/mL [38]. In South Africa other studies have been done on *S. pinnata* DCM/MeOH (1:1) crude extracts of the whole plant against *P. falciparum* NF parasite to give IC_{50} of 2.19 µg/mL [39]. In the same investigation they isolated two pure compounds Schkuhrin I and Schkuhrin II which were screened on *P. falciparum* NF-54 and NF strains to give IC_{50} of 2.05 and 1.67 µg/mL respectively. These results show that both crude extracts and pure compounds are effective antimalarial remedies.

Mature leaves of *C. papaya* are widely used to treat malaria. In a study conducted in Nigeria on petroleum ether, dichloromethane, methanol and aqueous crude extracts of the leaves [29] screened the extracts on *P. falciparum* to give IC_{50} values of 16.4, 2.6, 10.8 and >50 µg/mL respectively. This may be indicative of the presence of highly active compounds in this plant.

C. citratus is one of the most common herbs in Cameroon and other countries used to treat malaria and other fevers. The essential oils extracted from fresh leaves of this plant were active in the four-day suppressive *in vivo* test on *P. berghei* in mice giving IC_{50} from 6 to 9.5 µg/mL [40]. In Nigeria an investigation was carried out on antiplasmodial activity using solvents of different polarities (petroleum ether, DCM, MeOH and aqueous). Extracts of the leaves gave IC_{50} (9.1, 7.6, 12.1 and 15.9) µg/mL against *P. falciparum* parasites [29]. In studies on mice infected with *P. berghei* on crude extracts of ethanol of the leaves and the bark at doses of 200, 400 and 800 mg/kg using suppressive, curative and prophylactic models [41,42] got results that were dose dependent. The inhibitions were (82, 84, 99/66, 74, 83/43, 56, 70) % at the dose of 200, 400 and 800 mg/kg for the extracts from the leaves. The antiplasmodial results above show that the plant is an effective remedy against malaria which supports its use in the communities.

An evaluation was done using the *in vitro* antimalarial activity on *M. indica*, which is grown widely in Cameroon and other Countries for its fruits as food. The chloroform: methanol (1:1) extract showed a good activity on *P. falciparum in vitro* with a growth inhibition of 50.4% at 20 µg/mL [43].

In an investigated on essential oils from the leaves of *O. gratissimum* against local isolates of *P. falciparum* [40] found the activity to be high, with IC_{50} from 6.9 to 14.9 µg/mL. In Congo [44] studies on aqueous leaf extracts against the same parasite strain gave an IC_{50} of 7.25 µg/mL. The above the activity data supports the ethnobotanical use of this plant for the treatment of malaria.

A study was carried out on *P. guajava* using the parasite lactate dehydrogenase (pLDH) assay method [45]. This method is an *in vitro* enzymatic method for evaluating antiplasmodial activity. Among the aqueous leaf, stem-bark and fruit extracts tested on the chloroquine-sensitive *P. falciparum* D10 strain, the stem bark extract was the most active, with IC_{50} of 10–20 µg/mL.

The dichloromethane extract of the leaves of *S. longipedunculata* from Mali has shown antiplasmodial activity with an IC_{50} of 6.9 µg/mL against chloroquine sensitive D6 *P. falciparum* [27]. The methanol extract of the root suppressed *P. berghei* by 82% at a dose of 0.56 mg/kg [46]. The organic crude root extracts of this plant showed the highest chemo suppression value of 91.03% [47]. This was not significantly different ($p<0.05$) from that induced by chloroquine. Extracts of *S. longepedunculata* had high levels of toxicity among the four plants tested in its organic extracts at a single dose of 2,000 mg/kg. The reported toxicity was attributed to the presence of tannins and saponins in large quantities compared to alkaloids and flavonoids which were also present in the tested crude extract. This validates the ethnopharmacological use of the plant species in treating patients with malaria associated symptoms however precaution must be taken about the toxicity of the plant.

An *in vivo* antiplasmodial activity of 80% methanol extract and solvent fractions was carried out on the leaves of *C. macrostachyus* in rodent model of malaria [48]. The chemotherapeutic effect of the crude extract and chloroform fraction was in the ranges of 39-83% and 66-82%, respectively. Another study was conducted [48] i Ethiopia on methanol leaf extracts against *P. berghei* at doses of 200 and 400 mg/kg in the suppressive model to give inhibitions of 39% and 69% respectively. The results collectively indicate that the plant has a promising antiplasmodial activity against *P. berghei,* which supports the earlier *in vitro* findings as well as its traditional use. Therefore it could be considered as a potential source to develop new antimalarial agents.

In their *in vivo* study on *L. camara* methanol root extracts the percentage chemo suppression of 60.04% and 72.66% for 250 and 500 mg/kg of body weight of the extracts, respectively [28]. Another study also analyzed and showed very promising activity of dichloromethane extract of the leaves from *L. camara*. (Pink flower) [49]. This was tested using *in vitro* assay against cultures of chloroquine-sensitive (3D7) and chloroquine resistant (W2) strains of *P. falciparum* to give (IC_{50} 8.7±1.0 µg/mL and 5.7±1.6 µg/mL, respectively). Both *in vivo* and *in vitro* results showed good antiplasmodial activities which supports the use of the plant by the local people.

Other plants cited in this study that have been scientifically validated through research include *M. azedarach.* In Congo methanol and dichloromethane crude extracts of the leaves have been tested against chloroquine-sensitive (3D7) strains of *P. falciparum* to give IC_{50} 55.13 and 19.14 µg/mL respectively [50]. Investigations were conducted on *B. pilosa* dichloromethane leaf extracts in South Africa against chloroquine-sensitive (D10) strains of *P. falciparum* (IC_{50} 8.5 µg/mL, [52]). In their study [51] on ethanol leaf extracts of *C. reticulate* against chloroquine-sensitive D6 strain got an inhibition value of 33% at a concentration of 15.867 µg/mL. An investigation was carried out using the *in vivo* antiplasmodial activity assay on 70% ethanol extract of *C. sinensis* [52]. In their study doses were administered at 300, 500 and 700 mg/kg to give percentage suppression of parasitaemia of 33.65, 43.93 and 53.27%. An *in vivo* study in Nigeria on ethanol leaf extract of *O. basilicum* against mice infected with *P. berghei* was determined. The suppressive, curative and prophylactic models at doses of 200, 400 and 800 mg/kg was investigated [42]. The results for their investigation were (50, 58, 76) %, (61, 69, 82) % and (34, 45, 60) % at the above dose levels respectively.

Some of the *in vitro* and *in vivo* results for the same plant species by different researchers do not show the same trend of antiplasmodial activity, others have high activity while some low. The activity of an extract may be affected by solvent of extraction, geographical habitat, time and season of harvesting or other environmental factors [53]. The several classes of secondary plant metabolites that were responsible for antiplasmodial activities reported above for the 23 species identified in this study have been screened using different phytochemical techniques. The phyto-constituents and antiplasmodial activities are in agreement with the claimed therapeutic uses given by the respondents. However the ten plant species that were documented for first time as antimalarial remedies need to be screened for antiplasmodial activity and toxicity by *in vitro* and *in vivo* standard tests. This should be done in order to justify their local usage. Preservation and documentation of these medicinal plant species which may be lost due to erosion of age old traditional methods of biodiversity conservation and medicinal knowledge is another benefit of such investigations. The studies might lead to the isolation (and possibly the identification) of potentially active compounds, which may be regarded as future promising phyto-therapeutics in the treatment of malaria. It was from this back ground that three of the ten plant species documented for the first time as antimalarial were chosen for antiplasmodial and toxicity tests. The study that is in its final stages is investigating both *in vivo* and *in vitro* antiplasmodial and toxicity activities of *O. spinosa*, *A. sieberiana* and *E. latideus*. This study is investigating crude extracts of n-hexane, dichloromethane, ethyl acetate, methanol and pure isolated compounds from the three plants. Structure elucidation of the isolated pure compounds is also under way in the same study. The current study gives credit to the information provided by the traditional herbal practitioners who provided information on plants traditionally used to treat malaria in Butebo County, Eastern Uganda as shown from documented literature. Therefore they can be trusted with ethnobotanical and ethno pharmacological information in future studies on other medicinal plants.

4. CONCLUSION

Many of the plants identified in this study have been scientifically validated according to literature with high antiplasmodial activity and low toxicity. This shows that the ethnobotanical information provided by the local communities is correct and can be trusted. However some of the plants were documented for the first time as antimalarial plants therefore there is need to screen them for efficacy and toxicity. This would establish their candidature for any possible future research for active principles and the possible development of new cheap and more effective antimalarial drugs. Basing on this background it assumed that other plants that are used to treat other diseases in the study area should be documented. This would provide use full information to the local communities so that plants can conserved and preserved for future generations.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

Special thanks to Kyambogo University, Kampala Uganda and African Development Bank which contributed funds to carry out the survey. We are grateful to Professor Samuel T. Karuiki for identifying the remaining plants that were collected in latter stages of the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO. Traditional medicine: Planning for cost-effective traditional health services in the new century- a discussion paper. Centre for Health Development; 2002.
2. Cui L, Wang Z, Miao J, Miao M, Chandra R, Jiang H, et al. Mechanisms of *In vitro* resistance to Dihydroartemisininin *Plasmodium falciparum.* Mol. Microbiol. 2012;86(1):111-28.
3. Willcox ML, Bodeker G. Traditional herbal medicines for malaria. Brit. Med. J. 2004;329(7475):1156-59.
4. Muthaura CN, Rukunga GM, Chhabra SC, Mungai GM, Njagi EN. Traditional antimalarial phytotherapy remendies used by the Kwale community of the Kenyan Coast. J. Ethnopharmacol. 2007;114(3): 377-86.
5. Asase A, Oteng-Yeboah AA, Odamtten GT, Simmonds MS. Ethnobotanical study of some Ghanaian antimalarial plants. J. Ethnopharmacol. 2005;99(2):273-75.
6. Dike P, Olawole O, Ezekiel F, Adebiyi. Ethnobotanical survey for potential antimalarial plants in South-Western Nigeria. J. Ethnopharmacol. 2012;144(3): 618-26.
7. Ngarivhume T, Van't Klooster CIEA, de Jong JTVM, Westhuizen JHV. Medicinal plants used by traditional healers for the treatment of malaria in Chipinge District in Zimbabwe. J. Ethnopharmacol. 2015;159: 224-37.
8. Namukobe J, Kasenene JM, Kiremire BT, Byamukama R, Kamatenesi-Mugisha M, Krief V, et al. Traditional plants used for medicinal purposes by local communities

around the Northern Sector of Kibale National Park, Uganda. J. Ethnopharmacol. 2011;136(1):236-45.
9. Tugume P, Esezah K, Kakudidi KE, Mukadasi B, Namaalwa J, Kamatenesi M, Mucunguzi P, Kalema P. Ethnobotanical survey of medicinal plant species used by communities around Mabira Central Forest Reserve, Uganda. J. Ethnobiol. Ethnomed. 2016;12(1):5.
10. Tabuti JR, Dhillion SS, Lye KA. Traditional medicine in Bulamogi County, Uganda, its practitioners, users and viability. J. Ethnopharmacol. 2003;85(1):119-29.
11. Hassan-Abdallah A, Merito A, Hassan S, Aboubaker D, Djama M, Asfaw Z, et al. Medicianl plants and their uses by the people in the region of Randa, Djibouti. J. Ethnopharmacol. 2013;148(2):8701-13.
12. Mwanzia NJ, Mbaria MJ, Gathumbi KP, Gakuya D, Kabasa DJ, Kiama GS. Ethnodiagnostic skills of the Digo community for malaria: A lead to traditional bioprospecting. Front. Pharmacol. 2011;2: 30.
13. Anywar G, Charlotte IEA, Klooster V, Byamukama R, Willcox M, Patricia A, et al. Medicinal plants used in the treatment and prevention of malaria in Cegere Sub-County, Northern Uganda. Ethnobot. Res. Appl. 2016;14:505-16.
14. Katuura E, Waako P, Ogwal-Okeng J, Bukenya-Ziraba R. Traditional treatment of malaria in Mbarara District Western Uganda. Afri. J. Ecol. 2007;45(1):48-51.
15. Ssegawa P, Kasenene JM. Plants for malaria treatment in Southern Uganda: Traditional use, preference and ecological viability. J. Ethnobiol. 2007;27(1):110-131.
16. Tabuti JRS. Herbal Medicines Used in the Treatment of Malaria in Budiope County, Uganda. J. Ethnopharmacol. 2008;116(1): 33-42.
17. Stangeland T, Alele PE, Katuura E, Lye KA. Plants used to treat malaria in Nyakayojo Sub-County, Western Uganda. J. Ethnopharmacol. 2011;137(1):154-66.
18. Adia MM, Anywar G, Byamukama R, Kamatenesi-Mugisha M, Sekagya Y, Kakudidi EK. Medicinal plants used in malaria treatment by Prometra herbalists in Uganda. J. Ethnopharmacol. 2014;155(1): 580-88.
19. Kamatenesi MK, Acipa A, Oryem-Origa H. Medicinal plants of Otwal and Ngai Sub Counties in Oyam District, Northern Uganda. J. Ethnobiol. Ethnomed. 2011; 7(1):7.
20. Okello J, Ssegawa P. Plants used by communities of Ngai Sub-county, Apac District, Northern Uganda. Afri. J. Ecol. 2007;45(1):76–83.
21. Chekole G, Asfaw Z, Kelbessa E. Ethnobotanical study of medicinal plants in the environs of Tara-Gedam and Amba District North West Ethiopia. J. Ethnobiol. Ethnomed. 2015;11(1):4.
22. Maroyi A. Traditional use of medicinal plants in South Central Zimbabwe: Review & perspectives. J. Ethnobiol. Ethnomed. 2013;9(1):31.
23. Van Wyk BE, Wink M. Medicinal plants of the world: An illustrated scientific guide to important medicinal plants and their uses. Portland, OR: Timber Press. 2004;480.
24. Ogbonna OJ, Udla PM, Onyekpe PI, Ogbeihe GO. Comparative studies of the phytochemical and proximate analysis, mineral and vitamin compositions of the root and leaf extracts of *Tetracarpidium comophorum*. Arch. Appl. Sci. Res. 2013; 5(4): 55–59.
25. Searels JM, Keen KD, Horton JL, Clarke DH, Ward JR. Comparing ginsenoside production in leaves and roots of wild american ginseng (*Panax quinquefolius*). Am. J. Plant. Sci. 2013;4(5):1252-1259.
26. El Tahir A, Satti GM, Khalid SA. Antiplasmodial activity of selected Sudanese medicinal plants with Emphasis on *Maytenus senegalensis* (Lam.) Exell. J. Ethnopharmacol.1999;64(3):227-233.
27. Bah S, Jäger AK, Adsersen A, Diallo D, Paulsen BS. Antiplasmodial and GABA (A)-Benzodiazepine Receptor Binding Activities of five Plants Used in Traditional Medicine in Mali, West Africa. J. Ethnopharmacol. 2007;110(3):451-7.
28. Ranpariya VL, Sachin KP, Navin RS. Antiplasmodial activity of *Lantana camara* in mice infected with *Plasmodium berghei*. Brit. J. Pharmaceut. Res. 2016;13(4):1-8.
29. Melariri P, William C, Paschal E, Peter S. *In vitro* antiplasmodial activities of extracts from five plants used singly and in combination against *Plasmodium falciparum* parasites. J. Med. Plants. Res. 2012;6(47):5770-9.
30. Lawal B, Shittu OK, Kabiru AY, Jigam AA, Bello UM, Berinyuy BE, et al. Potential antimalarials from African natural products: A review. J. Intercult. Ethnopharmacol. 2015;4(4):318-43.

31. Clarkson C, Maharaj VJ, Crouch NR, Grace OM, Pillay P, Matsabisa MG, et al. *In vitro* Antiplasmodial activity of medicinal plants native to in South Africa. J. Ethnopharmacol. 2004;92(2):177-91.
32. Koch A, Tamez P, Pezzuto J, Soejarto D. Evaluation of plants used for antimalarial treatment by the Masai of Kenya. J. Ethanopharmacol. 2005;101(1):95-99.
33. 33. Gessler MC, Nkunya MH, Mwasumbi LB, Heinrich M, Tanner M. Screening Tanzanian medicinal plants for antimalarial activity. Acta Tropica. 1994; 56(1): 65-77.
34. Muganga R, Angenot L, Tits M, Frédérich M. Antiplasmodial and cytotoxic activities of Rwandan medicinal plants used in the treatment of malaria. J. Ethnopharmacol. 2010;128(1):52-57.
35. Kirira PG, Rukunga GM, Wanyonyi AW, Muregi FM, Gathirwa JW, Muthaura CN, et al. Antiplasmodial activity and toxicity of extracts of plants used in traditional malaria therapy in Meru and Kilifi Districts of Kenya. J. Ethnopharmacol. 2006; 106(3):403-7.
36. Isah AB, Ibrahim YK, Iwalewa EO. Evaluation of the antimalarial properties and standardization of tablets of *Azadirachta indica* (Meliaceae) in mice. Phytother. Res. 2003;17(7):807-10.
37. Saxena S, Pant N, Jain DC, Bhakuni RS. Antimalarial agents from plant sources. Curr. Sci. 2003;85(9):1314-29.
38. Bussmann WR, Malca G, Glenn A, Sharon D, Nilsen B, Parris B. Toxicity of medicinal plants used in traditional medicine in Northern Peru. J. Ethnopharmacol. 2011; 137(1):121-140.
39. Makoka TA, Xolani PK, Zimmermann S, Hata Y, Adams M, Kaiser M, et al. Antiprotozoal screening of 60 South African plants, and the identification of the antitrypanosomal germacranolides schkuhrin I and II. Planta Med. 2013; 79(14):1380-84.
40. Tchoumbougnang F, Amvam-Zollo PH, Dagne E, Mekonnen Y. *In vivo* antimalarial activity of essential oil from *Cymbopogon citratus* and *Ocimum gratissimum* on mice infected with *Plasmodium berghei*. Planta. Med. 2005;71(1):20-23.
41. Lydia DI, Noel NW, Clement AI, Kennedy IA. *In vivo* assessment of the antimalarial activity of *Cassia singueana* and *Cymbopogon citrutus*. Pharm. Chem. 2015;7:272-8.
42. Uraku AJ, Okaka AN, Ibiam UA, Agbafor KN, Obasi NA, Ajah PM, et al. Antiplasmodial activity of ethanolic leaf extracts of *Spilanthes uliginosa*, *Ocimum basilicum* (Sweet Basil), *Hyptis spicigera* and *Cymbopogon citratus* on mice exposed to *Plasmodium berghei* NK65. Int. J. Biochem. Res. Rev. 2015;6:28-36.
43. Bidla G, Titanji VP, Joko B, Ghazali GE, Bolad A, Berzins K. Antiplasmodial activity of seven plants used in african folk medicine. Indian J. Pharmacol. 2004;36: 245-46.
44. Muganza MD, Fruth BI, Nzunzu L J, Mesia GK, Kambu OK, Tona GL, et al. *In vitro* antiprotozoal and cytotoxic activity of 33 ethonopharmacologically selected medicinal plants from Democratic Republic of Congo. J. Ethnopharmacol. 2012; 141(1):301- 8.
45. Nundkumar N, Ojewole JA. Studies on the antiplasmodial properties of some South African medicinal plants used as antimalarial remedies in Zulu Folk Medicine. Methods and Findings in Experimental & Clinical Pharmacology. 2002;24(7):397-402.
46. Haruna Y, Kwanashie HO, Anuka JA, Atawodi SE, Hussaini IM. *In vivo* antimalarial activity of methanol root extract of *Securidaca longepedunculata* in mice infected with *Plasmodium bergei*. Int. J. Mod. Biol. 2013;3(1):7-16.
47. Douglas O, Saifudin FD, Mwanzia NJ, Akunda EM. Antimalarial activity and acute toxicity of four plant traditionally used in treatment of malaria in Msambweni District of Kenya. Eur. Int. J. Sci. Technol. 2014; 3(7):31-40.
48. Bantie L, Assefa S, Teklehaimanot T, Engidawork E. *In vivo* antimalarial activity of the crude leaf extract and solvent fractions of *Croton macrostachyus* Hocsht. (Euphorbiaceae) against *Plasmodium berghei* in mice. BMC Complement. Altern. Med. 2014;14(1):79.
49. Jonville MC, Kodja H, Humeau L. Screening of medicinal plants from reunion island for antimalarial and cytotoxic activity. J. Ethnopharmacol. 2008;120(3): 382-86.
50. Lusakibanza M, Mesia G, Tona G, Karemere S, Lukuka A, Tits M, et al. *In vitro* and *in vivo* antimalarial and cytotoxic activity of five plants used in Congolese traditional medicine. J. Ethnopharmacol. 2010;129(3):398-402.

51. Shimaa MA, Mona HH, Samir AR, Farid AB. Antiprotozoal and antimicrobial activity of selected medicinal plants growing in Upper Egypt, Beni-Suef Region. World J. Pharmaceut. Sci. 2015;4:1720- 40.
52. Chinwuba P, Akah AP, Emmanuel EI. *In vivo* antiplasmodial activity of the ethanol stem extract and fractions of *Citrus sinensis* in mice. Merit Res. J. Med. and Medical Sci. 2014;3(4):140-46.
53. Prance GT, Chadwick DJ, Marsh J. (Eds.). Ethnobotany and the search for new drugs. John, Wiley and Sons, Chichester, England. 1994;57-90.

APPENDIX

Ethnobotanical Survey Questionnaire

Ethnobotanical Antimalarial Medicinal Plant Community Survey Questionnaire

PRACTITIONER – NUMBER…………………………….

[A] RESPONDENTS DETAILS.

(1) Name:………………………………………………………………………………

(2) Sex:

(i) Female
(ii) Male

(3) Age: (years)

(i) 20 or less
(ii) 21-30
(iii) 31-40
(iv) 41-50
(v) 51-60
(vi) Above 60

(4) Level of education:

(i) No formal education
(ii) Primary
(iii) Secondary
(iv) Tertiary (college / University)

(5) Location of residence:…………………………………………..

(6) Occupation:…………………………………………………………..

(7) Tribe:……………………………………………………………………..

(8) Sub-county:…………………………………………………………..

(9) Village:……………………………………………………………….

[B] **INDEGENOUS KNOWLEDGE:**

(10) How do you diagnose a disease? (How do you confirm malaria before treating the patient)

(i) Hospital records
(ii) Patients symptoms / signs (i.e. fever, joint pain, weakness, headache, vomiting, sore throat, shivering, sores in the mouth, sweating, thirst etc.
(iii) Interviewing the patient.

(11) How many patients do you normally treat in a month?

(i) 1-5
(ii) 6-10
(iii) 11-15

(iv) 16-20
(v) 21 and above

(12) Who constitutes the majority of your patients?

(i) Men only
(ii) Women
(iii) Both women and men.

(13) What is the frequent age (years) group of your patients?

(i) Under 5
(ii) 6-12
(iii) 13-19
(iv) 20-50
(v) 51 and above

(14) What type of medicines do your patients prefer?

(i) Powder
(ii) Decoctions
(iii) Infusions
(iv) No preference
(v) Any other / explain

(15) Have you ever treated a patient who had previously been unsuccessfully treated in a public/ private clinic or hospital……………………

(16) Give the vernacular names of plants you use for treating malaria Refer to Table 1 on page 11.

(17) What other disease(s) are the plants named in (16) used for treating?

Refer to Table 1 on page 11.

(18) How would rank the plant in the treatment of malaria?

(i) Slightly effective
(ii) Effective
(iii) Highly effective

(19) Which parts of the plant do you use for treating malaria /fever? (i.e. stem bark, root bark ,inner bark or root, leaves or young leaves, seeds, fruits, whole plant, root tubers, young shoots, aerial flowers, stem, bulb, sap, pods, latex, twigs, grass). Refer to Table 1 on page 11 to collect this information.

(20) Name at least two cases of diseases that you are best known for treating.

……………………………………………………………………………………………………...

(21) Do you treat animals also? If so list names of plants used, parts of the plant used, cost, habitant, mode of preparation, administration and dose. Refer to Table 1, on page 11 to collect this information.

(22) Where do you always collect the plants from (Habitant)? (i.e wild, wooded grasslands, homestead (compound), gardens, road side, open grassland, grassland, forest, swamps. Refer to Table 1 on page 11 to collect this information.

(23) Where do you dry your plant material?

(i) Under a shade
(ii) In the open

(24) How did you get the source of information about the medicinal plants used for treating?

The diseases listed above.

(i) Parent.
(ii) Peers.
(iii) Grandparents.
(iv) In laws.
(v) Dreams.

(25) How do you keep the secret of the medicinal plants that you use for treating?

………………………………………………………………………………………………………...

(26) Are you always willing to share the knowledge of the medicinal plants with others?

(i) Yes
(ii) No

(27) Give reasons for the answer in question (27).

………………………………………………………………………………………………………...

………………………………………………………………………………………………………...

(28) Give reasons why medicinal plant species are used instead of the modern medicine.

(i) Medical facilities are far.
(ii) Poverty.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22425