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Herbal medicines used in the treatment of malaria in Budiope county, Uganda

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Abstract

Aim of the study: This study was conducted to document herbal medicines (HMs) used in the treatment of malaria as well as the existing knowledge, attitudes and practices related to malaria recognition, control and treatment in Budiope county, Uganda.
Methods: Data was collected using semi-structured interviews, and open- and close-ended questionnaires.
Results: The respondents had a good understanding of malaria, and could recognize it and distinguish it from other fever types. They were also aware that malaria was spread by mosquitoes. Malaria prevalence was high, and affected individuals an average of six times a year. Respondents avoided mosquito bites by using mosquito nets, clearing bush around their homesteads, and burning plant parts to generate smoke. They preferred treating malaria using allopathic medicines because, according to them, they lacked the appropriate traditional knowledge necessary to exploit plants for the treatment of malaria. Secondly, allopathic medicines were believed to be superior to HMs in the treatment of malaria. Twenty-seven species were used for the treatment of malaria. The most frequently mentioned were *Vernonia amygdalina*, *Momordica foetida*, *Zanthoxylum chalybeum*, *Lantana camara* and *Mangifera indica*. Drugs from these plants were prepared from single species as water extracts and were administered in variable doses over varied time periods.

Keywords: Medicinal plants; Traditional treatments; Ethnobotany; Antimalarial

1. Introduction

Malaria is the single most important cause of ill health, death and poverty in sub-Saharan Africa (Sachs and Malaney, 2002; Kilama, 2005; United Nations, 2005). It is estimated that there are as many as 300 million acute cases of malaria worldwide each year, resulting in one million deaths. Ninety percent of these deaths occur in sub-Saharan Africa, and most of victims are children aged less than five years (World Health Organization, 2003). Malaria is a major obstacle to social-economic development in Africa. It accounts for 40% of public health expenditure. Furthermore, the disease not only results in loss of life and productivity because of illness and premature deaths, it also hinders children in their schooling and social development both through absence from school and permanent neurological or other damage associated with severe episodes of the disease.

In Uganda, malaria is the commonest disease and accounts for 25–40% of out-patient attendance at health facilities, and 20% of in-patient admissions (Batega, 2004; Malaria Control Programme, 2005). It also kills the most people estimated at 9–14% of in-patient deaths. Children aged five years and below, and pregnant women are the most affected; more than 200 children die daily from the disease (Malaria Control Programme, 2005; Ministry of Health, 2006). In children malaria not only leads to illness and death but also has long term consequences on their development through low birth weight, chronic anaemia, reduced growth and in some cases severe mental retardation. In pregnancy, malaria may cause maternal anaemia, premature births, low-weight babies (which is the principal contributor to infant mortality) and still births. The disease is responsible for nearly 60% of miscarriages.

The disease also contributes to poverty. First of all, many productive days are lost through sickness or tending to sick relatives. Secondly, the cost of treatment or barriers to mosquito bites, such as insecticides or mosquito nets is high for the average

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Ugandan. The average cost of treating a single malaria episode is estimated at USD 0.8 (1 USD = UGX 1850). Indeed, a poor family can spend up to 25% of its income on malaria treatment and prevention (Ministry of Health, 2006).

Four major problems are associated with the management of malaria. The most important is that the parasites which cause malaria are resistant to the most widely available, affordable and safest first line treatments such as chloroquine and fansidar (Kilama, 2005; Sendagire et al., 2005). Secondly, the overall control of the mosquitoes which transmits malaria is made difficult by their resistance to a wide range of insecticides. The third, which is a new and rapidly developing problem, is the widespread production of fake antimalarial drugs. For example, in mainland Southeast Asia 53% of "artesunate" blister packs sampled contained no active ingredient (Newton et al., 2006). Lastly, many countries in Africa lack the necessary infrastructure and resources to manage and control malaria (World Health Organization, 2003).

Owing to the widespread suffering and death caused by malaria and the failure of the safest and most affordable antimalarials to treat the disease, there is an urgent need to develop new drugs or vaccines for the treatment, management, prevention and control of malaria (Kilama, 2005; Waako et al., 2005). This study was undertaken to document traditional knowledge about malaria, treatment and control practices, and attitudes about its treatment. The project contributes to millennium Development Goal "6" of combating HIV/AIDS, malaria and other diseases.

2. Methods

2.1. Study area

This study was conducted in Busambira and Buseete villages of Kinambogo Parish found in Budiope County, Kamuli district in Eastern Uganda. Kinambogo Parish is located 180 km from Kampala the capital city of Uganda, between 1° 17′–1° 25′ N; 33° 08′–33° 20′ E at an altitude of about 1075 m aslant and has a total area of 57 km^2. The vegetation consists of thickets; degraded bushlands, woodlands and grasslands.

The population of Kinambogo parish approximates 5200 people (91 people per square kilometer). Of these 22% are children aged less than five years (Uganda Bureau of Statistics, un-published data). The community is rural and depends on crop agriculture as its major source of livelihood. The people belong to the Basoga ethnic group and the main language spoken is Lusoga. The people are mostly Christians (78%). There are four health care centers close to the study communities: Wesunire Mission Hospital, Wesunire Family Life and Education Program, Buyende Health Centre and Wesunire Health Centre.

2.2. Data collection

This study was conducted between June and September, 2006. Data was collected through a survey employing semi-structured interviews and a guided open- and close-ended questionnaire. The semi-structured interviews were conducted using a checklist of questions and were held with individuals and local area leaders. Two group discussions that were held with community members, one in each of the study villages, complemented the interview and questionnaire survey. Participants in the group discussions were identified by the local area leaders. Traditional medicine practitioners were not included in the study because we were informed that no one consults them for the treatment of malaria. The questionnaire included questions on respondents bio-data; local names of malaria, perceptions of differences between fevers, causes of malaria, known signs and symptoms of malaria; details of harvesting, preparation, application and dosage of malaria herbal medicines. The questionnaire was translated into Lusoga, the principal language spoken in the study area.

Respondents for the questionnaire survey were selected randomly using the multistage random sampling method as follows. Buyende sub-county was randomly selected from among the seven sub-counties of Budiope county and was considered the primary sampling unit. From within Buyende sub-county, one parish (Kinambogo) was selected. In turn two villages Buseete and Busambira were selected from Kinambogo parish. The desired sample size was fixed at 61 respondents by assuming that 80% of the community had good knowledge regarding malaria and its treatment; a desired confidence interval of 95%; and a relative error of estimation of 10%.

Thirty-two households were randomly selected from each village by consulting the village household registers. From among the selected households, a random sample of 16 households was picked from which men were to be interviewed while the remainder constituted the women respondents. In this way, 29 respondents were interviewed in Busambira village and 37 from Buseete village. The sample consisted of 34 male and 32 female respondents. Two guides identified with the help of the local leader were hired in each village to help locate the selected respondents and to introduce the team members to the respondents. Direct observations were made on issues relevant to the study objectives, such as attributes of housing, drug preparation, and vegetation types.

All plant material mentioned by respondents in the study was identified in the field. A voucher specimen of each species was collected for confirmation and is deposited at Makerere University Herbarium. Species nomenclature follows the flora for tropical East Africa. Ethical approval for this study was given by the Uganda National Council for Science and Technology (No. HS 144). In addition, a written informed consent was obtained from the community representatives. The research objectives and methods were explained to respondents before every interview. At the end of the study, the findings were discussed with the community in a workshop.

Questionnaire survey data was entered in Excel spreadsheets. It was checked and edited for errors, and coded as described in Sarantakos (2005, p364). Thereafter, it was summarized using SPSS and reported in figures and tables. Semi-structured interview data was studied and the responses grouped into classes expressing similar ideas.

Table 1
Socio-economic characteristics of respondents ($n = 66$)

Characteristic	(%)
Household Head	
Male	92
Female	8
Tribe	
Musoga	67
Mulalo[a]	25
Itesoit	6
Mukenye	2
Formal education	
None	43
Primary	46
Secondary	11
Religion	
Catholic	46
Anglican	29
Muslim	12
Pentecostal	9
Seventh day adventist	3
Primary job	
Peasant crop agriculture	90
Herder	6
Trader	2
None	2
Secondary job ($n = 18$)	
Herder	33
Peasant crop agriculture	11
Builder	11
Trader	11
Artisan	6
Beer seller	6
Motorcycle taxi	6
Cattle trader	6
Cook	6
Politician	6

[a] Mulalo is generic and refers to people whose origins are in Western Uganda.

Table 2
Malaria symptoms mentioned by respondents ($n = 66$)

Symptom	(%)
Fever	97
Chills	86
Joint pain	85
Weakness	83
Headache	83
Lethargy	82
Sneezing	82
Loss of appetite	80
Coughing	77
Flu like symptoms	61
Vomiting	61
Sore throat	58
Redness of eyes	58
Shivering	55
Abdominal pain	53
Diarrhoea	52
Goose pimples	49
Anxiety	47
Sores in mouth	46
Palpitations	46
Chest pain	6
Irritability especially in babies	6
Drowsiness	5
Teary eyes	5
Anaemia	3
Itching	3
Painful eyes	3
Skin rash	3
Backache	2
Dehydration	2
Laboured breathing	2
Blocked nose in babies	2
Nightmares	2
Bitter taste in the mouth	2
Sweating	2
Thirst	2

3. Results

3.1. Respondents' socio-economic characteristics

Most respondents interviewed in this study lived in male headed households; belonged to the Basoga ethnic group; and had attained little (primary or secondary level) or no formal education (Table 1). The respondents belonged to the mainstream religions and were mostly Christians. Their main source of livelihood was peasant crop agriculture, while some were engaged in livestock herding as a secondary source of income. Respondents had, on average, four young dependants (1–15 years; S.D. $\pm$ 2) and one elderly dependant (>60 years).

Most households had grass-thatched huts constructed using mud. Many of the houses lacked windows while some had a hole provided for a window but without a shutter. At night, the hole was covered by a piece of cloth or woven mat.

3.2. Traditional knowledge about malaria

Respondents had good knowledge about malaria and could readily distinguish it from other fevers on the basis of accepted signs and symptoms such as raised body temperature, chills, joint pains, weakness, headache, lethargy, sneezing and flu like symptoms, loss of appetite, coughing, and vomiting (Table 2).

The people knew also that mosquitoes transmit malaria (Table 3). However, some people thought that keeping a dirty homestead or drinking dirty water caused malaria, while some believed that it was caused by dense bush or pools of stagnant water close to the homestead.

Conditions likely to favour the breeding of mosquitoes were observed in all homesteads. All homesteads had large plants within 3–5 m of the house as well as pits in the compound. In addition, livestock enclosures (kralls) were within 50 m of most homes (Table 4). Furthermore a good number of homesteads were in close proximity to wetlands and/or open wells.

A variety of strategies were employed by respondents to stop mosquito bites. These included the use of mosquito nets and mosquito repellents such as mosquito coils, the burning of logs

Table 3
Factors reported to be responsible for causing malaria

Factor	(%)
Mosquitoes	96
Dirty homestead	71
Drinking dirty water	62
Dense bush	29
Pools of stagnant water	11
Swamps	9
Cold breeze	6
Broken vessels/holes	5
Working or playing under rain	5
New season foods e.g. mangoes	6
Sleeping during daytime	2
Dust	2
Poor sleeping facilities	2
Sharing eating utensils	2
Smoking tobacco	2

and plants such as *Albizia coriaria* or cow-dung to generate smoke, filling up pits in the compound or removing materials likely to promote the breeding of mosquitoes, and closing windows and doors before nightfall (Table 5). Respondents also reported that they destroyed bushes around their homesteads. But this was not observed during the study instead, bushes were always observed and close to households.

3.3. Malaria treatment practices

Respondents reported suffering between 1 and 30 malaria episodes a year with a mean of six attacks (Fig. 1a). At the time this study was conducted 34% of the respondents reported that they were suffering from the disease; 31% had suffered an attack in the past one month (Fig. 1b).

The respondents stated a preference for allopathic medicine for the treatment of suspected malaria (Fig. 2). They commonly self-medicated using paracetamol, and fansidar or chloroquine. A variety of reasons were given why they preferred allopathic medicines over traditional medicines (TM). The principle reason was that they lacked the relevant traditional knowledge necessary to exploit herbal medicines (HMs) for the treatment of malaria (Fig. 3a). Another frequently mentioned reason was that they believed that allopathic medicines were more effective than HMs.

Some community members, on the other hand, preferred to self medicate with HMs. They shared information on malaria treatment amongst themselves. Their attitudes were influenced mainly by the fact that HMs were free, were readily accessible and/or were also more effective than allopathic medicines (Fig. 3b). Respondents claimed that they did not consult traditional medicine practitioners for the treatment of malaria because they knew how to prepare the necessary herbal medicines themselves.

Table 4
Distribution of homesteads by distance away from kralls and water bodies

Distance of homestead from	(%)
Krall	
Within 50 m	67
Within ½ km	1
More than 1 km	32
Wetland	
½ km	38
1 km	29
More than 1 km	33
Open well	
½ km	30
1 km	24
More than 1 km	46

Table 5
Practices employed to guard against mosquito bites and/or to protect households against malaria

Practice	(%)
Use mosquito net	77
Clear bushes close to homesteads	76
Burn mosquito coil	71
Clean houses from dirt	70
Burn plants to create smoke to deter mosquitoes[a]	67
Clean utensils	64
Close houses early in the evening	61
Fill pits and get rid of tins and broken pots where mosquitoes can harbour	64
Construct bathroom far from house	58
Clear rubbish	58
Burn logs to create smoke[b]	58
Burn cow-dung	56
Cover pit latrine	55
Cover drinking water	52
Have clean drinking water	50
Plaster walls	50
Use twigs of *Ficus exasperata* as insect brush	39
Construct houses/huts without ventilation	38
Plant neem tree	36
Plant night rose	35
Indoor residual spraying using cotton pesticide	5
Cover body	3
Do nothing	3
Plant moringa	3
Household insecticide	3
Limit consumption of new season food	2

[a] These include *Lantana camara*, *Cupressus lusitanica* Mill., *Albizia coriaria* Oliv., *Carica papaya* leaves.
[b] Some burn saw dust or millet husks.

3.4. Harvesting, processing and administration of herbal medicines

Twenty-seven species distributed between 24 genera and 16 families were reportedly used in herbal preparations for the treatment of malaria. Most of these were woody plants (shrubs and trees; $n = 17$). Tender leaves were commonly used in the preparations ($n = 20$ plants; Table 6). Respondents reported that the appropriate plant parts were collected as and when they were needed, and that there was no specific time to collect. They did not perform any rituals during collecting or processing of HMs.

The herbal drugs were prepared mostly as water extracts, as decoctions or as steam baths. The water extracts and decoctions were prepared as mono-preparations from single species

Table 6
Plants commonly used for the treatment of malaria

Species	Family	Local name	Specimen number (s)	Habit[a]	Status[b]	Habitat[c]	Part used[d]	No.[e]
Vernonia amygdalina Delile	Asteraceae	Lubilili	JRST 566, 585	S	We	Rs, Cf	L	33
Momordica foetida Schumach.	Cucurbitaceae	Luiwula	JRST 567	C	We	Rs, Hg	L	12
Zanthoxylum chalybeum Engl.	Rutaceae	Mutala irungu	JRST 563	T	Wi	Bu	R	9
Lantana camara L.	Verbenaceae	Kapanga	JRST 568	S	We	E	L	9
Mangifera indica L.	Anacardiaceae	Muyembe	JRST 582	T	SW	Hg[f]	L (most), Bk	7
Chenopodium ambrosioïdes L.	Chenopodiaceae	Kawuna wuna	JRST 562, 569	W	Wi		L	6
Chenopodium opulifolium Koch & Ziz	Chenopodiaceae	Namuvu	JRST 561	W	Wi	Hg	L	5
Azadirachta indica A. Juss.	Meliaceae	Neem	JRST 581	T	Cv	Cp	L	4
Moringa oleifera Lam.	Moringaceae	Moringa	JRST 560	T	Cv	Cp	L	2
Leonotis nepetifolia (L.) Ait.f.	Lamiaceae	Susuni	JRST 564	W	Wi	Rs, Cf	L	2
Combretum molle G. Don	Combretaceae	Ndaha	JRST 570	T	Wi	Bu, PCf	L	2
Coffea canephora Froehner	Rubiaceae	Mwanyi	JRST 580	S	Cv	Hg[f]	L	1
Citrus sinensis (L.) Osb.	Rutaceae	Mucungwa	JRST 579	S	SW	Hg	L	1
Conyza sumatrensis (Retz.) E.H. Walker	Asteraceae	Kati kati	JRST 584	W	Wi	Bu	L	1
Jatropha curcas L.	Euphorbiaceae	Kirowa	JRST 578	S	Cv	Bm	L	1
Kalanchoë densiflora Rolfe	Crassulaceae	Kisanasana	JRST 577	H	Cv	Hg	L	1
Flueggea virosa (Willd.) Voigt	Euphorbiaceae	Lukandwa	JRST 565	S	Wi	Bu, Rs	R	1
Talinum portulacifolium (Forssk.) Asch. ex Schweinf.	Portulacaceae	Mpozia	JRST 576	H	Wi	Rs, Cp	L	1
Ocimum gratissimum L.	Lamiaceae	Mujaja	JRST 555	W	SW	Bu, Hg	L	1
Albizia zygia (DC.) Macbr.	Fabaceae – Mimosoïdeae	Mulongo	JRST 558	T	Wi	Bu	Bk	1
Carissa edulis (Forssk.) Vahl	Apocynaceae	Muyunza	JRST 572	T	Wi	Bu	R	1
Acacia sieberiana DC.	Fabaceae	Mweramaino	JRST 571	T	Wi	Cf, Bu	R	1
Tamarindus indica L.	Fabaceae	Nkoge	JRST 575	T	SW	Bu	Bk	1
Cajanus cajan (L.) Millsp.	Fabaceae	Nkolimbo	JRST 557	W	Cv	Hg	L	1
Allium cepa L.	Alliaceae	Katungulu	Not collected	H	Cv	Hg	Bu	1
Melia azedarach L.	Meliaceae	Lira	JRST 574	T	Cv/SW	Cp	L	1
Harrisonia abyssinica Oliv.	Simaroubaceae	Lushaike	JRST 556	S	Wi	Bu, Rs	L	1

[a] C, climber; H, herb; S, shrub; T, tree; W, woody herb.
[b] Cv, cultivated; We, weed; Wi, wild; SW, semi-wild.
[c] Bm, boundary marker; Bu, bush; Cf, crop-field; Cp, compound; E, everywhere; Hg, Home garden; PCf, protected in crop-field; Rs, roadside.
[d] Bk. bark; Bu, bulb; L, leaf; R, root.
[e] Number of respondents mentioning use of the species for malaria treatment.
[f] Also found in a variety of habitats including compounds, roadsides, crop-fields, abandoned crop-fields (fallows).

(Table 7). Some concoctions were prepared as mixtures of *Vernonia amygdalina* and *Momordica foetida*; and *Cannabis* sp. and *Chenopodium opulifolium*; or *Mangifera indica* and *Tamarindus indica*. Oral doses were variable and were administered according to the age of the patient. They varied between 100 and 500 ml for adults; 100 and 250 ml for older children (more than 5 years); and 1–3 tablespoons for children younger than 5 years. The herbal drugs were taken 1–3 times a day for a period of 1–3 days or until the patient's condition has improved. Prepared herbal medicines were never kept and all that which remained after use was discarded. There was no need to keep any because the plants from which they were produced were readily available.

Most respondents who used HMs indicated that it was effective and that there were no side effects. However, three of the respondents did not think so and used it only as a first aid (e.g. to lower body temperature) in readiness to acquiring AM.

Table 7
Common concoctions for the treatment of malaria, showing species, part used, preparation and route of administration

Species	Part used[a]	Preparation	Administration
Zanthoxylum chalybeum	R	Decoction	Oral
Vernonia amygdalina	L	Water extract	Oral (sometimes bathed)
Momordica foetida	L	Water extract	Oral
Chenopodium opulifolium	L	Water extract/decoction	Oral/bathe
M. foetida, Azadirachta indica, C. opulifolium	L	Decoction	Oral
A. indica	L		Oral

This list does not include species used in steam baths. Most concoctions are made from single species except *M. foetida, Azadirachta indica,* and *C. Opulifolium*.
[a] L, leaf; R, root.

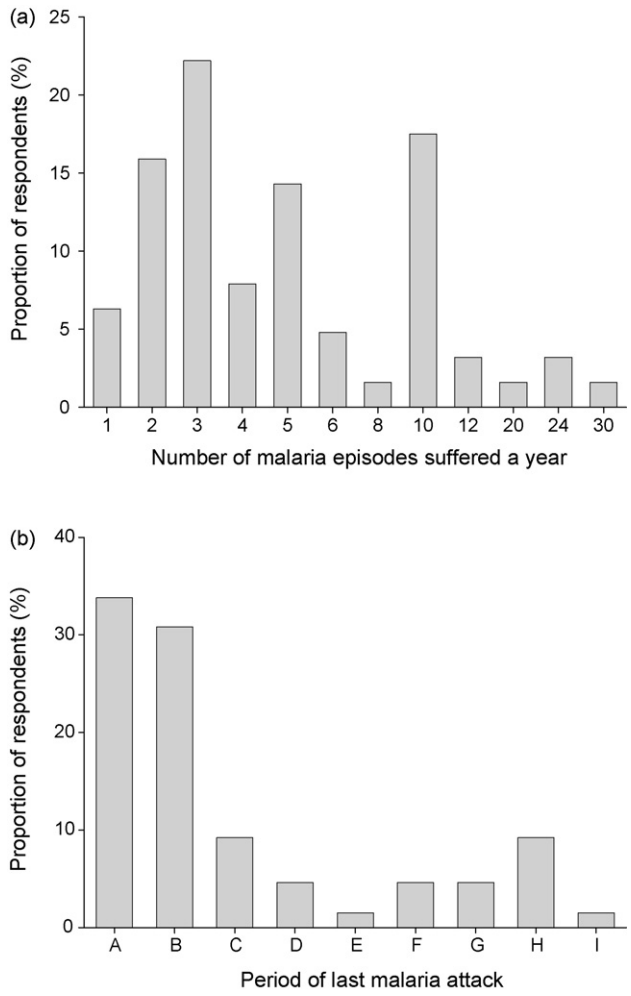

Fig. 1. (a) Number of malaria episodes suffered by respondents (mean 6.17 ± 0.73 SEM). (b) period of last malaria episode reported by respondents (A, currently suffering, B, One month ago, C, Two months ago, D, Three months ago, E, Four months ago, F, Five months ago, G, Six months ago, H, More than eight months ago, I, More than a year ago).

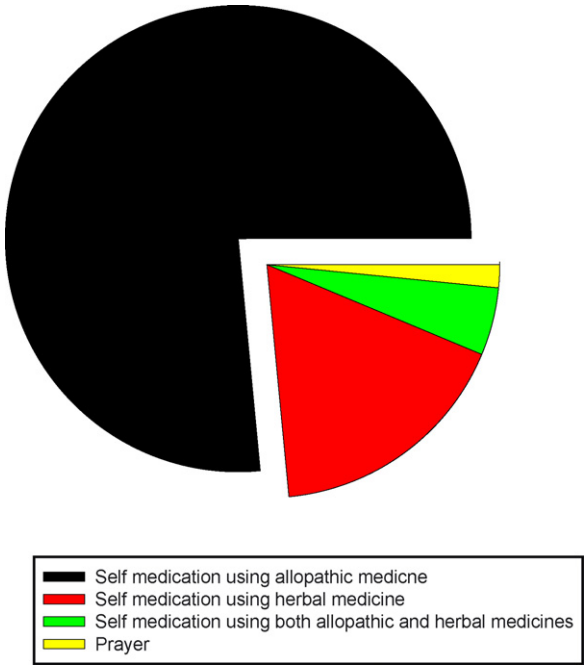

Fig. 2. Treatment used during the last malaria attack.

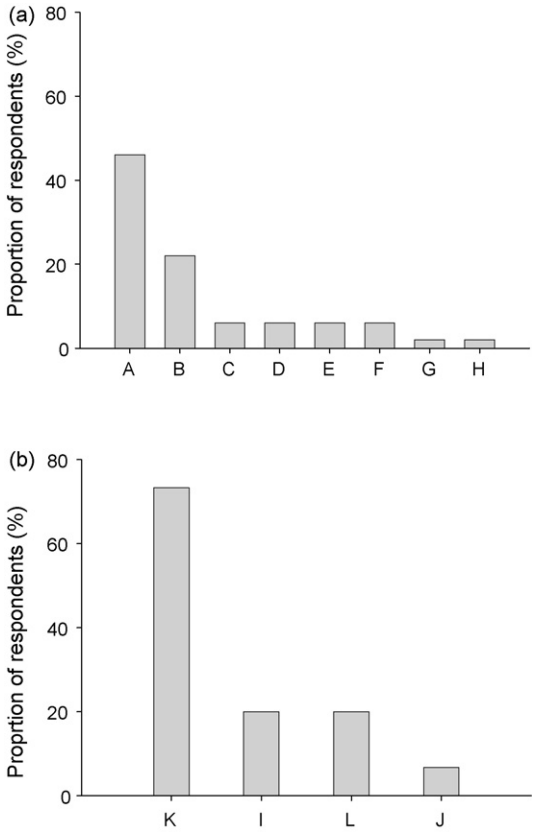

Fig. 3. (a) Reason why allopathic medicine (AM) is preferred over Traditional medicine (TM: $n = 48$). (b) Reason why TM is preferred over AM ($n = 18$). A: lacks traditional knowledge necessary to treat malaria; B: allopathic medicines are more effective; C: easy access to allopathic medicines; D: conflicts with religious beliefs; E: does not like TM, or prefers WM; F: TM is not effective against malaria; G: allopathic medicine is administered in precise doses; H: TMPs demand much and some are quacks; K: TM is free; I: easy access; L: TM is more efficacious and J: Hospital is far.

4. Discussion

4.1. Community Knowledge about malaria

The community of Kinambogo had good knowledge about malaria and readily distinguished it from other fever types on the basis of widely accepted malaria signs and symptoms shown in Table 2 (Gessler et al., 1995b; Ahorlu et al., 1997; Purcell, 2004; Malaria Control Programme, 2005). Besides knowing what malaria was, the people also knew the factors which contributed to malaria prevalence. Knowledge about malaria has steadily improved in Uganda, but some misconceptions still remain about the causes of malaria and symptoms of severe malaria (Batega, 2004) and these were also documented in this study (Tables 2 and 3). This relatively good understanding of the disease may help in the implementation of intervention measures aimed at reducing its incidence and prevalence (Ahorlu et al., 1997; Nuwaha, 2002) as opposed to some societies in developing countries that associate the disease with witchcraft (Nuwaha, 2002).

4.2. Prevalence of malaria

Malaria prevalence was high in the study community and corresponded with the national average of six episodes a year. A high prevalence such as the one observed in this study may have a significant impact on the well-being and economic potential of the community. A single malaria episode can result in the loss of 5–20 days of productive labour per year (Ministry of Health, 2006). This means, therefore, that 10–40 days are lost every year for an average sized family (six members) with two adults. This leads to lowered income earnings.

Among children sufferers, malaria causes absence from school and lethargy when in class leading to poorer academic performance which may, in turn, lead to long term social consequences. In addition to the above indirect social and economic costs, there is the direct cost of treating malaria or purchasing material to stop mosquito bites such as mosquito nets. The estimated cost for treating a single malaria episode in Uganda is put at USD 0.8 (Ministry of Health, 2006). For a family of six people suffering an average of six episodes a year, this translates into a total cost of USD 27 every year. This is equivalent to 4% of the annual household income in Kamuli district (Uganda Bureau of Statistics, 2002).

The suffering from malaria and its contribution to poverty is likely to continue in the foreseeable future because the disease is resistant to the most affordable, available and safe antimalarial drugs (Kilama, 2005; Sendagire et al., 2005). Out of concern for this resistance, the Ministry of Health of Uganda adopted the Artemisinin-based Combination Therapies (ACTs) Coartem® and Lumefentrine as the first line medicine for the treatment of uncomplicated malaria in 2006 following the recommendation by the World Health Organization (Malaria Control Programme, 2005). The efficacy and performance of Coartem® remains to be evaluated. Secondly the conditions in Kinambogo as elsewhere in Uganda are ideal for the breeding and survival of mosquitoes. Homesteads were surrounded by lush bush and the landscape had numerous bogs lying within the flight range of the mosquito *Plasmodium falciparum*, estimated at 3 km (Ghebreyesus et al., 1999). The government of Uganda intends to start indoor residue spraying using the controversial pesticide DDT which was sanctioned in September 2006 for use by the World Health Organization (World Health Organization, 2006). Lastly, the infrastructure for managing malaria in Uganda as elsewhere in Africa is still weak (World Health Organization, 2004). According to respondents Kinambogo parish had few and poorly manned Health Care centres.

4.3. Herbal medicines used to treat malaria

The malaria prevalence observed here and which has implications on peoples' health and economic well-being, calls for extensive research and development of effective and safe antimalarials. Within a context of growing antimalarial resistance and the difficulties for households to afford and access effective antimalarials, the development and promotion of phytomedicines may be the sustainable solution to malaria treatment. This focus is justified because herbal medicines are widely believed to be safe and also efficacious. Indeed many drugs used in allopathic medicine have been derived from higher plants using leads from traditional knowledge (Farnsworth, 1990; Fabricant and Farnsworth, 2001; van Wyk and Wink, 2004). Examples of drugs developed using traditional knowledge include the antimalarial agents quinolines and endoperoxides/artemisinin derivatives (Orwa, 2002; Waako et al., 2005).

Nineteen of the species documented for the treatment of malaria in this study have been used similarly in other parts of Uganda or other countries (Table 8)). This correspondence in use of the same species in different cultures over a long period suggests strongly that these species may be effective in the treatment of malaria (Orwa, 2002; van Wyk and Wink, 2004). It is important, however, to validate all claims of therapeutic efficacy and safety by undertaking pharmacological and toxicological studies. The literature reviewed in this study indicates that few such validation studies have been conducted (Table 8).

Validation of HMPs is important because it may generate higher confidence and hence wider use of such species (World Health Organization, 1987, 2000). From results of the present study this appears highly relevant because some respondents indicated a low level of confidence in the efficacy of HMPs for the treatment of malaria. Wider acceptance of HMPs can yield significant benefits for primary health care and also help create a herbal medicine market, with possibilities of adding value to medicinal plants.

Validations may proceed from observations of the treatment responses among patients taking the herbal medicines (Diallo and Paulsen, 2000. Promising herbal medicines identified in this way can then be subjected to pharmacological screening, phytochemical analysis and clinical trials to confirm their efficacy and safety, and also determine administration doses (World Health Organization, 2000).

4.4. Traditional knowledge associated to malaria treatment

The exploitation of HMPs depends to a large extent on local traditional knowledge. Traditional knowledge (TK) relevant to the treatment of malaria was found to be low and may be declining among the study community because only 50% of the respondents knew how to treat malaria. This knowledge was almost exclusively restricted to women because they were responsible for the health care of family members, especially children (Oberländer and Elverdan, 2000; Oreagba et al., 2004).

There is general consensus that TK must be conserved because of its vital role for human wellbeing. It is often argued, that if TK which has been generated over a long period of time is lost, exploitation of plants among other things will become difficult if not impossible. Among the reasons TK relevant for the exploitation of herbal medicines is considered reliable is that indigenous communities through a period of long experimentation with herbal medicines are likely to have retained those that are effective and tolerably safe while discarding preparations with low efficacy or acute toxicity (Balick, 1990; Cox, 1990; van Wyk and Wink, 2004).

Table 8
Comparative use of the species documented in this study for the treatment of malaria in other parts of Uganda or other countries

Species	Method of preparation of concoction, part used and country	Pharmacology
Flueggea virosa	1. Decoction prepared from stem bark; Guinea (Neuwinger, 1996)	Anti malarial activity detected (Gbeassor et al., 1989)
	2. Infusion prepared from leaves; Mali (Neuwinger, 1996)	
	3. Decoction prepared from roots; Ghana, Botswana (Neuwinger, 1996)	
	4. Decoction prepared from leaves; Burundi (Neuwinger, 1996)	
	5. Infusion prepared from leaves; Tanzania (Gessler et al., 1995a)	
	6. Roots used to treat malaria in many parts of Africa (Hutchings et al., 1996)	
Zanthoxylum chalybeum	1. Stem bark (method of preparation not mentioned); Uganda (Neuwinger, 1996)	Anti malarial activity detected (Neuwinger, 1996)
	2. Decoction prepared from stem bark; Kenya (Kokwaro, 1993)	
	3. Root bark (method of preparation not mentioned); Tanzania (Neuwinger, 1996)	
	4. Decoction prepared from roots, stem bark and leaves; Tanzania (Gessler et al., 1995a)	
	5. Species used to treat malaria (part and method of preparation not mentioned); Kenya (Njoroge and Bussmann, 2006)	
	6. Decoction prepared from roots; Uganda (Ssegawa and Kasenene, 2007.	
Jatropha curcas	1. Water extract prepared from twigs; Benin (Neuwinger, 1996)	
	2. Decoction prepared from root; Madgascar (Rasoanaivo et al., 1992)	
	3. Species used to treat malaria (part used and method of preparation not mentioned) in three continents (not mentioned) (Willcox and Bodeker, 2004)	
	4. Leaves are used to prepare a concoction (method of preparation not mentioned) (Arbonnier, 2004)	
	5. Leaves and roots used (method of preparation not mentioned); Nigeria (Hutchings et al., 1996)	
Mangifera indica	1. Species used to treat malaria (part used and method of preparation not mentioned) in three continents (not mentioned) (Willcox and Bodeker, 2004)	
	2. Decoction prepared from leaves of the species mixed with leaves of *A. indica* and *Carica papaya* (Asase et al., 2005)	
	3. Water extract from leaves of the species mixed with leaves of *Carica papaya, Psidium guajava* and *Cymbopogon citratus*; Nigeria (Tor-anyiin et al., 2003)	
Momordica foetida	1. Infusion prepared from leaves; Tanzania (Gessler et al., 1995a)	Anti malarial activity detected (Waako et al., 2005)
	2. Leaves used (method of preparation not mentioned); Rwanda (Hutchings et al., 1996)	
Azadirachta indica	1. Infusion prepared from roots, stem bark and leaves; Tanzania (Gessler et al., 1995a)	Anti malarial activity has been demonstrated clinically and experimentally. The active principles are nimbolide and gedunin (Sofowora, 1993, p71)
	2. Water extract prepared from leaf; Ghana (Asase et al., 2005)	
	3. Leaf decoction used in bath; Ghana (Abbiw, 1996)	
	4. Species used to treat malaria (part and method of preparation not mentioned) (van Wyk and Wink, 2004)	
	5. Species used to treat malaria (part and method of preparation not mentioned); Kenya (Njoroge and Bussmann, 2006)	
	6. Decoction prepared from leaf; Uganda (Ssegawa and Kasenene, 2007.	
	7. Infusion or decoction prepared from leaves; Nigeria (Tor-anyiin et al., 2003)	
	8. Leaves are used to prepare a concoction (method of preparation not mentioned) (Arbonnier, 2004)	
	9. Species used to treat malaria (part and method of preparation not mentioned); Nigeria (Sofowora, 1993, p71)	
Acacia sieberiana	1. Decoction prepared from roots; Ghana (Asase et al., 2005)	
Tamarindus indica	1. Decoction prepared from leaves and stem bark; Ghana (Asase et al., 2005)	
	2. Leaves are used to prepare a concoction (method of preparation not mentioned) (Arbonnier, 2004)	
Carissa edulis	1. Decoction prepared from root; Kenya (Kokwaro, 1993)	
	2. Species used to treat malaria (part and method of preparation not mentioned); Kenya (Njoroge and Bussmann, 2006)	
Lantana camara	1. Species used to treat malaria (part and method of preparation not mentioned); Kenya (Njoroge and Bussmann, 2006)	
Chenopodium ambrosioïdes	1. Extract from twigs used to treat fevers; Uganda (Adjanohoun et al., 1993)	
	2. Leaves used to cure fever in infants (method of preparation not mentioned); Rwanda (Hutchings et al., 1996)	
Moringa oleifera	1. Leaf infusion; Uganda (Ssegawa and Kasenene, 2007).	
Vernonia amygdalina	1. Decoction prepared from leaves mixed in maize porridge; Ghana (Asase et al., 2005)	Antiplasmodial activity ($5 < IC50 < 10$ μg/ml) (Tona et al., 2004)

Table 8(*Continued*)

Species	Method of preparation of concoction, part used and country	Pharmacology
	2. Decoction prepared from leaves of the species mixed with those of *Justicia insularis*; infusion prepared from leaves of the species mixed with those of *Ambrosia maritima*; Uganda (Adjanohoun et al., 1993)	
	3. Infusion prepared from leaves; Uganda (Hamill et al., 2000; Ssegawa and Kasenene, 2007)	
	4. Infusion prepared from leaves; Cameroon (Betti, 2004)	
	5. Water extract prepared from leave*s*; Nigeria (Tor-anyiin et al., 2003)	
	6. *V. amygdalina* is considered a quinine substitute. Leaves are used to prepare a concoctions (method of preparation not mentioned) (Arbonnier, 2004)	
	7. Leaves used to cure fever in infants (method of preparation not mentioned); Rwanda (Hutchings et al., 1996)	
Cajanus cajan	1. Species used to treat malaria (part and method of preparation not mentioned); Kenya (Njoroge and Bussmann, 2006)	
Albizia zygia	1. Decoction prepared from stem bark; Kenya (Kokwaro, 1993)	
Ocimum gratissimum	1. Water extract prepared from twigs of the species mixed with those of *Chromolaena odorata*; Nigeria (Tor-anyiin et al., 2003)	
Citrus sinensis	1. Fruits used to prepare a concoction (method of preparation not mentioned) (Arbonnier, 2004)	
Melia azedarach	1. Species used to treat malaria (part and method of preparation not mentioned); Nigeria (Sofowora, 1993)	The active principle is gedunin (Sofowora, 1993, p71). The species has antipyretic activity.
	2. Infusion prepared from root bark; Madagascar (Hutchings et al., 1996)	
Combretum molle	Unspecified plant parts used to treat fevers; South Africa and Ghana (Hutchings et al., 1996)	

All authors cited in the table report that the drugs were administered orally.

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