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Traditional antimalarial phytotherapy remedies used by the South Coast community, Kenya

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ABSTRACT

Aim of the study: This study was conducted to document herbal medicines used in the treatment of malaria as well as the existing knowledge, attitudes and practices related to malaria recognition, control and treatment in South Coast, Kenya.
Methods: Data was collected using semistructured questionnaires and interviews. A focused group discussion held with the community members, one in each of the study villages supplemented the interview and questionnaire survey.
Results: The respondents were found to have a good understanding of malaria and could 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 four times a year. Community members avoided mosquito bites by using mosquito nets, clearing bushes around their homesteads and burning plant parts to generate smoke. They prevented and treated malaria by taking decoctions or concoctions of traditional herbal remedies. Forty plant species in thirty-five genera distributed in twenty-four families were used as antimalarials in the study area. Five plant species, namely; *Heeria insignis* Del. (Anacardiaceae), *Rottboelia exaltata* L.F (Gramineae), *Pentanisia ouranogyne* S. Moore (Rubiaceae), *Agathisanthenum globosum* (A. Rich) Hiern (Rubiaceae), and *Grewia trichocarpa* Hochst ex A. Rich (Tiliaceae) are documented for the first time in South Coast, Kenya, for the treatment of malaria.
Conclusions: The plants documented in the current study are a potential source for new bioactive compounds of therapeutic value in malaria treatment. The results provide data for further pharmacological and toxicological studies and development of commercial antimalarial phytotherapy products.

1. Introduction

Malaria is a serious cause of mortality globally (Nguta et al., 2010). The disease causes 120 million episodes annually and claims the lives of around two million people worldwide. Seventy-five percent of these deaths occur in African children under the age of five (Najera and Hempel, 1996). World Health Organization (WHO) and UNICEF (2003) report a million deaths every year in sub-Saharan Africa, 90% of the deaths worldwide. The increasing prevalence of strains of *Plasmodium falciparum* resistant to chloroquine (CQ) which had been efficacious, safe, accessible and affordable poses a serious problem for malaria control (Trape, 2002), and leaves Africa with unprecedented situation in which the only affordable treatment options are rapidly losing therapeutic efficacy (Fidock et al., 2004). Although a number of advances have been made towards the understanding of the disease, relatively few antimalarial drugs have been developed in the last 30 years (Ridley, 2002). Drug resistant strains of *Plasmodium falciparum* have been found in many endemic areas of the world and majority of conventional antimalarial drugs have been associated with treatment failure (Olliaro and Bloland, 2001). These developments and the difficulty of creating efficient vaccines coupled with adverse side effects of the existing antimalarial drugs underline the urgent need for novel, well tolerated and more efficient antimalarial drugs (Bickii et al., 2000) affordable to the poor, living in malaria endemic tropical countries.

Historically, majority of antimalarial drugs have been derived from medicinal plants or from structures modeled on plant derived compounds. These include the quinoline-based antimalarials as well as artemisinin and its derivatives. In endemic countries, accessible treatments against malaria are mainly based on the use of traditional herbal remedies. Medicinal plants are commonly used

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in Kenyan traditional healthcare to treat a range of ailments, including malaria and its associated symptoms. The importance of diverse medicinal plants in Kenya lies not only in their chemotherapeutic value in traditional healthcare but also in their potential as sources of new chemical entities for drug discovery. Indeed, indigenous plants have been shown to play an important role in the treatment of many diseases (Phillipson and Wright, 1991) and 80% of the people worldwide are estimated to use herbal remedies (Phillipson, 1994; Geoffrey and Kirby, 1996).

Four major problems are associated with the treatment and 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 (Tabuti, 2008). 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 (Waako et al., 2005; Kilama, 2005). In Kenya, malaria treatment continues to be a national concern as it plays a major role in the high mortality seen in infants and children. It is also responsible for abortion, premature deliveries, growth retardation, low birth weight and anemia (Geissler et al., 1998). In Kenya, malaria is responsible for 30–50% outpatient treatments, 19% admissions and accounts for 8–10 million treatments per year (Ochola, 2003). *Anopheles gambiae* and *Anopheles funestus* are the primary vectors of malaria in East Africa (Murphy et al., 2001). The use and mis-use of chloroquine (CQ) to prevent and treat *falciparum* malaria has led to widespread appearance of chloroquine (CQ) resistant parasites in Kenya and other tropical countries (Milliken, 1997).

Kenya, through the division of malaria control (DOMC), ministry of health has developed several strategies for dealing with malaria. In regard to South-Coast endemic malaria for example, management strategies have been proposed which include, improved planning for the annual resurgent outbreak augmented by simple central nationwide early warning which is likely to lead to increased epidemic preparedness (Hay et al., 2003). Other key strategic approaches to malaria control in Kenya include case management, providing malaria prevention and control to pregnant women, ensuring use of insecticide treated nets (ITNs) as well as improving malaria preparedness and response (Division of Malaria Control, 2003). Despite these efforts the disease is still rampant, with over 170 million working days lost annually and treatment unaffordable to many Kenyans (Ochola, 2003) due to the rising costs of non-chloroquine drugs, high poverty levels as well as high prices of insecticide treated nets (Guyatt et al., 2002). Some of the plants used in malaria control in Kenya are used as repellants for the mosquitoes (Kuria et al., 2002) while others are taken as herbal medicines (Zowai et al., 2003). The drug resistant phenomenon has created urgent need to search for new drugs and alternative medicines for malaria and other diseases in Kenya (Muregi et al., 2003). Some of the plants used traditionally for malaria treatment have been investigated for their efficacy with positive results. The extracts tested *in vitro* have been shown to be active against chloroquine (CQ) sensitive and resistant strains of *Plasmodium falciparum*. Such plant extracts have been recommended for use as sources for novel antimalarial compounds to be used alone or in combination with chloroquine (Zowai et al., 2003). The plants tested are far too few. An often limiting factor to these investigations is lack of comprehensive ethnobotanical data to help choose plant candidates for efficacy and safety tests. Kenyan communities have unique and rich traditional practices for prophylaxis and treatment of malaria. The traditional ethnophytotherapeutic knowledge owned by the various communities is passed from generation to generation by oral means. Kenya is currently undergoing a rapid and traumatic change in its forest cover, which implies a rapid loss of this type of knowledge. There is a need therefore to package knowledge on medicinal plants used as antimalarial herbal remedies in a format that can be passed to the future generation.

Some ethnobotanical studies have been accomplished in Kenya targeting the different cultures and localities among others (Johns et al., 1990). These studies cover various aspects of plant utilization by local communities in Kenya. Studies on specialized knowledge on antimalarial herbal remedies in Msambweni, one of the malaria endemic districts in South Coast Kenya have been accomplished (Nguta et al., 2010). In the neighbouring country of Uganda, Tabuti (2008), has studied the common knowledge on herbal medicines (HMs) used in the treatment of malaria in Budiope county as well as the existing knowledge, attitudes and practices related to malaria recognition, control and treatment. The purpose of the present study was to utilize the common knowledge in order to document useful medicinal plants with a clearly defined therapeutic and prophylactic context of being used to treat and prevent malaria in a locality where malaria is endemic and with the most diverse flora and vegetation-South Coast, Kenya. This paper also addresses the following questions: (1) Which medicinal plant does the South Coast community in Kenya use to treat malaria and how is the taxonomic richness? Here we are working with the supposition that the traditional medicinal knowledge of the study community is firmly rooted in the past, and is considered to be both cumulative and dynamic, building on the experiences of earlier generations and adapting to the new technological and social-economic changes of the present. Traditional knowledge is also assumed to be communal and herbal remedies are mainly used to treat malaria which is endemic in this region. Also traditional methods of treatments based on medicinal plants are still an important part of social life and culture and the acceptability of medicinal plants as claimed effective remedies is still quite high among the population of the study area; (2) What is the existing knowledge, attitudes and practices in regard to malaria recognition, control and treatment amongst the South Coast community, Kenya? We believe that the people of South Coast, Kenya have rich ethnodiagnostic skills developed over time to positively diagnose malaria and have well developed methods utilized in malaria treatment and prevention; (3) Considering that malaria is endemic in this region, and that medicinal plants are widely used as putative antimalarial remedies, are there differences in the relative importance of the different species used? In the same way that we suspect that there will be a taxonomic richness of the species utilized to treat malaria, the influence of modern communication and informal information exchange between people might result in new uses being ascribed to a given plant (de Albuquerque et al., 2007).

Effort was made in this study to indicate the frequency of mention of each antimalarial plant species, factors responsible for causing malaria, practices employed to guard against mosquitoes bites and or to protect households against malaria, malaria treatment practices and attributes that favor the breeding of mosquitoes in the entire survey. The results provide data for further pharmacological and toxicological studies. Since the plant parts utilized in preparation of antimalarial herbal remedies are reported in this study, this may add information to the valuation of biodiversity and to forward suggestions for its sustainable use and conservation.

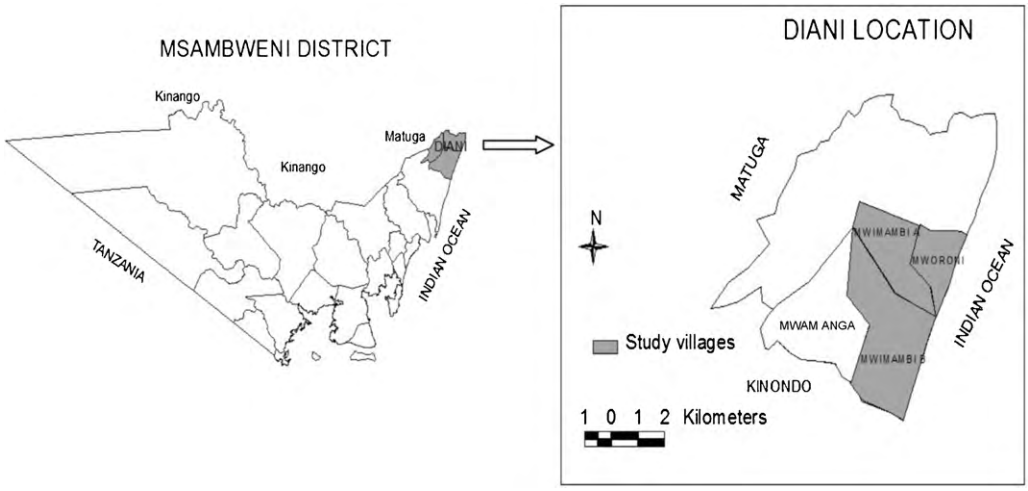

Fig. 1. Map of Msambweni district showing Diani location with study villages Mwamambi A, Mwamambi B and Mwaroni.

2. Materials and methods

2.1. Study area

In South Coast, the study area centered around 04°28′59.2″S latitude and 039°33′36.2″E longitude in and around Mwaroni, Mwamambi A and Mwamambi B villages of Ngombato sub-location, Diani location found in Diani division, Msambweni district in Coast province of Kenya (Fig. 1). The area is hot and humid all year round with annual mean temperatures ranging between 23 °C and 34 °C and the average relative humidity ranging between 60% and 80%. The soils are made of sandstone and grit and are fairly fertile for cultivation. The area has monsoon climate, hot and dry from January to April while June to August is the coolest period. Rainfall comes in two seasons with short rains from October to December and long rains from March/April to July. The total precipitation varies from 900 mm to 1500 mm per annum along the coastal belt to 500–600 mm in the hinterland, which comprise 92% of the land whose agricultural potential is low (Muthaura et al., 2007; Nguta et al., 2010). The study area is mainly inhabited by the Digo community, a Bantu tribe with a population of 225,000 (1999 Kenya National Population Census), 90% of who are Muslims and are concentrated on the southern coastal strip of Kenya between Mombasa and the border of Tanzania (Nguta et al., 2010). The community is rural and depends on crop agriculture as its major source of livelihood.

The medicinal knowledge of the Digo is considered communal, and the knowledge on the use of medicinal plants was bequeathed to them by their fathers orally from generation to generation. In most parts of South Coast, the traditional way of life and customary beliefs are however, quite intact and the acceptability of antimalarial and other medicinal plants as putative remedies is quite high among the population of this area (Nguta et al., 2010). The inhabitants of this region obtain their medicinal plants from the *Kaya* forests. These forests were the traditional social–cultural focal point of the Digo community in Kenyan South Coast, one of the nine deeply traditional ethnic groups that form the Mijikenda community of Kenyan South Coast (Muthaura et al., 2007; Nguta et al., 2010). They were preserved as sacred ceremonial sites, as sources of medicinal plants and social taboos prohibited the cutting of trees except for select purposes, thus biodiversity was sustained. More than half of the Kenya's rare plants grow in the coastal region; most have been identified within the *Kaya* forest patches, which comprise about 10% of the Kenya's Coastal forest. The traditional medicinal knowledge from the resources of these forests, in possession of the community, requires documentation for the benefit of current and future generations (Muthaura et al., 2007; Nguta et al., 2010).

2.2. Data collection

This study was conducted between May and November, 2009. Data was collected through a survey employing semistructured interviews and a guided open and closed ended questionnaire. The semistructured interviews were conducted using a checklist of questions and were held with individuals and local area leaders. Three 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. Herbalists were not included in the study since their specialized knowledge on the use of antimalarial herbal remedies along the Kenyan South Coast had been documented (Nguta et al., 2010). We were also informed that the community had good knowledge on management of malaria using traditional herbal remedies. The questionnaire included questions on respondent's biodata, 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 malarial herbal medicines. Questions on the existing knowledge, attitudes and practices related to malaria recognition, control and treatment in South Coast Kenya were also included. The questionnaire was translated in to Kidigo and Kiduruma, the principal languages spoken in the study area.

Respondents for the questionnaire survey were selected randomly using the multistage random sampling method as follows: Diani location was randomly selected from among the eleven locations of Msambweni district and was considered the primary sampling unit. From within Diani location, one sub-location (Ngombato) was selected. In turn, three villages; Mwaroni, Mwamambi A and Mwamambi B were selected from Ngombato sub-location. The desired sample size was fixed at 65 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%.

Twenty-two households were randomly selected from each village by consulting the village household registers. From among the selected households, random samples of thirty-three households were picked from which men were to be interviewed while the remainder constituted women respondents. In this way, 44 respondents were interviewed in Mwaroni and Mwamamambi A villages

Table 1
Socio-economic characteristics of respondents ($n = 65$).

Characteristic	(%)
Household head	
Male	75
Female	25
Tribe	
Digo	85
Duruma	15
Formal education	
None	40
Primary	10
Secondary	45
College	5
Religion	
Muslim	100
Primary job	
Peasant crop agriculture	85
Village elder	10
Animation	5
Secondary job	
Peasant crop agriculture	70
Trader	10
Artisan	5
Village elder	15

and 21 from Mwamamambi B village. The sample consisted of 34 male and 31 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 plant harvesting, drug preparation and vegetation types.

All antimalarial plants mentioned by respondents in the study were identified during ethnobotanical walks with informants in the field. A voucher specimen of each plant species was collected for identification and is deposited both at the National Museums of Kenya, an herbarium with regional and international access and also at the University of Nairobi Herbarium. Species nomenclature follows the flora for tropical East Africa. A written informed consent was obtained from all the respondents in the study. The research objectives and methods were explained to respondents before each interview. The information gathered included plant species, part used, plant habit, method of preparation, dosage, vernacular names and the existing knowledge, attitudes and practices related to malaria recognition, control and treatment.

2.3. Statistical analysis

Questionnaire survey data was entered in Excel spreadsheets. It was checked and edited for errors, and coded as described in Sarantakos (2005). Thereafter it was summarized using SPSS and reported in figures and tables as described by Tabuti (2008). Semistructured interview data was studied and the responses grouped into classes expressing similar ideas (Tabuti, 2008).

3. Results

3.1. Respondents' social-economic characteristics

Most respondents interviewed in this study lived in male headed households, belonged to the Digo ethnic group and had attained little (primary or secondary level) or no formal education (Table 1). All the respondents belonged to the Muslim religion. The main source of income of the respondents interviewed was peasant crop agriculture, while some served as traders, artisans and village elders as a way to earn secondary income. Respondents had, on average, four young dependants (1–15 years) and one elderly dependant (>60 years). Most households had *Makuti* (palm leaved) thatched huts constructed using mud. Many of the houses owned by the respondents 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.

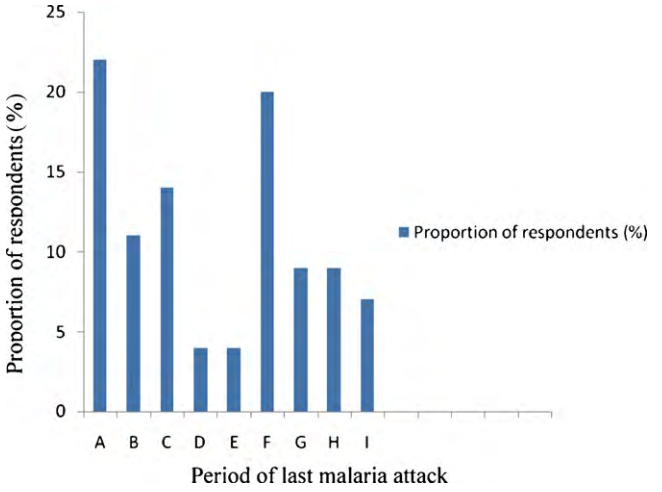

Fig. 2. Period of last malaria episode reported by respondents (A, currently suffering; B, 1 month ago; C, 2 months ago; D, 3 months ago; E, 4 months ago; F, 5 months ago; G, 6 months ago; H, 1 year, I, can't remember).

3.2. Traditional knowledge about malaria

Respondents had good knowledge about malaria and could readily distinguish it from other fever types on the basis of accepted signs and symptoms such as raised body temperature, chills, joint pains, weakness, headache, lethargy, abdominal pain, sneezing and flu like symptoms, loss of appetite, coughing and vomiting. The respondents knew that mosquitoes were involved in transmission of malaria. They also reported that young children, pregnant mothers, individuals with malnutrition and those with diseases such as AIDS and tuberculosis were most commonly affected by malaria. 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 their homesteads.

Conditions likely to favor the breeding of mosquitoes were observed in all homesteads. Garbage, empty tins, tall grass, cattle sheds and uncleared bushes were within 5 m of most homes. All homesteads had tall plants within 3–5 m of the house as well as untreated stagnant water in the compound. 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 repellants such as mosquito coils, cleaning the environment, burning the leaves of fresh *Azadirachta indica* (L) Burm, burning the ripe seeds *of Plectranthus barbatus* Andr., burning logs of plants such as *Ocimum bacilicum* L., burning the leaves of *Ocimum suave* Willd. and also removing materials likely to promote the breeding of mosquitoes such as draining stagnant water and treating water ponds with old engine oil. Respondents also reported that they cleared bushes around their homesteads. However, this was not observed during the study, and instead, bushes were always observed close to households (Fig. 2).

Table 2
Plants used in the treatment of malaria by the South Coast community, Kenya ($n = 0.25$).

Family/Species/(Voucher specimen no.)	Vernacular name	Habit[a]	Status[b]	Habitat[c]	Part used[d]/Mp[e]	No (%).[f]
Amaranthanceae *Amaranthus hybridus* L. (JN 120)	Mchicha (Swa)	H	Wi	Bu	L/D	1.7
Anacardiaceae *Heeria insignis* Del. (JN 127)	Mwamadzi (D)	Tree	Wi	Bu	SB/C	1.7
Apocynaceae *Laudolphia buchananii* (Hall.f) Stapf. (JN 126)	Mhonga (Swa)	L	Wi	Bu	L/D	1.7
Bombacaceae *Adansonia digitata* Linn. (JN 109)	Mbamburi (Swa)	T	Wi	Bu	L/D	8.6
Bursaraceae *Commiphora schimperi* (Berg) Engl. (JN 129)	Dzongodzongo (D)	Tree	Wi	Bu	R, SB, L/C	1.7
Caesalpiniaceae *Cassia occidentalis* L. (JN 119)	Mnuka uvundo (Swa)	H	Wi	Bu	R, L/C	1.7
Caesalpiniaceae *Tamarindus indica* L. (JN 139)	Mkwadzu (Swa)	T	Wi	Bu	SB/C	1.7
Combretaceae *Combretum padoides* Engl and Diels. (JN 121)	Phozo (D)	S	Wi	Bu	L/D	1.7
Compositae *Launea cornuta* (Oliv and Hiern) C. Jeffrey (JN 106)	Mtsunga wa utsungu (D)	H	Wi	Bu	L/D	14
Compositae *Senecio syringitolius* O. Hoffman (JN 122)	Reisa (D)	H	Wi	Bu	L/D	1.7
Cucurbitaceae *Gerranthus lobatus* (Cogn.)Jeffrey (JN 114)	Mgore manga (D)	L	Wi	Bu	R/C	5.2
Euphorbiaceae *Bridelia micrantha* Baill. (Hochst). (JN 137)	Mdungu (D)	Tree	Wi	Bu	SB, L/D	1.7
Euphorbiaceae *Ricinus communis* L. (JN 104)	Mbono/Mbonombono (D)	S	Cv, Wi	Bu, Cf, Rs	R, L/C	40
Flacourtiaceae *Flacourtia indica* (Burm.f) Merr. (JN 112)	Mtondo mbare (D)	S	Cv	Cf	R, SB/D	5.2
Gramineae *Rottboelia exaltata* L.F (JN 128)	Mpunga (D)	Grass/Herb	Wi	Bu	L/D	1.7
Labiatae *Hoslundia opposita* Vabl. (JN 132)	Mtserere (D)	Shrub	Wi	Bu	R/D	1.7
Labiatae *Ocimum bacilicum* L. (JN 108)	Kivumbani (D)	H	Wi	Bu	L/D	10
Labiatae *Ocimum suave* Willd (JN 124)	Murihani (G)	H	Wi	Bu	L/D	1.7
Labiatae *Plectranthus barbatus* Andr. (JN 115)	Kizimwilo/Mumbu (D)	S	Wi	Bu	L/D	3.4
Liliaceae *Aloe deserti* Berger. (JN 102)	Ngolonje (D)	H	Wi, Cv	Bu, Bm	L/D	52
Liliaceae *Aloe secundiflora* Engl. (JN 136)	Mshubiri (D)	Herb	Wi	Bu	L/I	1.7
Liliaceae *Aloe macrosiphon* Bak. (JN 125)	Golonje (G)	H	Wi	Bu	L/I	1.7
Liliaceae *Aloe vera* (L) Webb. (JN 113)	Alvera (D)	H	Wi, Cv	Cf, Bu	L/I	5.2
Meliaceae *Azadirachta indica* (L) Burm. (JN 100)	Mkilifi (D)	T	Cv, Wi	Cp, Bu, Cf	RB, SB, L/C	98
Mimosaceae *Acacia seyal* Del.						

Table 2 (*Continued*)

Family/Species/(Voucher specimen no.)	Vernacular name	Habit[a]	Status[b]	Habitat[c]	Part used[d]/Mp[e]	No (%).[f]
(JN 133)	Mgunga (D)	Tree	Wi	Bu	R/D	1.7
Mimosaceae	Chinjiri (D)	Shrub	Wi	Bu	R/C	1.7
Dichrostachys cinerea (L) Wight and Arn.						
(JN 134)						
Moraceae	Mgandi (D)	T	Wi	Bu	R, L/D	3.4
Ficus bussei Warp ex Mildbr and Burret.						
(JN 116)						
Papilionaceae	Mzigi (D)	S	Wi	Bu	R, SB, L/C	8.6
Securidaca longepedunculata Fres.						
(JN 110)						
Rubiaceae	Chivuma nyuchi (D)	Herb	Wi	Bu	R/D	1.7
Agathisanthenum globosum (A.Rich) Hiern						
(JN 131)						
Rubiaceae	Chungu (D)	Herb	Wi	Bu	R/C	1.7
Pentanisia ouranogyne S.moore						
(JN 130)						
Rubiaceae	Mhonga/Mronga (D)	S	Wi	Bu	F/C	1.7
Canthium glaucum Hiern.						
(JN 118)						
Rutaceae	Mtondombare (D)	Tree	Wi	Bu	L, SB/D	1.7
Clausena anisata (Willd) Hook.f ex. Benth.						
(JN 135)						
Rutaceae	Mulaga dare (DR)	S	Wi	Bu	R/D	5.2
Teclea simplicifolia (Eng) Verdoon						
(JN 111)						
Rutaceae	Muangani (D)	T	Wi	Bu	L/D	1.7
Fagaropsis angolensis (Engl) Del.						
(JN 123)						
Rutaceae	Mjafari/Mporojo(G)	T	Wi	Bu	RB/D	55
Zanthoxylum chalybeum (Eng) Engl.						
(JN 101)						
Simaroubaceae	Mdungu/Chidore(D/G)	S	Wi	Bu	RB, L/D	52
Harrisonia abyssinica Oliv.						
(JN 103)						
Solanaceae	Mtugudza koma (D)	S	Wi	Bu	R, L/D	14
Solanum incanum L.						
(JN 107)						
Tiliaceae	Cone (D)	S	Wi	Bu	R/D	1.7
Grewia trichocarpa Hochst ex A.Rich.						
(JN 138)						
Tiliaceae	Mkone (D)	S	Wi	Bu	R, L/C	1.7
Grewia hexaminta Burret.						
(JN 117)						
Verbenaceae	Mjasasa (D)	S	Wi	Bu	L/D	17
Lantana camara L.						
(JN 105)						

DR: Duruma; D: Digo; G: Giriama; Swa: Swahili.
[a] C: climber; H: herb; S: shrub; T: tree; W: woody herb.
[b] Cv: cultivated; We: weed; Wi: wild; Sw: semiwild.
[c] Bm: boundary marker; Bu: bush; Cf: crop field; Cp: compound; Rs: roadside.
[d] Bk: bark; Rb: root bark; F: fruit; R: root; L: leaves; SB: stem bark; Wp: whole plant.
[e] Method of preparation of medicinal plants: D: decoction; C: concoction; I: infusion.
[f] Percentage number of participants mentioning use of the species for malaria treatment.

3.3. Malaria treatment practices

The respondents reported suffering between 1 and 6 malaria episodes a year with a mean of four attacks. At the time the current study was conducted, 14% of the respondents reported that they were currently suffering from the disease while 22% had suffered an attack in the past 1 month (Fig. 3). The respondents stated a preference for herbal remedies for the treatment of suspected malaria (Fig. 3). They commonly self-medicated with a decoction of the stem bark of *Azadirachta indica*, where approximately 125 ml was taken three times a day for 4–5 days. They shared information on malaria treatment amongst themselves. A variety of reasons were given why they preferred self-medication using herbal remedies over self-medication with allopathic medicine or even visiting a medical practitioner. The principle reason was that the herbal remedies cured suspected malaria more effectively than allopathic medicine. They also reported that herbal remedies were free, readily accessible and were also more effective

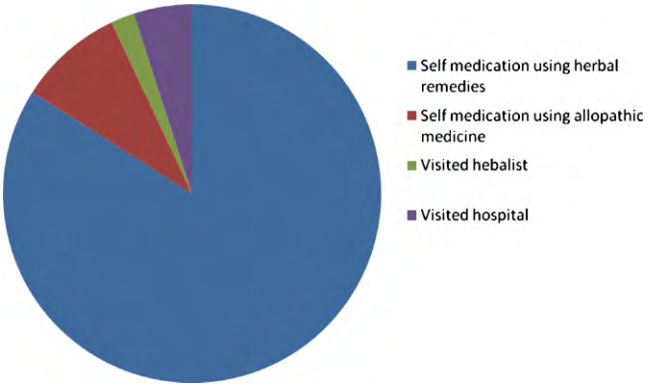

Fig. 3. Treatment used during the last malaria attack.

than allopathic medicines. Respondents also mentioned that herbal remedies had no toxic effects if the correct dosage was taken. Majority of the respondents reported that they did not seek the services of herbalists since they knew how to prepare the necessary herbal preparations themselves.

Some community members, however, preferred to self-medicate themselves with allopathic medicine. They commonly self-medicated using ibuprofen, chloroquine, metakelfin, Coartem (ACTs), amodiaquine and fansidar (Fig. 3). The main reason was that they lacked the relevant traditional knowledge necessary to exploit herbal medicines for the treatment of malaria. Another frequently mentioned reason was that they believed allopathic medicine was more effective than herbal remedies. Respondents also consulted western trained medical practitioners. They preferred doctors since they believed they will correctly diagnose the disease before treatment is initiated. They also reported that they were likely to get correct treatment from the hospital.

3.4. Plant species used in the treatment of malaria

Forty species distributed between 35 genera and 24 families were reportedly used in herbal preparations for the treatment of malaria (Table 2). Most of these were woody plants (Shrubs and trees). Mature leaves were commonly used in the preparations. 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 collection or processing of herbal remedies.

The herbal remedies were prepared mostly as infusions, decoctions or concoctions. The infusions and decoctions were prepared as mono-preparations from single plant species. The preparations were mostly administered orally and also at times topically as steam baths. Oral doses were variable and were administered according to the age of the patient. They varied between 80 ml and 500 ml for adults; 80 ml and 125 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 3–5 days. Prepared herbal remedies were consumed immediately and never kept. The preparation that remained after use was discarded. There was no need to keep any since the plants from which they were produced from were readily accessible. Respondents who used herbal remedies indicated that they were effective and had no side effects if the correct dose was taken. However, some community members reported adverse effects such as vomiting, headache and dizziness. They usually took fresh milk or raw egg as an antidote. Others reported that the adverse effects were usually mild and disappeared without any treatment.

3.5. Reports from literature supporting use of plant species for the treatment of malaria

Information from the literature shows that 86% of the reported plant species are used by people in other countries for the treatment of malaria (Table 3).

4. Discussion

4.1. Community knowledge about malaria

The respondents interviewed in this study had good knowledge about malaria and readily distinguished it from other illnesses on the basis of widely accepted malaria signs and symptoms (Gessler et al., 1995b; Ahorlu et al., 1997; Purcell, 2004; Tabuti, 2008). The community recognized the clinical features of malaria such as chills, profuse sweating, joint pains, abdominal pain, diarrhea, vomiting, anorexia and inability to stand (Ministry of Health, 2006). Malaria continues to be a major health challenge in Kenya especially due to the emergence of parasite resistance to commonly used and relatively cheap antimalarials. Knowledge about malaria has steadily improved in Kenya, but some misconceptions still remain about the causes and symptoms of severe malaria, and this were also documented in this study. However, majority of the respondents knew that malaria was spread by mosquitoes and one of the major symptoms of the disease was fever. This relatively good understanding of the causes and signs 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 communities in developing countries that associate the disease with witchcraft (Nuwaha, 2002).

4.2. Prevalence of malaria

Malaria remains a leading cause of morbidity and mortality in Kenya, especially in young children and pregnant women. It accounts for 30% of outpatient attendants and 19% of admissions to health facilities (MOH, 2006). This compares well with the prevalence observed in this study of four episodes a year. Malaria is the most important cause of death in children under 5 years of age and is estimated to cause 20% of all deaths in this age group (MOH, 2006). Parasite prevalence amongst childhood communities often exceeds 50% in high malaria risk areas such as the coastal endemic zone (MOH, 2006). This was not observed in this study since the study community mainly comprised of adults who have developed immunity to the disease. A high malaria prevalence 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 labor per year. This means, therefore, that 10–40 days are lost every year for an average sized family (six members) with two adults (Tabuti, 2008). This translates 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 (Tabuti, 2008). The estimated cost for treating a single malaria episode in Kenya is put at USD 0.8 (MOH, 2006). For a family of six people, suffering an average of four episodes a year, this translates into a total cost of USD 19.2 every year.

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; Tabuti, 2008). Out of concern for this resistance, the Ministry of Health of Kenya adopted the Artemisinin-based Combination Therapy (ACTs) as the first line medicine for the treatment of uncomplicated malaria in 2006 following recommendation by the World Health Organization (Malaria Control Programme, 2005). The efficacy and performance of ACTs remains to be evaluated (Tabuti, 2008). Secondly, the conditions in Diani Location as elsewhere in high malaria risk areas in Kenya are ideal for the breeding and survival of mosquitoes. Homesteads were surrounded by dense bush and the landscape had numerous logs lying within the flight range of the mosquito *Plasmodium falciparum*, estimated at 3 km (Ghebreyesus et al., 1999). Lastly, the infrastructure for managing malaria in Kenya as elsewhere in Africa is still weak (World Health Organization, 2003). According to the respondents, Diani location had few and poorly manned health care centres.

Table 3
Validation of medicinal action against malaria symptoms of the identified plant species.

Species	Reported ethnomedical uses	Pharmacology/Chemical constituents
Acacia seyal	The bark is used as a febrifuge in treatment for malaria	No previous reports
Adansonia digitata	The leaves are used as a diaphoretic and as a prophylactic against fevers (Watt and Breyer-Brandwijk, 1962), fever remedy (Abbiw, 1990); leaf decoction used for malaria (Nguta et al., 2010)	Antiplasmodial activity (Kristina, 2002); bioactivity (Cantrell, 2003)
Agathisanthenum globosum	No previous reports	No previous reports
Aloe deserti	A leaf decoction is used to treat the spleen (Kokwaro, 1993); Leaf infusion used for malaria (Nguta et al., 2010)	Anthrone C-glycosides, the chromones and a large mixed group of phenolic compounds (Reynolds, 2008)
Aloe macrosiphon	A leaf decoction is used to treat the spleen (Kokwaro, 1993); leaf infusion used to treat malaria (Nguta et al., 2010)	No previous reports
Aloe secundiflora	Leaf decoction is used to treat the spleen (Kokwaro, 1993)	Antimalarial activity (Oketch-rabah et al., 1999)
Aloe vera	The fleshy stock is chopped small, dried and roasted to powder. One small spoonful to be sucked twice a day between meals for the treatment of malaria (De La Pradilla, 1988); leaf infusion used for malaria (Nguta et al., 2010)	Stimulation of gap junctional intercellular communication and proliferation of human skin fibroblasts in diabetes mellitus (Abdullah, 2002)
Amaranthus hybridus	Leaf decoction used for malaria (Nguta et al., 2010)	Antioxidant activity (Adewumi, 2005); bioactivity (Cantrell, 2003)
Azadirachta indica	Leaf infusion used for malaria (Gessler et al., 1995a; Ibrahim et al., 1992; Tella, 1977; Van Der Nat et al., 1986); infusion prepared from roots, stem bark and leaves (Gessler et al., 1995b); root bark, stem bark and leaf decoction used for malaria (Nguta et al., 2010)	Antiplasmodial activity (El Tahir et al., 1999; Kirira et al., 2006), antimalarial activity has been demonstrated clinically and experimentally (Sofowora, 1993), active compounds gedunin, nimbinin (Bray et al., 1990), compounds meldenin, isomeldenin, nimocinolnimbandiol
Bridelia micrantha	No previous reports	Antiplasmodial activity (Edith et al., 2005)
Canthium glaucum	Fruits are boiled and drunk for malaria (Nguta et al., 2010)	No previous reports of biological activity
Cassia occidentalis	It has a special reputation as an excellent oxytocin, cholagogue, anti-fever medicine, anti-worm medicine and remedy for swellings. As a cholagogue, 15 g of leaves boiled in 1 l of water and 1 glass drunk daily; as a diuretic: 4 g of leaves in 180 g of water each day as an infusion (Neuwinger, 1994); root and leaf decoction used for malaria (Nguta et al., 2010)	Antiplasmodial activity (Cimanga, 2004; Tona, 1999). Terpenes, steroids, coumarins, flavonoids, phenolic acids, lignans, xanthones, anthraquinones(Cimanga, 2004)
Clausena anisata	Pounded roots are put into soup, as a cure for malaria (Kokwaro, 1993); roots and leaves used to treat malaria (Weenen et al., 1990)	Antiplasmodial activity observed (Clarkson et al., 2004)
Combretum padoides	Leaves for snakebites and the roots for eliminating hookworms (Neuwinger, 2000); leaf decoction used for malaria (Nguta et al., 2010)	Mono and bi-desmosidic triterpenoids from leaves (Rodgers, 1999); acetone extracts of leaves have antimicrobial effects (fresh leaves more effective than dried) MIC 0.8 μg/ml against *E.coli* and *Enterobacter faecalis* (Eloff, 1999)
Commiphora schimperi	The inner bark is boiled in water. Strain, add milk, drink for malaria and constipation (Koch et al., 2005)	In vitro antimalarial and cytotoxic activity (Koch et al., 2005)
Dichrostachys cinerea	In Burkina Faso, a handful of fruits is boiled for 15 min in 5 l of water; used to drink and as a wash twice daily for 3 days for malaria (De La Pradilla, 1988)	No previous reports
Fagaropsis angolensis	Used for management of malaria (Njoroge and Bussman, 2006); leaf decoction used for malaria (Nguta et al., 2010)	Bioactivity and antiplasmodial activity (Kirira et al., 2006)
Ficus bussei	A decoction of leafy twigs is used as a remedy for fever pains associated with malaria (Kerharo and Bouquet, 1950); root and leaf decoction used for malaria (Nguta et al., 2010)	Steroidal sapogenins (Wall, 2006)
Flacourtia indica	The leaf sap is mixed with a root decoction as a malaria cure (Burkill, 1994); decoction from leaves and roots used for malaria (Nguta et al., 2010)	Antiplasmodial activity (Clarkson et al., 2004)
Gerranthus lobatus	Fresh leaf juice mixed with 10 ml of brandy given twice in a week is used to treat heart diseases and hypertension; hot water extract from the leaves used for malaria (Nguta et al., 2010)	Flavonoid compounds (Imperato, 2005)
Grewia hexaminta	Hot water extract from the leaves used for malaria (Nguta et al., 2010)	Triterpenoid compounds (Raghunathaiyar, 1996)
Grewia trichocarpa	No previous reports	No previous reports
Harrisonia abyssinica	Root decoction used for fever (Kokwaro, 1993), venereal diseases (Beentje, 1994); hot water extract of fresh and dried root bark is used in Tanzania to treat skin diseases (Sawhney et al., 1978a,b); decoction of fresh and dried root bark and leaves used for malaria (Nguta et al., 2010)	Antimalarial activity (El Tahir et al., 1999); antiplasmodial activity (Kirira et al., 2006; Maregesi et al., 2010); methanol extract of dried root bark exhibited activity against *Trichophyton mentagrophytes* and *Candida albicans* (Sawhney et al., 1978b). Chloroform extract of the stem bark exhibited antifungal activity against *Aspergillus niger*, *Microsporum canis*, *Trichophyton mentagrophytes* and *Aspergillus fumigates* (Balde et al., 1995)
Heeria insignis	A root decoction is used to treat epilepsy (Moshi et al., 2005)	Myrcene, β-pinene, α-pinene (Ayedoun et al., 1998)
Hoslundia opposita	Used for mental disorders, malaria, convulsions in children (Hedberg et al., 1983a)	Antimalarial activity confirmed (Gessler et al., 1994)
Lantana camara	The infused leaves are used as a diaphoretic and febrifuge (Burkill, 2000), the roots are used for malaria, and said to be effective in cases which are not responsive to quinine (Burkill, 2000). Tea of the leaves is believed to prevent weakness of memory and enhances intellect and cognition (Muller-Ebeling and Ratsch, 1989); decoction from leaves used as antimalarial (Nguta et al., 2010)	Antiplasmodial activity (Clarkson et al., 2004). Quinine like alkaloid, *lantanine*, is present in the leaves (Burkill, 2000)
Laudolphia buchananii	Leaf decoction used for malaria (Nguta et al., 2010)	No previous reports

Table 3 (*Continued*)

Launea cornuta	The roots are pounded and infused or decocted, the liquid being drunk as a remedy for typhoid (Kokwaro, 1993); leaves are boiled and drunk for malaria (Nguta et al., 2010)	Tannins and astringents (Burkill, 1985)
Ocimum bacilicum	For abdominal cramps, upset stomach, nervous migraine, memory "strengthens the heart and the head" loss and forgetfulness (Fuchs, 1543; Sfikas, 1980); leaf decoction used for malaria (Nguta et al., 2010)	Antifungal activity (Dambolena, 2007), linalool, geranical, camphor compounds (Dambolena, 2007)
Ocimum suave	In Tanzania, the scrappings of the roots mixed with *Zingiber officinalis* are used for inflamed tonsils (Hedberg et al., 1983b) and the dried twigs are used as a chewing stick (Khan et al., 2000). Used for treatment of Candida infections including oral candidiasis (Runyoro et al., 2006); hot water extract from the leaves used for malaria (Nguta et al., 2010)	The essential oil isolated from the aerial structures of the plant was reported active against a number of microorganisms (Janssen et al., 1989). The ethanol extract of the leaves of Rwandese plants were found to be active against *Bacillus subtilis* and *Microsporum canis* (Vlientinck, 2000). Triterpenes (Tan, 1997); anti-ulcerogenic activity (Tan, 1997)
Pentanisia ouranogyne	No previous reports	No previous reports
Plectranthus barbatus	The plant is used as a mosquito repellant (Watt and Breyer-Brandwijk, 1962); leaf decoction used for malaria (Nguta et al., 2010)	Antiplasmodial activity (Meyer, 2002)
Ricinus communis	Leaves are used as a remedy for fever (Burkill, 1994), dried root is used as a febrifuge (Watt and Breyer-Brandwijk, 1962), the oil is added to paraffin-based spray as an antimalarial agent (Burkill, 1935); hot water extract from leaves and roots used as antimalarial (Nguta et al., 2010)	Antiplasmodial activity (Clarkson et al., 2004)
Rottboelia exaltata	Powdered roots are mixed with oil and left for 2 days. The mixture is applied topically. The patient is made to shave the head and rub it with the mixture once or twice a day for epilepsy (Moshi et al., 2005)	No previous reports
Securidaca longepedunculata	The roots are used against malaria (Williamson, 1975); hot water extract from the roots, stembark and leaves used for malaria (Nguta et al., 2010)	The roots contain steroids, saponosides and monotropitoside (De La Pradilla, 1988); aqueous, dichloromethane and ethanol extracts are reported to have activity against *Candida albicans* (Desta, 1993; Taniguchi et al., 1978).
Senecio syringitolius	Leaf decoction used for malaria (Nguta et al., 2010)	No previous reports
Solanum incanum	A root decoction is used against fever (Kokwaro, 1993); root decoction used for malaria (Nguta et al., 2010)	Antiulcerogenic effect (Farina et al., 1998), active triterpenoid compounds-Ursolic acid (3a) (Hirota et al., 1990)
Tamarindus indica	In Burkina Faso, 4 bunches of leafy twigs are boiled in 10 litres of water for 15 min. Bathe the body twice daily, and drink a little, for 4 days for malaria (De La Pradilla, 1988).	The leaves contain luteoline, apigenine, orientine, isorientine, vitexine and pinitol (De La Pradilla, 1988).
Teclea simplicifolia	In Kenya, the roots are regarded as poisonous (Neuwinger, 1996). The maasai use a root infusion for gonorrhea (Neuwinger, 2000); in Kenya, the Digo use a decoction of the roots for malaria (Nguta et al., 2010)	Quinoline compounds (Wondimu, 1998)
Zanthoxylum chalybeum	Stem, root bark and leaves used for malaria (Beentje, 1994; Gessler et al., 1994; Hedberg et al., 1983a), in Kenya, a decoction is prepared from stem bark (Kokwaro, 1993), in Uganda, a decoction is prepared from roots, the fresh leaves of the plant from Tanzania are pounded with leaves of *Acalypha fruticosa* and *Surigada zanzibariensis* and the resulting juice is used for skin infections (Hedberg et al., 1983b). The fresh twigs of the plant from East Africa are used as tooth brush, air fresheners and for skin infections (Hedberg et al., 1983b; Johns et al., 1990); Root bark used for malaria (Nguta et al., 2010)	Antiplasmodial activity (Gessler et al., 1994), Antimalarial activity detected (Neuwinger, 1996), quinoline alkaloids (Kato et al., 1996). The bark of the Kenyan plant was reported active against *Bacillus subtilis*, *Penicillium crustosum* and *Saccharomyces cerevisiae* (Taniguchi et al., 1978)

4.3. Herbal medicines used to treat malaria

Malaria continues to be a major health challenge in Kenya especially due to resistance of *Plasmodium* to the drugs in use currently (Njoroge and Bussman, 2006). The results of this study show both indigenous and introduced species are in use for malaria treatment. This indicates that traditional medicinal practices in this region are dynamic. The information on frequently utilized antimalarial plant species is an important lead to the species that can be targeted for further pharmacological, toxicological and phytochemical analysis. Since there is no safer, effective and cheaper antimalarial remedies than chloroquine (Gessler, 1995) in the treatment of malaria, development of new antimalarial drugs especially from plant sources may be the way forward in dealing with global drug resistant problems of malaria.

Malaria prevalence observed in the study community and which has direct implications on the people's health and economic well-being, calls for extensive research and development of effective and safe antimalarials (Tabuti, 2008). Within the 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 (Tabuti, 2008). This focus is justified because herbal medicines are widely accepted as safe and efficacious remedies by the study community. Indeed many drugs used in malaria treatment have been derived from higher plants using leads from traditional knowledge (Fransworthy, 1990; Fabricant and Farnsworth, 2001; Van Wyk and Wink, 2004; Tabuti, 2008). These include the quinoline-based antimalarials as well as artemisinin and its derivatives (Orwa, 2002; Waako et al., 2005).

There are species, which were commonly cited in this study that are also known to be used as sources of antimalarial remedies in other parts of Kenya or other countries (Table 3). 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 however, important to validate all claims of therapeutic efficacy and safety by undertaking pharmacological and toxicological studies (Tabuti, 2008). The literature reviewed in this study reveals that few toxicological studies have been conducted (Table 3).

Validation of traditional medical practices is important because it may generate higher confidence and hence wider use of such species (World Health Organization, 2000). Wider acceptance of traditional herbal remedies can yield significant benefits for primary health care and also help create a herbal medicine market, with possibilities of adding value to medicinal plants (Tabuti, 2008). 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, toxicological 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

Most knowledge on medicinal plants is transferred orally in many communities (Fratkin, 1996) and there is therefore the danger of losing this precious cultural heritage (Muthaura et al., 2007). In view of the rapid loss of natural habitats, traditional community life, cultural diversity and knowledge of medicinal plants, an increasing number of ethnobotanical inventories need to be established (Van Wyk et al., 2002). The exploitation of traditional herbal practices depends to a large extent on local traditional knowledge (Tabuti, 2008). Traditional knowledge relevant to the treatment of malaria was found to be high amongst the study community.

There is general consensus that traditional knowledge must be conserved because of its vital role for human wellbeing. It is often argued that if traditional knowledge which has been generated over a long period of time is lost, exploitation of plants among other things will become difficult if not impossible (Tabuti, 2008). Among the reasons traditional knowledge 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; Tabuti, 2008).

The local community of South Coast, Kenya is the owner of traditional knowledge presented in this paper. Consequently, any benefits that may accrue following the use of this knowledge must be shared with them.

5. Conclusions

Most plant species reported in this study have been used in other parts of Kenya and also in other countries as antimalarial herbal remedies. Five plant species are documented for the first time for the treatment of malaria. Respondents also mentioned some plant species that have already been investigated for their phytoconstituents and pharmacological activities, the latter being in agreement with ethnomedical uses reported in this study. This study calls for rational investigation of indigenous plants along South Coast Kenya for antiplasmodial properties. Considering that most antimalarial plant species reported in this study have not been investigated pharmacologically, toxicologically or phytochemically, they remain a potential source of leads for antimalarial drug development. The claimed therapeutic value of the species reported in this study call for scientific evaluation so as to establish their safety and efficacy. Ecological studies on regeneration of plant species reported in this study are recommended since they could provide data on management of these species for sustainable utilization.

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