Journal of Ethnopharmacology 128 (2010) 424–432

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jethpharm

Antimalarial herbal remedies of Msambweni, Kenya

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ARTICLE INFO

Article history:
Received 4 October 2009
Received in revised form 7 January 2010
Accepted 10 January 2010
Available online 22 January 2010

Keywords:
Medicinal plants
Traditional treatments
Antimalarial
Msambweni
Ethnobotany

ABSTRACT

Malaria is a serious cause of mortality globally. The disease is of regional concern in Africa and of national interest in Kenya due to its high morbidity and mortality as a result of development of resistant strains of *Plasmodium falciparum* to many existing drugs such as chloroquine. Alternative medicine using herbal remedies are commonly used to treat malaria in Kenya. However, plants used in some rural areas in Kenya are not documented. Many antimalarial drugs have been derived from plants. This study was conducted to document medicinal plants that are traditionally used by the Msambweni community of Kenyan South Coast to treat malaria, where the disease is endemic. Herbalists were interviewed by administration of semistructured questionnaires in order to obtain information on medicinal plants traditionally used for the treatment of malaria. Focused group discussions held with the herbalists supplemented the interview and questionnaire survey. Twenty-seven species of plants in 24 genera distributed in 20 families were reported to be used in this region for the treatment of malaria. Labiatae, Rutaceae and Liliaceae families had each eleven percent of the plant species reported and represented the species that are most commonly used. Thirteen plant species, namely; *Aloe deserti* Berger (Liliaceae), *Launea cornuta* (Oliv and Hiern) C. Jeffrey (Compositae), *Ocimum bacilicum* L. (Labiatae), *Teclea simplicifolia* (Eng) Verdoon (Rutaceae), *Gerranthus lobatus* (Cogn.) Jeffrey (Cucurbitaceae), *Grewia hexaminta* Burret. (Tiliaceae), *Canthium glaucum* Hiern. (Rubiaceae), *Amaranthus hybridus* L. (Amaranthaceae), *Combretum padoides* Engl and Diels. (Combretaceae), *Senecio syringitolius* O. Hoffman. (Compositae), *Ocimum suave* Willd (Labiatae), *Aloe macrosiphon* Bak. (Liliaceae) and *Laudolphia buchananii* (Hall.f) Stapf. (Apocynaceae) are documented from this region for the first time for the treatment of malaria. These results become a basis for selection of plants for further pharmacological, toxicological and phytochemical studies in developing new plant based antimalarial drugs.

1. Introduction

Malaria is the most important cause of ill health, death and poverty in sub-Saharan Africa (Kilama, 2005). It is estimated that there are 300–500 million acute cases of malaria worldwide annually (Tabuti, 2008). About 80% of these are in Africa leading to 1.75–2 million deaths annually, mostly children under 5 years old (World Health Organization, 2003). Worldwide, 3000 children die everyday from malaria. Malaria is therefore a major obstacle to social-economic development in Africa. It constitutes 10% of Africa's total disease burden; 40% health expenditure and 30–50% of inpatient cases (WHO, 2001). Total African cost estimate is in the range of US$12 billion annually.

In Kenya, 22 million people are at risk of malaria, 70% of them are in rural areas. About 34,000 Kenyan children die every year from malaria compared to a total estimate of 42,000 people dead (Director of Medical Services, Kenya, 2006). 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 (Tabuti, 2008).

There are many antiplasmodial drugs that have been developed during the course of time. Quinine was identified as a useful drug from the South American plant of the genus *Cinchona* since 1645. The extracts of the plant were used for a long time without emergence of resistant parasites. However, it exhibited relatively high mammalian toxicity and was also not readily available. The problem of resistance development makes the search for antimalarial drugs an elusive and continuous undertaking. Indeed, due to this problem, the situation of malaria therapy is worse now than it

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doi:10.1016/j.jep.2010.01.033

was 20 years ago. According to the Kenyan Director of Medical Services, Kenyan government has discouraged the use of chloroquine and sulfadoxin/pyrimethamine drugs due to development of resistance. Artemisinin, a plant product and its derivatives are currently the drugs of choice for treatment of malaria in Kenya. This compound was isolated from the age old Chinese plant *qinq hao* or *Artemisia annua* which is now a widely grown crop in Kenya and neighbouring countries. Artemisinin has excellent antiplasmodial properties but is more expensive compared to other antimalarial drugs. The Global Fund (GF) for malaria and AIDS has allocated funds to purchase and provide Kenya with free artemisinin combination therapy drugs (ACTs) for 2 years to help in the war against malaria. It is going to be very difficult for Kenya to sustain availability of these drugs after the GF period runs out.

Medicinal plants are important in ethnomedical practices with malaria ranking as the most important disease treated with herbal remedies. Due to either limited availability or affordability of conventional medicines in tropical countries, about 80% of the rural population depends on traditional herbal remedies (Zirihi et al., 2005). Although there is widespread use of traditional herbal remedies in the management of malaria (Gessler et al., 1995), scientific understanding of the plants is however largely unexplored (WHO, 2002) and therefore, there is a need to collect ethnobotanical information on antimalarial plants as a first step prior to evaluation of their efficacy and safety. Historically, majority of conventional antimalarial drugs have been derived from plants or from structures modeled on plant derived compounds (Klayman, 1985). Quinine and artemisinin were obtained directly from plants. Research on medicinal plants used in folk medicine represents a suitable approach for the development of new drugs (Calixto, 1996). To meet the criteria of efficacy, safety and quality control like synthetic drug products, the pharmacological, toxicological and phytochemical profiles of the plant extracts have to be scientifically evaluated (Wagner, 1997). However, the World Health Organization (WHO) recognizes that the centuries-old use of certain plants as therapeutic resources should be taken into account of their efficacy (Gilbert et al., 1997). Thus, it considers phytotherapy in its health care programs and suggests basic procedures for the validation of drugs from plant origin in developing countries (Vulto and Smet, 1998).

Malaria is endemic in Msambweni district in Kenya and prevalent in many other parts of the country. The disease prevalence, morbidity and mortality have increased with increasing drug resistance by the malaria parasite, *Plasmodium falciparum* (WHO, 2001). This has necessitated countries like Kenya to revise their treatment policy and adopt artemisinin combination therapy (ACTs) as first line drug for the treatment of uncomplicated malaria. ACTs are expensive and majority of Kenyans cannot afford them. This underscores the extent of the disease burden and economic loss for the country. However, the practice of traditional medicine continues unabated alongside conventional medicine because of ease of availability, inaccessibility of healthcare centre's and also due to social cultural factors (Cunningham, 1988). Conventional healthcare provided by the government of Kenya has been expanded in the last decades, but is often not readily available and many regions remain completely underserved (Muthaura et al., 2007). Hence, most communities still use herbal remedies as readily and cheaply available alternative.

Most of Africa's biodiversity play major specific roles in the cultural evolution of human societies (Mugabe and Clark, 1998) and plants have been an integral part of life in many indigenous communities (Sidigia et al., 1995). Many communities in Africa have much elaborated plant knowledge (Barrow, 1996). Traditional medicinal plant knowledge is transferred orally in rural communities and there is the danger of losing this precious cultural heritage (Fratkin, 1996). 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). In Msambweni area, Kenya, the traditional way of life and customary beliefs are intact and the acceptability of antimalarial and other medicinal plants as putative remedies is high among the inhabitants of this area.

Some ethnobotanical studies have been accomplished in Kenya targeting the different communities and localities (Njoroge and Bussman, 2006). These studies cover various aspects of utilization of traditional herbal remedies by local communities in Kenya. Studies, however, to document traditional antimalarial herbal remedies in Msambweni district have not been done. Effort was made in this study to indicate the frequency of mention of each plant species traditionally used to treat malaria as an estimation of agreement on use in the study area. The results provide data for further pharmacological, toxicological and phytochemical studies. Since the plant parts utilized in preparation of antimalarial herbal remedies are reported in this study, it serves as an indication of species that may need further ecological assessment on their regeneration status.

2. Materials and methods

2.1. Study area

In Msambweni, the study area centered around 04°28′59.2″S latitude and 039°13′48.9″E longitude in Diani, Pongwe Kidimu and Dzombo/Kikoneni locations of Msambweni district (Fig. 1). The vegetation consists of thickets, woodlands and grasslands. 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 ranges between 60% and 80%. The soils are made of sandstone and grit and are fairly fertile for cultivation. The type of climate is monsoon, 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 comprises 92% of the land whose agricultural potential is low (Muthaura et al., 2007).

The population of Msambweni approximates 225,000 (1999 National population Census), 90% of who are Muslim and are concentrated on the southern coastal strip of Kenya between Kwale district and the border of Tanzania (Msambweni district). The community is rural and depends on crop agriculture as its major source of livelihood. The people belong predominantly to three ethnic groups, with the Digos being the majority followed by Durumas while Kambas are the minority. The main language spoken is Kidigo. The medicinal knowledge of the communities is considered communal; however there is individually held knowledge by the herbalists. The indigenous knowledge held by the herbalists on the use of medicinal plants was transferred to them by their fathers orally. More than half of the Kenya's rare plants grow in the coastal region, most of which have been identified within the *Kaya* forest patches which comprise about 10% of the Kenya's coastal forests (Muthaura et al., 2007). The traditional medicinal knowledge from the resources of these forests, in possession of a few herbalists, needs to be documented for the benefit of the present and future generations.

2.2. Data collection

This study was conducted between April and July, 2009. Data on medicinal plants traditionally used to treat malaria was collected through a survey employing standardized questionnaires and interviews. Focused group discussions were held with the

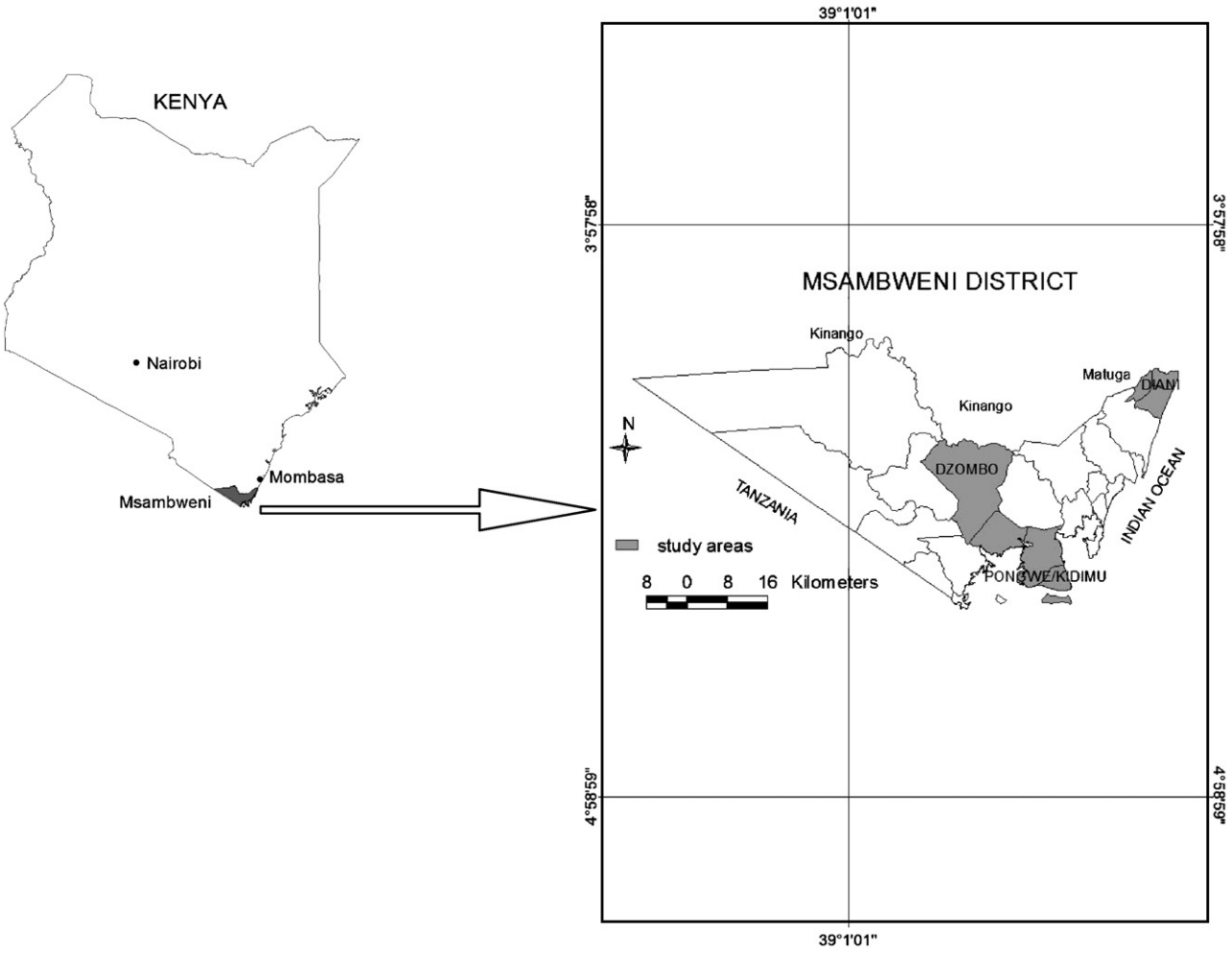

Fig. 1. Map of Kenya showing Msambweni district with study areas Diani, Pongwe Kidimu and Dzombo/Kikoneni locations.

herbalists to supplement the interview and questionnaire survey. Twenty herbalists from both genders were selected from all the locations in Msambweni district. Seventy five percent were male while 25% were females and their ages ranged from 38 to over 57 years. They were interviewed to obtain information on medicinal plants traditionally used for the treatment of malaria. An herbalist and a taxonomist who was conversant with the flora of the area was part of the collection team.

2.3. Sample collection and identification of antimalarial plants

Plants reported to be traditionally used as antimalarial herbal remedies were collected by a team comprising of herbalists, a botanist and the research team. Traditionally malaria is treated in function of symptoms and those plants claimed to treat malaria, fevers, joint pains, headache, loss of appetite and vomiting as identified by the herbalists were collected. The plants were identified by a taxonomist and voucher specimens deposited at the University of Nairobi Herbarium. Each specimen was assigned a number. The information gathered included plant species, parts used, plant status, plant habit, plant habitat, method of preparation, route of administration, dosage and vernacular names.

3. Results

Twenty herbalists, whose experience in the use of traditional medicine ranged from 10 to 50 years, were interviewed on the plants that they used for treatment of malaria. Twenty-seven species distributed between 24 genera and 20 families were reportedly used in herbal preparations for the treatment of malaria (Table 1).

Shrubs comprised of 41% of all the species traditionally used for the treatment of malaria while lianas constituted only 4% of all the plant species reported in the study. Mature leaves were commonly used in the preparation of herbal remedies. Herbalists 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 drugs were prepared mostly as decoctions, concoctions, water extracts usually prepared just before use or as steam baths. The water extracts and decoctions were prepared as mono-preparations from single species. Some concoctions were prepared as mixtures of *Azadirachta indica* (Meliaceae) and *Ricinus communis* (Euphorbiaceae); *Teclea simplicifolia* (Rutaceae) and *Flacourtia indica* (Flacourtiaceae) or *Grewia hexaminta* (Tiliaceae), *Solanum incanum* (Solanaceae) and *Azadirachta indica* (Meliaceae). The plant material was used fresh or dried and most plant parts to be used as remedies were stored for later use in the dry state, which allowed their utilization throughout the year. Oral doses were variable and were administered according to the age of the patient. They varied between 100 ml and 500 ml for adults; 100 ml and 250 ml for older children (more than 5 years) and 1–3 tablespoons for children younger than 5 years. The herbal preparations were taken 1–3 times a day for a period of 4–5 days or until the patient's

Table 1
An inventory of plants commonly used for the treatment of malaria.

Family/Species/(Voucher specimen no.)	Vernacular name	Habit	Status	Habitat	Pu[a]/P[b]/Ra[c]	No.[d]
Amaranthanceae, *Amaranthus hybridus* L. (JN 430)	Mchicha (Swahili)	Herb	Wild	Bush	L/D/O	1
Apocynaceae, *Laudolphia buchananii* (Hall.f) Stapf. (JN 427)	Mhonga (Swahili)	Liana	Wild	Bush	L/D/O	1
Bombacacea, *Adansonia digitata* Linn. (JN 414; 415)	Mbamburi (Swahili)	Tree	Wild	Bush	L/D/O	2
Caesalpiniaceae, Cassia *occidentalis* L. (JN 425)	Mnuka uvundo (Swahili)	Herb	Wild	Bush	R, L/D/O	1
Combretaceae, *Combretum padoides* Engl and Diels. (JN 434)	Phozo (Digo)	Shrub	Wild	Bush	L/D/O	1
Compositae, *Senecio syringitolius* O. Hoffman. (JN 432)	Reisa (Digo)	Herb	Wild	Bush	L/D/O	1
Cucurbitaceae, *Gerranthus lobatus* (Cogn.) Jeffrey (JN 405; 406; 407)	Mgore manga (Digo)	Liana	Wild	Bush	R/D/O	1
Euphorbiaceae, *Ricinus communis* L. (JN 431)	Mbono/Mbonombono (Digo)	Shrub	Cultivated, Wild	Bush,Crop field	R, L/D, C, B/O	2
Flacourtiaceae, *Flacourtia indica* (Burm.f) Merr. (JN 436)	Mtondo mbare (Digo)	Shrub	Cultivated	Crop field	R, Sb, L/D/O	1
Labiatae, *Plectranthus barbatus* Andr. (JN 418)	Kizimwilo/Mumbu (Digo)	Shrub	Wild	Bush	L/D/O	1
Labiatae, *Ocimum bacilicum* L. (JN 428)	Kivumbani (Digo)	Herb	Wild	Bush	L/D/O	2
Labiatae, *Ocimum suave* Willd (JN 408; 409)	Murihani (Giriama)	Herb	Wild	Bush	L/D/O	1
Liliacea, *Aloe deserti* Berger. (JN 424)	Ngolonje (Digo)	Herb	Cultivated, Wild	Bush, Boundary marker	L/We/O	5
Liliaceae, Aloe *macrosiphon* Bak. (JN 435)	Golonje (Giriama)	Herb	Wild	Bush	L/We/O	1
Liliaceae, *Aloe vera* (L) Webb. (JN 421)	Alvera (Digo)	Herb	Wild, Cultivated	Crop field, Bush	L/We/O	2
Meliaceae, *Azadirachta indica* (L) Burm. (JN 412; 422)	Mkilifi (Digo)	Tree	Cultivated, Wild	Crop field, Bush	Rb, Sb, L/D, C, B/O	19
Moracea, *Ficus bussei* Warp ex Mildbr and Burret. (JN 403)	Mgandi (Digo)	Tree	Wild	Bush	R, L/D, C/O	1
Papilionaceae, *Securidaca longepedunculata* Fres. (JN 423)	Mzigi (Digo)	Shrub	Wild	Bush	R, Sb, L/D/O	1
Rubiaceae, *Canthium glaucum* Hiern. (JN 426)	Mhonga/Mronga (Digo)	Shrub	Wild	Bush	Fr/D/O	1
Rutaceae, *Fagaropsis angolensis* (Engl) Del. (JN 437)	Muangani (Digo)	Tree	Wild	Bush	L/D/O	1
Rutacea, *Teclea simplicifolia* (Eng) Verdoon (JN 413)	Mulaga dare (Duruma)	Shrub	Wild	Bush	R/D/O	1
Rutaceae, *Zanthoxylum chalybeum* (Eng) Engl. (JN 433)	Mjafari/Mporojo(Giriama)	Tree	Wild	Bush	Rb/D, C/O	5
Simaroubaceae, *Harrisonia abyssinica* Oliv. (JN 438)	Mdungu/Chidore(Digo/Giriama)	Shrub	Wild	Bush	Rb, L/D/O	3
Solanacea, *Solanum incanum* L. (JN 416; 417)	Mtugudza koma (Digo)	Shrub	Wild	Bush	R, L/D/O	2
Tiliaceae, *Grewia hexaminta* Burret. (JN 401; 402)	Mkone (Digo)	Shrub	Wild	Bush	R, L/D/O	1
Verbenaceae, *Lantana camara* L. (JN 429)	Mjasasa (Digo)	Shrub	Wild	Bush, Boundary marker	L/D/O	2

Rb: root bark; Sb: stem bark; L: leaves; O: oral; B: bathed; R: roots; Fr: fruit. D: decoction (remedy is prepared by boiling a plant part in water). C: concoction (remedy is prepared by boiling parts from different plants in water). We: water extract (remedy is prepared by dissolving a plant part in water for sometime).

[a] Part used.
[b] Method of preparation.
[c] Route of administration.
[d] Number of herbalists mentioning use of the species for malaria treatment.

condition improved. Prepared herbal medicines were never stored and remnants were discarded. There was no need to keep any since the plants from which they were prepared from were readily available. Herbalists indicated that their herbal remedies were effective and cured 100% of their patients. They also reported that their remedies had no side effects.

There are species, which were reported in this study that are also known to be used as sources of antimalarial remedies in other countries (Table 2). They have also been investigated for their phytoconstituents and antimalarial activities (Table 2), the latter being in agreement with ethnomedical uses reported in this study. A total of 52% of the plants collected have been reported in literature as having been used for malaria or fever, an indication that the herbalists could be trusted with the information they imparted about the plants they traditionally use for preparation of antimalarial herbal remedies.

4. Discussion

The objective of the ethnomedical survey was to document the plants used traditionally at Msambweni, Kenya, against malaria. Considerable similarity of information on the use of plant species for treatment of malaria was reported by several herbalists. The use of a decoction of *Azadirachta indica* stem bark had 95% frequency

Table 2
Plant species collected from Msambweni district based on traditional knowledge on their use as antimalarials.

Plant species	Method of administration	Active constituents	Ethnomedicinal uses
Adansonia digitata	Oral, one cup is taken 3 times daily for 3–4 days or until the patient recovers.	Antiplasmodial activity (Kristina, 2002); bioactivity.	The leaves are used as a diaphoretic and as a prophylactic against fevers, fever remedy (Abbiw, 1990).
Aloe deserti	Oral, a quarter of a glass is taken 3 times for a day.	Anthrone C-glycosides, the chromones and a large mixed group of phenolic compounds (Reynolds, 2008).	A leaf decoction is used to treat the spleen (Kokwaro, 1993).
Aloe macrosiphon	Oral, a quarter of a cup is taken 3 times daily for 2–3 days.	No previous reports.	A leaf decoction is used to treat the spleen (Kokwaro, 1993).
Aloe vera	Oral, a quarter of a cup is taken 3 times daily for 2–3 days.	Stimulation of gap junctional intercellular communication and proliferation of human skin fibroblasts in diabetes mellitus (Abdullah, 2002).	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).
Amaranthus hybridus	Oral, one cup is taken 3 times daily for 4–5 days.	Antioxidant activity (Adewumi, 2005); bioactivity (Cantrell, 2003).	No previous reports on ethnomedical use.
Azadirachta indica	Oral, a quarter of a glass is taken 3 times per day for 2–3 days.	Antiplasmodial activity (El Tahir et al., 1999; Kirira et al., 2006), active compounds gedunin, nimbinin (Bray et al., 1990).	Leaf infusion used for malaria (Gessler et al., 1995; Ibrahim et al., 1992; Tella, 1977; Van Der Nat et al., 1986).
Canthium glaucum	Oral, one cup is taken 3 times daily for 4–5 days.	No previous reports of biological activity.	No previous reports on ethnomedical use.
Cassia occidentalis	Oral, one cup is taken 3 times daily for 3–4 days.	Antiplasmodial activity (Cimanga, 2004; Tona, 1999). Terpenes, steroids, coumarins, flavonoids, phenolic acids, lignans, xanthones, anthraquinones (Cimanga, 2004).	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).
Combretum padoides	Oral, one cup is taken 3 times daily for 3–5 days.	Mono and bi-desmosidic triterpenoids from leaves (Rogers and Coombes, 1999); acetone extracts of leaves have antimicrobial effects (fresh leaves more effective than dried) MIC 0.8 μg/ml against *Escherichia coli* and *Enterobacter faecalis* (Eloff, 1999).	Leaves for snakebites and the roots for eliminating hookworms (Neuwinger, 2000).
Fagaropsis angolensis	Oral, one cup is taken 3 times daily for 3–4 days.	Bioactivity and antiplasmodial activity (Kirira et al., 2006).	Used for management of malaria (Njoroge and Bussman, 2006).
Ficus bussei	Oral, one cup is taken 3 times daily for 4–5 days.	Steroidal sapogenins (Wall, 2006).	A decoction of leafy twigs is used as a remedy for fever pains associated with malaria (Kerharo and Bouquet, 1950).
Flacourtia indica	Oral, one cup is taken 3 times daily for 3–4 days.	Antiplasmodial activity (Clarkson et al., 2004).	The leaf sap is mixed with a root decoction as a malaria cure (Burkill, 1994).
Gerranthus lobatus	Oral, one cup is taken 3 times daily for 3–4 days.	Flavonoid compounds (Imperato, 2005).	No previous reports on ethnomedical use.
Grewia hexaminta	Oral, one cup is taken 3 times daily for 3–4 days.	Triterpenoid compounds (Raghunathaiyar, 1996).	No previous reports on ethnomedical use.
Harrisonia abyssinica	Oral, one cup is taken 3 times daily for 2–3 days.	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).	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).
Lantana camara	Oral, one cup is taken 3 times daily for 3–4 days.	Antiplasmodial activity (Clarkson et al., 2004). Quinine like alkaloid, *lantanine*, is present in the leaves (Burkill, 2000).	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).
Laudolphia buchananii	Oral, one cup is taken 3 times daily for 3–4 days.	No previous reports.	No previous reports.
Launea cornuta	Oral, one cup is taken 3 times daily for 4–5 days.	Tannins and astringents (Burkill, 1985).	The roots are pounded and infused or decocted, the liquid being drunk as a remedy for typhoid (Kokwaro, 1993).
Ocimum bacilicum	Oral, one cup is taken 3 times daily for 3–4 days.	Antifungal activity (Dambolena, 2007), linalool, geranical, camphor compounds (Dambolena, 2007).	For abdominal cramps, upset stomach, nervous migraine, memory "strengthens the heart and the head" loss and forgetfulness (Fuchs, 1543; Sfikas, 1980).

Table 2 (*Continued*)

Plant species	Method of administration	Active constituents	Ethnomedicinal uses
Ocimum suave	Oral, one cup is taken 3 times daily for 3–5 days.	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).	In Tanzania, the scrappings of the roots mixed with *Zingiber officinalis* are used for inflamed tonsils (Hedberg et al., 1983a) 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).
Plectranthus barbatus	Oral, one cup is taken 3 times daily for 3–4 days.	Antiplasmodial activity (Meyer, 2002).	The plant is used as a mosquito repellant.
Ricinus communis	Oral, one cup is taken 3 times daily for 3–4 days.	Antiplasmodial activity (Clarkson et al., 2004).	Leaves are used as a remedy for fever (Burkill, 1994), dried root is used as a febrifuge, the oil is added to paraffin based spray as an antimalarial agent (Burkill, 1935).
Securidaca longepedunculata	Oral, one cup is taken 3 times daily for 3–4 days.	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).	The roots are used against malaria (Williamson, 1975).
Senecio syringitolius	Oral, one cup is taken 3 times daily for 3–4 days.	No previous reports.	No reports.
Solanum incanum	Oral, one cup is taken 3 times daily for 3–4 days.	Anti-ulcerogenic effect (Farina et al., 1998), active triterpenoid compounds – ursolic acid (3a) (Hirota et al., 1990).	A root decoction is used against fever (Kokwaro, 1993).
Teclea simplicifolia	Oral, a quarter of a cup is taken 3 times daily for 2–3 days.	Quinoline compounds (Wondimu, 1998).	In Kenya, the roots are regarded as poisonous (Neuwinger, 1996). The maasai use a root infusion for gonorrhea (Neuwinger, 2000).
Zanthoxylum chalybeum	Oral, a half of a glass is taken 3 times daily for 3–4 days.	Antiplasmodial activity (Gessler et al., 1994), 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).	Stem, root bark and leaves used for malaria (Beentje, 1994; Gessler et al., 1994; Hedberg et al., 1983), 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., 1983a). The fresh twigs of the plant from East Africa are used as tooth brush, air fresheners and for skin infections (Hedberg et al., 1983a; Johns et al., 1990).

among the respondents. *Azadirachta indica* has been reported to have antiplasmodial activity (Kirira et al., 2006) and active compounds isolated such as gedunin and nimbinin (Bray et al., 1990) which are responsible for the antimalarial activity of the plant species. Some of the plants identified by the herbalists have been reported in the literature as having been used for treatment of malaria related symptoms in other parts of the world, an indication that the herbalists could be trusted for the information they gave about the plants they use. They have also been investigated for their phytoconstituents and antimalarial activities (Table 2). However, to the best of our knowledge, thirteen plant species, namely *Aloe deserti* Berger (Liliaceae), *Launea cornuta* (Oliv and Hiern) C. Jeffrey (Compositae), *Ocimum bacilicum* L. (Labiatae), *Teclea simplicifolia* (Eng) Verdoon (Rutaceae), *Gerranthus lobatus* (Cogn.) Jeffrey (Cucurbitaceae), *Grewia hexaminta* Burret. (Tiliaceae), *Canthium glaucum* Hiern. (Rubiaceae), *Amaranthus hybridus* L. (Amaranthaceae), *Combretum padoides* Engl and Diels. (Combretaceae), *Senecio syringitolius* O. Hoffman. (Compositae), *Ocimum suave* Willd (Labiatae), *Aloe macrosiphon* Bak. (Liliaceae) and *Laudolphia buchananii* (Hall.f) Stapf. (Apocynaceae) are documented for the first time for the treatment of malaria.

The results of this study show that a large number of medicinal plants are traditionally used for treatment of malaria among the Msambweni community of Kenyan Coast. Twenty-seven species in 24 genera and 20 families were documented. Labiatae, Rutaceae and Liliaceae families represented the species most commonly cited (Fig. 2), which would indicate the importance of these families as possible sources of antimalarial drugs.

The information on the frequently utilized antimalarial plant species is an important lead to the species that can be targeted for pharmacological, toxicological and phytochemical tests. *Azadirachta indica* (Meliaceae), *Zanthoxylum chalybeum* (Rutaceae), *Aloe deserti* (Liliaceae), *Harrisonia abyssinica* (Simaroubaceae), *Launea cornuta* (Compositae), *Ricinus communis* (Euphorbiaceae) and *Lantana camara* (Verbenaceae) represented the species most commonly cited. Plant species have been assigned numbers according to the extent of their use in treating malaria (Important value for the treatment of Malaria or IV mal (Willcox and Bodeker, 2004). The use of *Ricinus communis* (Euphorbiaceae) in treatment of malaria has been reported in three continents and has an IV mal of 8, while *Lantana camara* (Verbenaceae) has been reported in two continents and has an IV mal of 7 (Fowler, 2006). This was consistent with our results as *Ricinus communis* (Euphorbiaceae) and *Lantana camara* (Verbenaceae) were reported as some of the commonly used species in preparation of antimalarial remedies and would indicate the importance of these plants as possible sources of antimalarial agents. Due to development of resistance to the commonly used agents, development of new antimalarial drugs from plant sources may be the way forward in dealing with global drug resistant problems of malaria (Gessler, 1995). Natural products and their derivatives represent over 50% of all drugs in clinical use in the world (Van Wyk et al., 2002).

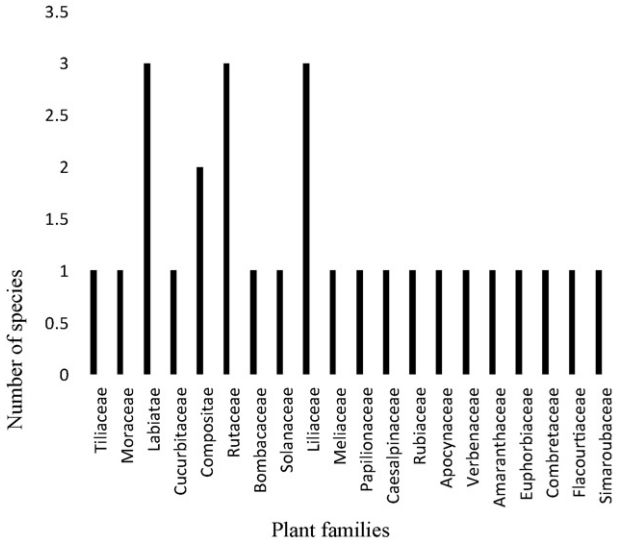

Fig. 2. Frequency of traditional antimalarial plant species in the 20 families used in Msambweni, Kenya.

The roots were the second commonly used part of the plant and this was found to be destructive where in some cases the whole plant had to be uprooted. This calls for conservation and good harvesting strategies to facilitate sustainable utilization of these plant resources (Cunningham, 2001). The stem bark or the leaves may be alternative parts, if the chemical composition is not significantly different from that in the roots (Muthaura et al., 2007). Medicine, in several developing countries, using herbal remedies, is still the mainstay of healthcare. Among African medicines, indigenous plants play an important role in the treatment of a variety of diseases (Phillipson, 1995) and are often used by herbalists to treat diseases identified as malaria (Omulokoli et al., 1997). Indigenous plants are commonly used in East Africa (Chhabra et al., 1993; Kokwaro, 1993), South Africa (Watt and Breyer-Brandwijk, 1962) and West Africa (Oliver-Bever, 1986).

There are genera, which were reported in this study with species that are also known to be used as sources of antimalarial remedies in other parts of Africa. They have also been reported to contain antiplasmodial activity against *Plasmodium falciparum*. Those from Western Uganda include *Lantana trifolia* L., screened against wild strains of *Plasmodium falciparum* using the parasite lactate dehydrogenase (pLDH) assay. The petroleum, chloroformic and ethanolic extracts from the aerial parts of the plant had an IC_{50} (μg/ml) of 13.2, >50 and >50, respectively (Katuura et al., 2007). Those from South Africa included plants screened against *Plasmodium falciparum* strain D10 using the parasite lactate dehydrogenase (pLDH) assay such as *Aloe forex* leaves (IC_{50} of 21 μg/ml) and *Ricinus communis* leaves (IC_{50} of 11.4 μg/ml). Others were *Ricinus communis* stems (IC_{50} of 8 μg/ml), *Ricinus communis* fruits (IC_{50} of 90 μg/ml) and *Lantana camara* leaves (IC_{50} of 11 μg/ml) (Clarkson et al., 2004). Gessler et al. (1994), while screening chloroquine resistant *Plasmodium falciparum* strain K1 against plant extracts from Tanzania found *Zanthoxylum chalybeum* root bark (IC_{50} of 4.2 μg/ml) to be one of the species with the strongest antiplasmodial activity among the antimalarial plants tested.

Kirira et al. (2006) while screening chloroquine sensitive *Plasmodium falciparum* strain NF54 and chloroquine resistant strain ENT30 against plant extracts from Meru and Kilifi districts found *Azadirachta indica* leaves (IC_{50} >250 μg/ml) to be inactive. It is interesting to note that the most commonly used antimalarial plant species reported in this study, *Azadirachta indica*, which has also been cited severally as a potent traditional antimalarial remedy, was reported as having insignificant antimalarial activity whereas other studies have reported good antiplasmodial activity. El Tahir et al. (1999) while screening some medicinal plants from Sudan against chloroquine sensitive *Plasmodium falciparum* strain 3D7 and resistant strain Dd2 found *Azadirachta indica* leaves (IC_{50} of 5.8 and 1.7 μg/ml, for 3D7 and Dd2, respectively) with highly potent antiplasmodial activity. The observed antiplasmodial activity from extracts of *Harrisonia abyssinica* against chloroquine sensitive *Plasmodium falciparum* strain NF54 and chloroquine resistant strain ENT30 (Kirira et al., 2006) has recently been confirmed by Maregesi et al. (2010) while screening Tanzanian medicinal plants for activity against *Plasmodium falciparum* and human immunodeficiency virus (Maregesi et al., 2010). This makes the plant quite promising as a lead for further studies.

It is noted that the plants used by the Msambweni community to treat malaria have been used in many other countries in the world for the treatment of fever frequently associated with malaria. Omino and Kokwaro (1993) reports widespread use of Apocynaceae in traditional medicine in Africa. Fowler (2006) reports the use of *Ricinus communis* (Euphorbiaceae) and *Lantana camara* (Verbenaceae) in three and two continents, respectively. The potency of the extracts may also be affected by solvent of extraction, georeference, time and season of harvesting or other environmental factors (Prance, 1994).

It is important to note that phytochemical compounds in traditionally used antimalarial herbal remedies are responsible for antiplasmodial activity. The most important and diverse biopotency has been observed in alkaloids, quassinoids, sesquiterpene lactones, coumarins, triterpenoids, limonoids and quinoline alkaloids (Saxena et al., 2003). Quinoline alkaloids isolated from *Zanthoxylum chalybeum* (Kato et al., 1996), steroidal sapogenins from *Ficus bussei* (Wall, 2006), Coumarins from *Cassia occidentalis* (Cimanga, 2004), gedunin and nimbinin, triterpenoids from *Azadirachta indica* (Bray et al., 1990; Mackinnon et al., 1997) are some of the specific examples. Other components responsible for antiplasmodial activity as in *Securidaca longepedunculata* roots are steroids, saponosides and monotropitosides (De La Pradilla, 1988) and the leaves of *Lantana camara* have been reported to contain quinine like alkaloid, *lantanine* (Burkill, 2000).

Azadirachta indica, the most commonly used species to treat malaria by the Msambweni community, South coast, is the third most commonly used herbal medicine to treat malaria in Kenya after *Ajuga remota* and *Caesalpinia volkensii* (Kuria et al., 2001). As Sofowora (1982) noted, many people in several African countries take a decoction of *Azadirachta indica* (neem tree) for malaria fever. Their reasons for doing so include reaction to chloroquine, a dislike for synthetic drugs, and the cost and unavailability of synthetic antimalarials (Muthaura et al., 2007). The lack of standardization and quality control is one of the main disadvantages of traditional herbal remedies (Evans-Anfom, 1986; Sofowora, 1982). Isolation and characterization of active constituents need to be undertaken for use as markers in standardization of the extracts, thus minimizing the risk of over dosage and also for identification of possible lead structures that could be used for the development of novel antimalarial drugs.

Some of the species documented in this study for the treatment of malaria have been used similarly in other continents of the world. This correspondence in the 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, toxicological and good quality clinical studies. The literature reviewed in this study indicates that few toxicological studies have been conducted (Table 2).

Majority of the plants documented in this study were collected from community land, which is facing great pressure due to overutilization of indigenous trees and hence medicinal plants may disappear before their uses are documented. Most of the inhabitants of Msambweni district are in the low social-economic bracket and very often the medicinal plant use is the only affordable treatment option. Medicinal plant use will therefore remain an integral part of the health care system to the community for a long time to come. Consequently, ethnobotanical exploration should not only be a cost effective means of locating new and useful tropical plant compounds but also be linked to the urgent need for sustainable conservation strategies for medicinal plants, since human expansionist demands can be expected to cause environmental deterioration and biotic destruction well into the next century (Muthaura et al., 2007). Kenya's strategy for conservation of forests involves intensification of timber and other non-wood products outside forest areas (Njunguna et al., 2000). Some plant resource users in other developing countries have realized that community forestry is not a question of trees but should include on-farm non-timber forest products for subsistence as well as for commercial purposes (Bryon, 1995).

5. Conclusion

Many plant species reported in this study have been investigated for their phytoconstituents and pharmacological activities, the latter being in agreement with ethnomedical uses reported in this study. Thirteen plant species are documented for the first time for treatment of malaria. In Msambweni district, traditional methods of treatments based on medicinal plants are still an important part of social life and culture and the acceptability of these plants as claimed effective remedies is quite high among the population of this area. The claimed therapeutic value of the reported species call for modern scientific studies to establish their safety and efficacy and to preserve and document this flora which may otherwise be lost due to erosion of age old traditional methods of biodiversity conservation and medicinal knowledge as had been practiced in the *Kayas* (Muthaura et al., 2007). There is general consensus that traditional knowledge on the use of medicinal plants must be conserved because of its vital role for human wellbeing. It is often argued, that if traditional knowledge which have 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 traditional knowledge is considered reliable for the exploitation of herbal remedies 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).

The herbalists of Msambweni district, South Coast Kenya are the owners of the traditional knowledge presented in this paper. Consequently, any benefits that may accrue from the use of the knowledge presented in this study must be shared with them.

Acknowledgements

The Carnegie Corporation of New York is gratefully acknowledged for supporting this study through Regional Initiative in Science and Education (CR-AFNNET) African natural product network. The authors are indebted to the community of Msambweni district for sharing their knowledge and time with them. The herbarium staff at the Department of Land Resource and Management (LARMAT), University of Nairobi is acknowledged for identification of plant species and voucher specimen preparation.

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