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ScienceDirect
Journal of Ethnopharmacology 114 (2007) 377–386
Journal of ETHNO-PHARMACOLOGY
www.elsevier.com/locate/jethpharm

Traditional antimalarial phytotherapy remedies used by the Kwale community of the Kenyan Coast

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Received 16 January 2007; received in revised form 8 June 2007; accepted 13 August 2007
Available online 25 August 2007

Abstract

In Kenya, most people especially in rural areas use traditional medicine and medicinal plants to treat many diseases including malaria. Malaria is of national concern in Kenya, in view of development of resistant strains of *Plasmodium falciparum* to drugs especially chloroquine, which had been effective and affordable. There is need for alternative and affordable therapy. Many antimalarial drugs have been derived from medicinal plants and this is evident from the reported antiplasmodial activity. The aim of the study was to document medicinal plants traditionally used to treat malaria by the Digo community of Kwale district. Traditional health practitioners were interviewed with standardized questionnaires in order to obtain information on medicinal plants traditionally used for management of malaria. Twenty-five species in 21 genera and 16 families were encountered during the study. Celestraceae, Leguminosae and Rubiaceae families represented the species most commonly cited. Three plant species, namely; *Maytenus putterlickioides*, *Warburgia stuhlmannii* and *Pentas bussei* are documented for the first time for the treatment of malaria.

Keywords: Traditional remedies; Antimalarial plants; Kwale district

1. Introduction

Plants have been an integral part of life in many indigenous communities, and Africa is no exception (Sidigia et al., 1995). Most of Africa's biodiversity play major specific roles in the cultural evolution of human societies (Mugabe and Clark, 1998). Apart from other ethnobotanical uses, plants are especially important in their ethnomedical uses and among the many diseases traditionally treated with medicinal plants, malaria ranks as the single most important condition treated with herbal remedies. Due to either limited availability or affordability of pharmaceutical medicines in many tropical countries, about 80% of the rural population in Africa depends on traditional herbal remedies (WHO, 2002; 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 which is essential for further evaluation of the efficacy and safety of the plants as antimalarial remedies.

Historically, majority of antimalarial drugs have been derived from medicinal plants or from structures modeled on plant lead compounds (Klayman, 1985). Quinine and artemisinin, the drugs of choice for treatment of malaria, were either obtained directly from plants or developed using chemical structures of plant derived compounds as templates (Basco et al., 1994; Kayser et al., 2003). Research on medicinal plant extracts 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 (Wagner, 1997); the pharmacological, toxicological and phytochemical profiles of the extracts have to be scientifically evaluated. 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 pro-

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doi:10.1016/j.jep.2007.08.033

grams and suggests basic procedures for the validation of drugs from plant origin in developing countries (Vulto and Smet, 1998).

Malaria is endemic in Kwale and prevalent in many other communities in Kenya. The situation has become worse with increasing drug resistance by the malaria parasite, *Plasmodium falciparum* (WHO, 2001). This has necessitated many countries to revise their treatment policy and adopt an effective medicinal plant compound Artemisinin, isolated from *Artemisia annua* in combination therapy (ACT) as first line drugs for treatment of uncomplicated malaria. ACT's are expensive and the government of Kenya found it necessary to provide free ACT therapy in health care facilities since majority of the population would not afford the cost of the new treatment. This underscores the extent of the disease burden and economic loss for the country. However, the practice of traditional medicine which is deep rooted in rural areas continues unabated alongside conventional medicine because of ease of availability, inaccessibility of health centres and also due to social cultural factors (Cunningham, 1988; Katz and Kimani, 1982). Western style healthcare provided by the government has been expanded in the last decades, but is often not readily available and many regions remain completely underserved. Subsequently, most communities still use herbal remedies as readily and cheaply available alternative.

Many tribes in Africa have much elaborated plant knowledge (Barrow, 1996). 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. 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 most parts of Kwale, the traditional way of life and customary beliefs are however, quite intact and the acceptability of antimalarial and other medicinal plants as claimed effective remedies is quite high among the population of this area.

The kaya forests were the traditional social–cultural focal point of the Digo community in Kwale district, one of the nine deeply traditional ethnic groups that form the Mijikenda community of the coast province. The forests sheltered small-fortified villages of the various groups when they first appeared in the region three centuries ago (Spear, 1978). 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. With growth in population, the groups began to establish new settlements outside the kaya forests and in recent times the existence of the forests became threatened due to increased human activities. However, the sacred sites were recognized for their key role in biodiversity conservation and in 1992 the Kenya government protected the kayas as National Monuments under the Antiquities and Monuments Act. More than half of the Kenyan'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 a few traditional healers, requires documentation for the benefit of current and future generations.

2. Study site and methods

2.1. Kwale district study area

In Kwale, the study area centred around 4°12′S latitude and 39°25′E longitude in and around the vicinity of the Shimba Hills Game Reserve and adjoining part of Kinango division (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 coastal uplands commonly known as Shimba Hills rise steeply from the coastal belt to 462 m above sea level. 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.

The Digo are a Bantu tribe with a population of 225,000 (1999 National Population Census), 90% of who are Muslim and are concentrated on the southern coastal strip of Kenya between Mombasa and the border of Tanzania (Kwale district). Traditional practices (such as animism and ancestor worship) have more influence on the Digo community than does Islam. The medicinal knowledge of the Digo is considered communal; however there is individually held knowledge by the traditional health practitioners (THP). These are revered and trusted people in the community and play multiple roles as spiritual guides, counsellors and healers. These attributes and the knowledge on the use of medicinal plants were bequeathed to them by their fathers, albeit orally, from generation to generation. The spirit of the departed THP was supposed to possess the chosen THP, who would in turn keep the knowledge to himself and only pass it on, to a lineage in the family a few years before death.

2.2. Collection of ethnomedical information

Fieldwork to collect plant samples were carried out between October and December, 2005. Permission for a sustainable plant harvesting was granted by Kenya Wildlife Service (KWS) in the forest game reserve, and the local community outside the forest areas. To obtain information on medicinal plants traditionally used for the management of malaria, local people facilitated access to THP who were interviewed with standardized questionnaires. Prior to surveys in each area, a research assistant was identified who had grown up in the area and knew the people and the local language well. Several contacts were made with THP before the actual interview to win their trust. A taxonomist who was conversant with the flora of the area was part of the collection team. Nine THP (2 women and 7 men; mean age: 55 years) were interviewed.

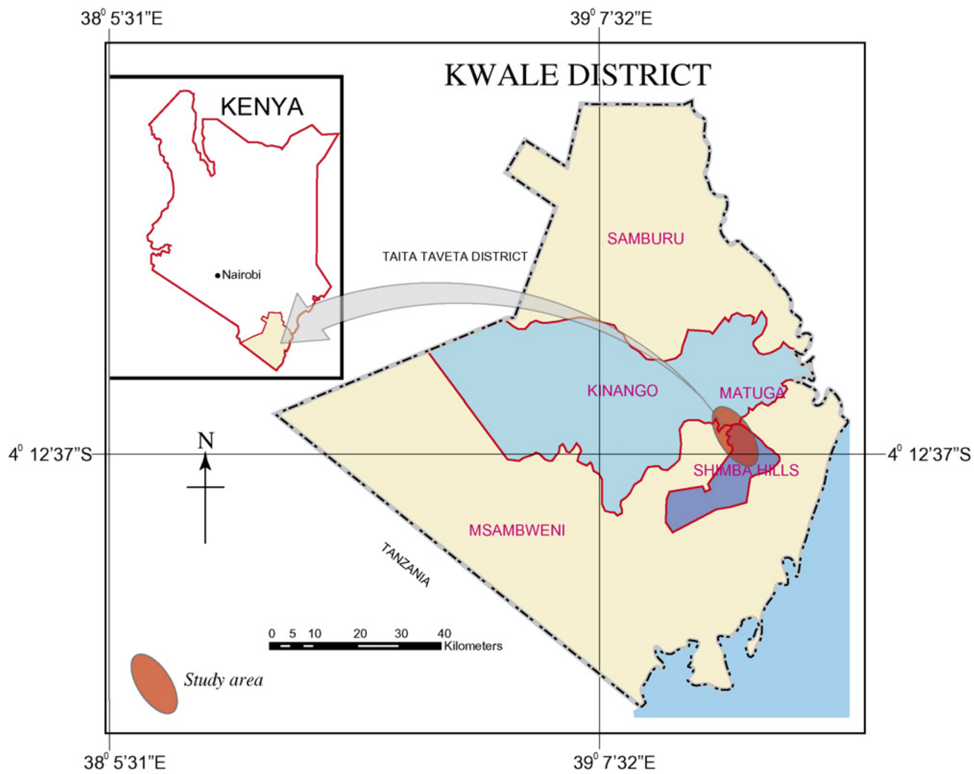

Fig. 1. Map of Kenya showing Kwale district with study areas Shimba Hills Game Reserve and Kinango.

2.3. Collection of plant samples

Traditionally the disease is treated in function of symptomatology and those plants claimed to treat malaria, fevers and joint pains as identified by THP were collected. The plants were identified by the taxonomist and voucher specimens deposited at the East Africa Herbarium, National Museums of Kenya. The information gathered included plant species, parts used, plant habit, method of preparation, posology and vernacular names.

3. Results

Table 1 shows a documentation of plant species collected from the study area based on traditional reputation for their use as antimalarials. Nine THP, who had many years of experience in the use of traditional medicine were interviewed on the plants that they used for treatment of malaria. *Azadirachta indica*, *Zanthoxylum chalybeum*, *Toddalia asiatica*, *Albizia anthelmintica*, *Harrisonia abyssinica*, *Cassia abbreviata*, *Acacia nilotica* and *Maytenus senegalensis* were mentioned by all the informants. The rest of the species were mentioned each by at least 50% of the informants. The plant parts mostly reported were the root bark (58%), stem bark (16%), leaves (16%) and whole plant (10%)· The method of preparation was mostly a decoction or a hot water infusion usually prepared just before use· The plant material was used fresh or dried and most plants to be used as a remedy were stored for later use in the dry state, which allowed their utilization throughout the year. Posology was difficult to quantify but was indicated as drinking boiled but cold decoction half a glass twice daily for adults and half this amount for children which approximated to: a half glass ~125 ml; a pinch: 5 g of powdered plant material in 250 ml (1/2 glass × 2) of water to be taken twice daily; a few leaves: 5 g wet leaves or 10 g dry leaves in 250 ml of water to be taken twice daily; and a handful: 20 g of powdered plant material, or 40 g coarse plant material in 250 ml of water to be taken twice daily. Doses were mainly taken twice a day because people are present at home on the morning and evening. Treatment was supposed to be continued until recovery.

The plant families Celestraceae, Leguminosae and Rubiaceae had the highest number of species mentioned in treatment of malaria (Fig. 2). Six families had at least two species mentioned in the treatment of malaria. The root bark was the most frequently mentioned part of the plant used in preparation of the herbal remedies and results from the habit of the species show that 68% of the antimalarial herbal remedies were obtained from trees and shrubs (Fig. 3).

4. Discussion

The aim of the ethnomedical survey and documentation was to catalogue the plants used traditionally against malaria. A considerable amount of duplication of information relating to the use of the plants was reported by several THP (32% of the plants had 100% consensus among the THP) which may confirm the antimalarial efficacy of traditional herbal remedies prepared from these species. Most of the plants collected have been reported in the literature, as having been used for malaria or fever, an indication that the healers could be trusted for the information they imparted about the plants they use. However, to the

Table 1
Plant species collected from Kwale district based on traditional reputation for their use as antimalarials

Family/species/(Voucher specimen no.)	Vernacular name	Habit	Part used	Treatment preparation	Biological activity/chemical constituents	Relevant reported ethnomedical uses
Annonaceae						
Uvaria scheffleri Diels (CM 088)	Mguma (Swa)	Liana	RB/L	Decoction, hot water extract	Antiplasmodial activity (Nkunya et al., 1991), indole alkaloid-(DL)-schefflone (Nkunya et al., 2004, 1990)	Root decoction used for malaria (Beentje,1994; Kokwaro, 1993)
Apocynaceae						
Carissa edulis Forssk. (CM 045K)	Mtanda mboo (Swa)	Shrub	RB	The roots boiled in meat bone broth	Antiplasmodial activity (Clarkson et al., 2004; Koch et al., 2005), saponins (Reed, 1986), sesquiterpenes (Achenbach et al., 1985)	Root decoction used for malaria (Kirira et al., 2006; Kokwaro, 1993)
Apocynaceae						
Rauvolfia mombasiana Stapf (CM 130)	Kibombo (D)	Shrub	RB	Root boiled, decoction	Antiplasmodial activity (Weenen et al., 1990), yohimbine-an indole alkaloid (Iwu and Court, 1979)	Root decoction used for malaria (Beentje, 1994; Kokwaro, 1993)
Asclepiadaceae						
Centella asiatica (L.) Urban (CM 138)	Mupunga (Swa)	Herb	W/p	Decoction, hot water extract or infusion	Antiplasmodial activity (Clarkson et al., 2004), alkaloids, sesquiterpenes (Holeman et al., 1994)	Whole plant decoction used for fever (Bhattarai, 1992; Manandhar, 1993)
Canellaceae						
Warburgia stuhlmannii Engl. (CM 119)	Mkaa (Swa)	Tree	SB/L	Hot water decoction	Antibacterial, *Bacillus subtlis* (Taniguchi et al., 1978), sesquiterpenes (Manguro et al., 2003)	Stem bark used for toothache and rheumatism (Beentje, 1994; Watt and Breyer-Brandwijk, 1962)
Celastraceae						
Maytenus putterlickioides (Loes.) Excell and Mendonca (CM 116)	Mtsokolangongo-mume (D)	Shrub	RB	Hot water decoction in soup	DNA polymerase inhibition (Feng et al., 2004), dihydroagarofuran sesquiterpene alkaloids (Schaneberg et al., 2001)	Root bark used in Tanzania as emmenagogue (Hedberg et al., 1983), roots decoction used as aphrodisiac and leaves for hookworm (Kokwaro, 1993)
Celestraceae						
Maytenus senegalensis (Lam.) Exel (CM 129)	Mtsokolangongo-mke (D)	Shrub	RB	Hot water decoction in soup	Antiplasmodial activity (Clarkson et al., 2004; El Tahir et al., 1999), sesquiterpene alkaloid (Fong et al., 1970)	Root bark decoction used for malaria (Gessler et al., 1994), root infusion used for fever (Chhabra et al., 1991; Kokwaro, 1993)
Celestraceae						
Maytenus undata (Thunb.) Blakelock (CM 133)	Muriakitu (G)	Tree	RB	Decoction in water	Antiplasmodial activity (Clarkson et al., 2004) triterpene, secotriterpene acids (Muhammad et al., 2000)	Root decoction used for syphilis and diseases of the urethra (Kokwaro, 1993)
Combretaceae						
Terminalia spinosa Engl. (CM 081)	Mwanga kululu (D)	Tree	SB	Cold water infusion	Antiplasmodial activity (Omulokoli et al., 1997)	Stem bark infusion used for jaundice (Beentje, 1994)
Compositae						
Tridax procumbens L. (CM 115)	Luvumbani (G)	Herb	W/p	Cold water infusion	Antimalarial activity (Clarkson et al., 2004; Weenen et al., 1990), cpd-bergenin (Akbar et al., 2002)	Leaves chewed for malaria and stomachache (Kokwaro, 1993)
Euphorbiaceae						
Flueggea virosa (Willd.) Voigt. (CM 118)	Mukwamba (G)	Shrub	RB/L	Decoction, hot water extract	Antiplasmodial activity (Clarkson et al., 2004), cpd-bergenin (Nyasse et al., 2004), alkaloids (Gan et al., 2006)	Root decoction used for chest pains (Beentje, 1994)
Euphorbiaceae						
Suregada zanzibarensis Baill (CM 141)	Mchungwa Koma (D)	Shrub	RB/L	Decoction, hot water extract	Antiplasmodial activity (Omulokoli et al., 1997), alkaloids (Smolenski et al., 1975)	Root decoction drunk for malaria (Chhabra et al., 1990a)
Guttiferae						
Harungana madagascariensis Poir. (CM 128)	Mukokotsaka (D)	Tree	RB/SB	Decoction in water	Antiplasmodial activity (Gessler et al., 1994), anthraquinones, saponins, steroids (Tona et al., 1998), quinoids (Iinuma et al., 1995)	Leaf decoction used in Rwanda for malaria (Hakizamungu et al., 1992; Kokwaro, 1993), leaf, stem bark decoction for malaria (Gessler et al., 1994)

Leguminosae						
Cassia abbreviata Oliv. (CM 122)	Muhumba mkulu (D)	Tree	RB	Hot water decoction	Antiplasmodial activity (Connelly et al., 1996; Gessler et al., 1994; Weenen et al., 1990), flavonoids (Malan et al., 1996)	Root decoction used for fever or malaria (Chhabra et al., 1987; Gessler et al., 1994; Kokwaro, 1993; Mutasa and Kahn, 1995)
Leguminosae						
Acacia nilotica (L.) Del. (CM 132)	Chigundigundi (D)	Tree	RB	Roots boiled in water, decoction	Antiplasmodial activity (Clarkson et al., 2004; Kirira et al., 2006), flavonoids (Malan, 1991) cpd-D-pinitol (Chaubal et al., 2005)	Stem bark decoction used for fever (Kokwaro, 1993), fruit used as febrifuge (Anis and Iqbal, 1994; Etkin, 1997)
Leguminosae						
Albizia anthelmintica Brongn (CM 123)	Mjafari/Mporojo (G)	Shrub	SB	Decoction in hot water	Antiparasitic activity (Gathuma et al., 2004), triterpenes from stem bark (El-Hamidi, 1970), saponins (Carpani et al., 1989)	Root bark decoction used for malaria, fever and as emetic (Johns et al., 1994), for malaria (Carpani et al., 1989; Kokwaro, 1993)
Meliaceae						
Azadirachta indica A. Juss (L) (CM 120)	Mwarubaini (G/D)	Tree	SB/L	Hot water extract, decoction	Antiplasmodial activity (El Tahir et al., 1999), active cpds-gedunin, nimbinin (Bray et al., 1990), cpds-meldenin, isomeldenin, nimocinol, nimbandiol (Joshi et al., 1998)	Leaf infusion used for malaria (Gessler et al., 1995; Ibrahim et al., 1992; Tella, 1977; Van Der Nat et al., 1986)
Menispermaceae						
Cissampelos mucronata A. Rich. (CM 137)	Kishiki cha buga (Swa)	Liana	RB	Decoction, hot water extract	Antiplasmodial activity (Gessler et al., 1994), bisbenzylisoquinone alkaloids (Tshibangu et al., 2003)	Root decoction used for malaria (Gessler et al., 1994), for febrifuge (Chhabra et al., 1990a)
Rubiaceae						
Pentas bussei K. Krause (CM 139)	Mdobe (D)	Herb	RB	Hot water decoction	Oxygen heterocycles (Bukuru et al., 2002, 2003)	Root decoction used for venereal diseases by the Digo (Beentje, 1994; Kokwaro, 1993)
Rubiaceae						
Pentas longiflora Oliv. (CM 126)	Mdobe dombe (D)	Herb	RB	Decoction, hot water extract	Antiplasmodial activity (Wanyoike et al., 2004), quinoid cpds (El-Hady et al., 2002)	Root decoction in milk used for malaria (Kokwaro, 1993)
Rubiaceae						
Pentas agathisanthemum Kl. (CM 124)	Mdobe (D)	Herb	W/p	Decoction, hot water extract	Quinoid cpds (Kusamba et al., 1993)	Whole plant used for cerebral malaria (Chhabra and Mahunnah, 1994)
Rutaceae						
Toddalia asiatica (L.) Lam. (CM 136)	Kikombe-Cha-Chui (D)	Liana	RB	Root bark boiled in water	Antiplasmodial activity (Kuria et al., 2001), active cpd-nitidine (Gakunju et al., 1995), quinoline alkaloids (Ishii et al., 1991)	Leaf decoction used for malaria (Chhabra et al., 1991; Gakunju et al., 1995; Novy, 1997)
Rutaceae						
Zanthoxylum chalybeum Engl. (CM 127)	Mdungu (G)	Shrub	RB	Decoction, hot water extract	Antiplasmodial activity (Gessler et al., 1994) quinoline alkaloids (Kato et al., 1996)	Stem, root bark and leaves used for malaria (Beentje, 1994; Gessler et al., 1994; Hedberg et al., 1983)
Simaroubaceae						
Harrisonia abyssinica Oliv. (CM 134)	Kidori (D)	Shrub	RB	Infusion in hot water	Antimalarial activity (El Tahir et al., 1999), limonoids cpds (Rugutt et al., 2001), terpene cpd (Balde et al., 2001)	Root decoction used for fever (Kokwaro, 1993), venereal diseases (Beentje, 1994)
Verbenaceae						
Clerodendrum myricoides (Hochst.) Vatke (CM 125)	Muumba (D)	Shrub	RB	Infusion in hot water	Antimalarial activity (El Tahir et al., 1999), spermidine alkaloids (Bashwira and Hootele, 1988)	Root infusion used for malaria (Kokwaro, 1993), root decoction used for malaria and venereal diseases (Beentje, 1994)

RB: root bark, SB: stem bark, W/p: whole plant, L: leaves, D: Digo, G: Giriama, Swa: Swahili.

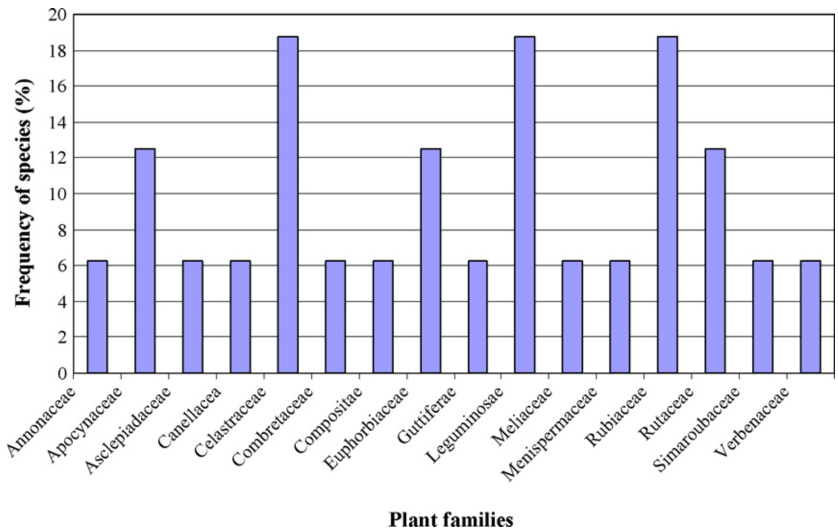

Fig. 2. Frequency of the species in the families from Kwale district.

best of our knowledge, three plant species, namely *Maytenus putterlickioides*, *Warburgia stuhlmannii* and *Pentas bussei* were documented for the first time for 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 Digo community of Kwale. Twenty-five species in 21 genera and 16 families were documented. Celestraceae, Leguminosae and Rubiaceae families represented the species most commonly cited. Studies from other regions of Africa indicate Rubiaceae to have many species used in the management of malaria in different countries (Iwu, 1994). This was consistent with our results but Leguminosae and Celestraceae had a similar frequency on the number of species cited as sources of antimalarial remedies as Rubiaceae (Fig. 2), which would indicate the importance of these families as possible sources of antimalarial plants. The information on the frequently utilized antimalarial plant species is also an important lead to the species that can be targeted for antiplasmodial tests and phytochemical analysis. Since there is no safer, effective and cheaper antimalarial remedies than chloroquine in the treatment of malaria, 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 the drugs in clinical use in the world (Van Wyk et al., 2002).

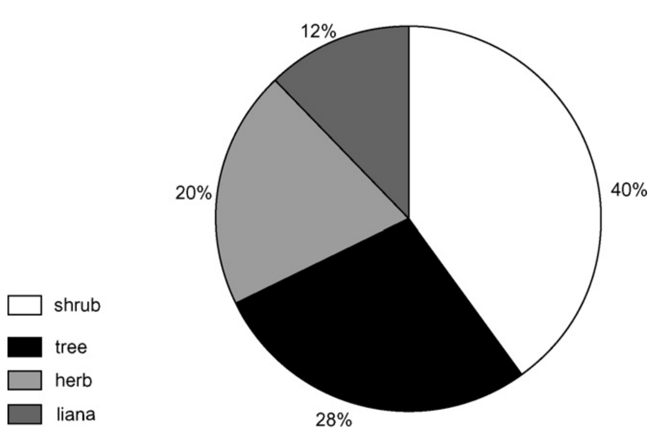

Fig. 3. Habit of the species used in management of malaria.

The root bark was the most 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 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. Among African medicines, indigenous plants play an important role in the treatment of a variety of diseases (Phillipson, 1995) and are often used by healers to treat diseases identified as malaria (Omulokoli et al., 1997; Sofowora, 1980). They 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). The practice of traditional medicine is widespread in China, Japan, Sri Lanka, Pakistan and Thailand. In China and India pharmaceutical companies produce and market galenicals (Norman et al., 1985).

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 Africa. They are also reported to contain antiplasmodial activity against *Plasmodium falciparum*. Those from South Africa included plants screened against *Plasmodium falciparum* on chloroquine (CQ) sensitive strain D10 such as *Carissa edulis* stems (IC_{50}, 33 μg/ml) and *Maytenus undata* leaves (IC_{50}, 21 μg/ml). Others were *Centella asiatica* leaves (IC_{50}, 8.3 μg/ml), *Tridax procumbens* whole plant (IC_{50}, 17 μg/ml), *Maytenus senegalensis* roots (IC_{50}, 15.5 μg/ml), *Flueggea virosa* leaves (IC_{50}, 19 μg/ml) and *Acacia nilotica* twigs (IC_{50}, 13 μg/ml) (Clarkson et al., 2004).

In Kajiado district, Kenya, Koch et al. (2005) reported some of the species as having antiplasmodial activity against CQ sensitive *Plasmodium falciparum* clone D6 although his defined activity was rather high ($IC_{50} < 10$ μg/ml). These were *Carissa edulis* root bark (IC_{50}, 6.41 μg/ml) and *Cleroden-*

drum myricoides root bark ($IC_{50} > 10\,\mu g/ml$). Other notable antiplasmodial activity for a similar species from Kisii district, Kenya screened against CQ sensitive strain K39 was *Clerodendrum myricoides* root bark (IC_{50}, 8.5 μg/ml) (Muregi et al., 2003, 2004). Others screened against *Plasmodium falciparum* CQ sensitive strain K67 included *Toddalia asiatica* root bark (IC_{50}, 5.0 μg/ml) (Gakunju et al., 1995), *Terminalia spinosa* stem bark (IC_{50}, 9.9 μg/ml) and *Suregada zanzibarensis* leaves (IC_{50}, 1.5 μg/ml) (Omulokoli et al., 1997). Gessler et al. (1994) while screening CQ resistant *Plasmodium falciparum* strain KI against plant extracts from Tanzania found *Maytenus senegalensis* root bark (IC_{50}, 0.62 μg/ml), *Cissampelos mucronata* roots (IC_{50}, 0.38 μg/ml), *Zanthoxylum chalybeum* root bark (IC_{50}, 4.2 μg/ml) and *Harungana madagascariensis* leaves (IC_{50}, 11 μg/ml) to have the strongest antiplasmodial activity among the plant species tested.

Kirira et al. (2006) while screening CQ sensitive *Plasmodium falciparum* strain NF54 and CQ resistant strain ENT30 against plant extracts from Meru and Kilifi districts found *Harrisonia abyssinica* root bark (IC_{50}, 72.66 μg/ml) and *Acacia nilotica* root bark (IC_{50}, 70.33 μg/ml) active while *Carissa edulis* root bark ($IC_{50} > 250\,\mu g/ml$) and *Azadirachta indica* leaves ($IC_{50} > 250\,\mu g/ml$) were inactive. It is interesting to note that the latter two species, which have been cited severally as potent traditional antimalarials, were reported as having insignificant activity whereas other studies reported good antiplasmodial activity. El Tahir et al. (1999) while screening some medicinal plants from Sudan against CQ sensitive *Plasmodium falciparum* strain 3D7 and resistant strain Dd2 found *Azadirachta indica* leaves (IC_{50}, 5.8 and 1.7 μg/ml, for 3D7 and Dd2, respectively) and stem bark (IC_{50}, 8.5 and 40.0 μg/ml, respectively) with highly potent antiplasmodial activity. *Carissa edulis* described above by Clarkson et al. (2004) was extracted in dichloromethane while that reported by Kirira et al. (2006) was extracted in methanol.

It is important to note that these plants have been used in many other African countries for the treatment of fever frequently associated to malaria. Omino and Kokwaro (1993) reports widespread use of Apocynaceae in traditional medicine in Africa. These plants could be effectively more active on *Plasmodium falciparum* in man, as it is the case for plants containing prodrugs non-active by themselves but which are metabolized to active drugs as has been demonstrated for *Azadirachta indica* extracts (Parida et al., 2002). This underlies the limit of the in vitro tests. The potency of the extract may also be affected by solvent of extraction, georeference, time and season of harvesting or other environmental factors (Prance, 1994).

Several classes of secondary plant metabolites are responsible for antiplasmodial activity; the most important and diverse biopotency has been observed in alkaloids, quassinoids, sesquiterpene lactones, coumarins, triterpenoids, limonoids and quinones (Saxena et al., 2003). Nitidine, an alkaloid isolated from *Toddalia asiatica* (Gakunju et al., 1995), sesquiterpene lactone from *Artemisia annua* (Klayman, 1985), courmarins from *Vernonia brachycalyx* (Oketch-Rabah et al., 1998, 1997), 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 potential as in *Carissa edulis* leaves; roots (Reed, 1986) and in *Clerodendrum myricoides* roots (Johns et al., 1999) have been reported to contain saponins.

Azadirachta indica 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 expense and unavailability of synthetic antimalarials. The lack of standardization and quality control is one of the main disadvantages of traditional medicine (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 risk of overdoses and also for possible lead structures that could be developed as novel antimalarial drugs.

Most of the plants were collected from the community land, which is facing great pressure due to over-utilization of indigenous trees and medicinal plants may disappear before their uses are documented. The majority of the population in Kwale district is in the low social–economic bracket and very often the medicinal plant use is the only affordable treatment option. Medicinal plant use therefore, will 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 wreak environmental deterioration and biotic destruction well into the next century. Kenya's strategy for conservation of forests involves intensification of timber and other non-wood products outside forest areas (Njuguna 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 commercial purposes (Byron, 1995).

5. Conclusion

Many plant species reported in this study have been investigated for their phytoconstituents and pharmacological activities, the latter are in agreement with ethnomedical uses reported in this paper. Three plant species are documented for the first time for treatment of malaria. In Kwale, 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 practised in the kayas.

Acknowledgements

This work received financial support from WHO Regional Office for Africa. We thank the Director, KEMRI for allowing the publication of this study.

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