Ethnomedical Survey of Herbs for the Management of Malaria in Karnataka, India

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Research

Abstract

Herbs used by traditional healers for malaria management were documented in the Tumkur district of Karnataka, India. In total, 31 species of plants in 20 families were used. Thirty percent of the herbal remedies contained species in only three plant families: Fabaceae, Piperaceae, and Zingiberaceae. Leaves were the most commonly used plant part (29%). Eight plant species used in the study area were documented for the first time for their use in the treatment of malaria. Ethnomedical and antiplasmodial activity of documented species was assessed by comparison with published literature.

Introduction

Malaria continues to be a major public health concern in many developing countries, affecting mainly poor communities and consisting of the combined effects of the infection on the population as a whole (Koram & Molyneux 2007). In 2008, 247 million cases of malaria were reported from 109 malaria-endemic countries (WHO 2008). Over 40% of the world's population live in malaria-endemic areas. Poor populations are at greatest risk; 58% of the cases occur in the poorest 20% of the world's population, and these patients receive the worst care and have catastrophic economic consequences from their illness (Breman *et al*. 2004).

Especially in developing countries, lack of efficient health care infrastructure is the major concern in tackling malaria. The available modern antimalarial drugs have their own limitations in terms of accessibility, affordability, acceptability, safety, and development of resistance. Thus, communities in affected regions have used local plants as a means of preventing and treating malaria (Willcox *et al*. 2004). In tropical regions, up to 75% of patients choose to use traditional medicines to treat malaria (Willcox & Bodeker 2004). Thus there is a gathering momentum globally for management of malaria through natural medicines. Indian traditional healers are also moving in the same direction (Tangjang *et al*. 2011).

Traditional health care practices (folk knowledge) that largely remain undocumented are passed on from one generation to the next by word of mouth. Habitat degradation, loss of plant ecosystems, and related cultural diversity are disrupting the continuation of traditional health care practices (Van Wyk & Wink 2004). Systematic exploration of traditional pharmacopeia is a high priority to support discoveries of new treatments for diseases such as malaria (Pieroni 2000) as evidenced in earlier exemplary discoveries of drug sources from traditional knowledge such as quinine and artemisinin (Srisilam & Veersham 2003). Ethnobotanical studies of herbal malaria treatments in different Indian communities have been conducted (Namsa *et al*. 2011). To the best of our knowledge, however, there is no publication that has documented traditional antimalarial herbal remedies in the Tumkur district of Karnataka,

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South India. The purpose of this survey was to identify the species of plants used for the management of malaria by traditional healers of Tumkur district of Karnataka.

Materials and Methods

Study site

The study was carried out in Tumkur district of Karnataka, South India (Figure 1), with collective efforts of two local non-government organizations: BAIF Institute for Rural Development-Karnataka (BIRD-K), Tiptur, Tumkur, Karnataka, and the Institute of Ayurveda and Integrative Medicine (I-AIM), Bangalore. The district is situated in the eastern belt of the southern part of Karnataka in South India, between latitudes 12°45′ North and 14°22′ North and longitudes 76°24′ East and 77°06′ East. The district covers a total land area of 10,598 km^2. The population was estimated to be 2,681,449 as of 2011 (Population Census India 2011). The day temperature reaches a maximum of 41°C during summer (March to May), and the average annual rainfall of the district is 688 mm during the rainy season or south-west monsoon season from June to September. There is also a post-monsoon season covering the months of October and November and a dry or winter season from December to February (Tumkur district data 2009). The major crops are **ragi** (finger millet) and groundnut, which occupy about 70% of the cultivable area, followed by rice paddies. Traditional medicine is important to the people because of limited health facilities in the district. Malaria is a major problem in rural areas of Tumkur district and the *Anopheles culicifacies* mosquito is a vector responsible of malaria transmission (Ghosh *et al*. 2006). On average 15,000 malaria cases are reported annually with more than 25% being caused by *Plasmodium falciparum*, which is about 15-20% of malaria cases of the Karnataka state (Raghavendra *et al*. 2011).

Data collection

In Tumkur we observed many traditional healers treating fever/malaria cases using traditional herbal remedies. BAIF was involved in promotion of traditional remedies to address the problem of malaria.

Semi-structured survey interviews were conducted to obtain information from traditional healers on knowledge of malaria and its management. The survey questionnaire contained mainly open-ended questions. After careful formulation of the questions, the questionnaire was translated into Kannada, the principal language spoken in the study area. The survey questionnaire addressed the following question categories:

1. Demographic profile: age, sex, address, education, healer's experience in the field of practice.
2. Knowledge and understanding of malaria: causes, sign & symptoms, diagnosis.
3. Traditional antimalarial remedies: plants species, collection, parts used, quantity, method of preparation, method of administration, dose, duration.

Prior informed written consent was obtained before conducting interviews. Three local NGO staff working in the

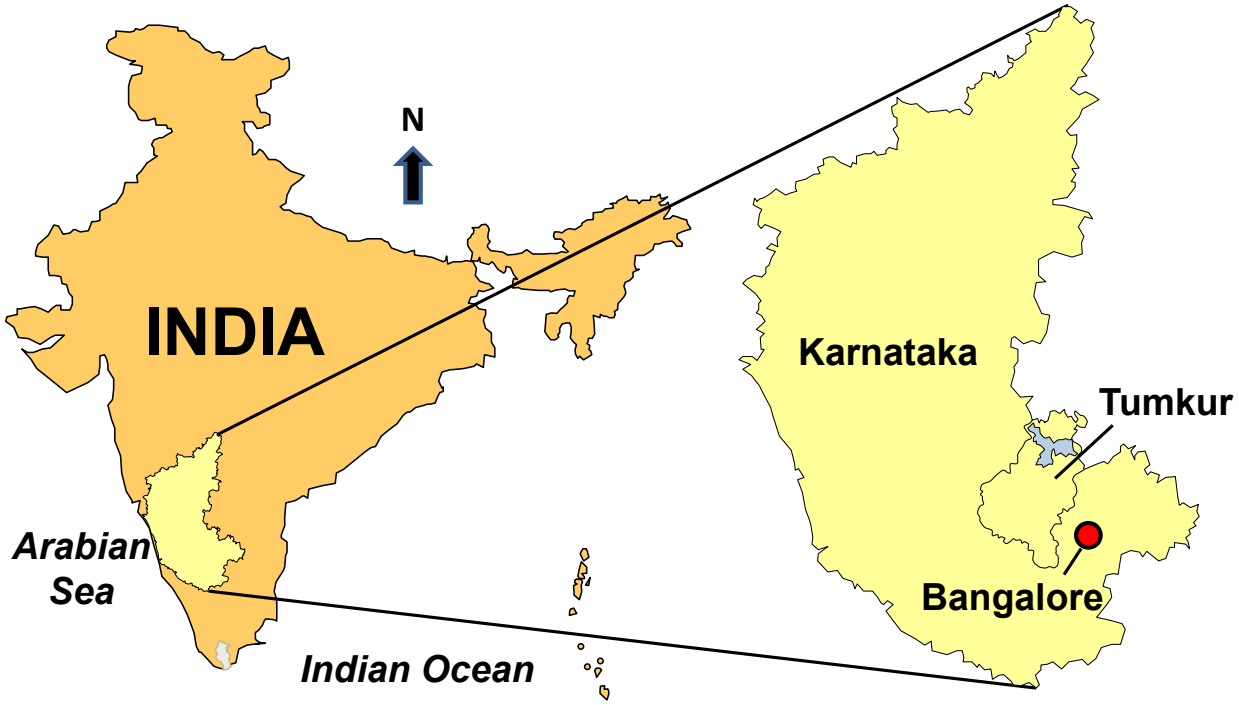

Figure 1. Tumkur district of Karnataka, India.

study area for 5-6 years were trained in interview techniques and contracted to assist with the interviews. Several visits to the villages, meetings and contacts with the elders in the traditional healer's association were made in order to gain their trust before the actual interviews were conducted. Traditional healers were identified by convenience sampling, i.e., with the help of staff from BAIF; through recommendations from a local traditional healer's association; and the majority were identified by local villagers.

Voucher specimens were collected with the aid of interviewers for all the species of plants and deposited at the I-AIM herbarium. An experienced botanist who was conversant with the area flora was part of the team and assisted with plant identification. Voucher specimens were identified by a senior botanist and Ayurvedic physicians at I-AIM and also compared with already identified specimens at the I-AIM herbarium (Saldanha 1984, Singh 1988). Data accumulated was entered into Microsoft Excel® and cross-checked before analysis.

Results

Healer demographics

A total of 24 healers were interviewed to understand their traditional knowledge and practices about malaria and its treatment. All healers were male ranging in age from 40 to 70 years.

Traditional knowledge about malaria and treatment practices

Malaria is locally known as **chali jvara**, **vishama jvara**, and **tandi jvara**. Healers interviewed identified malaria based on signs and symptoms that included fevers (92% of healers), chills (83%), headache (67%), joint pain (50%), sweating (42%), bitter taste in mouth (75%), and loss of appetite (58%). The mode of transmission of the disease was well known to all healers. Due to both the familiarity with clinical signs and symptoms and a lack of access to testing facilities, healers mostly used clinical diagnoses.

The majority of healers mentioned that they acquired this knowledge from their grandparents and parents through oral communication. During the interview, healers reported that traditional knowledge is under serious threat as existing knowledge and practice on traditional medicinal plants are getting eroded due to rapid urbanization and lack of avenues of such knowledge transfer.

All the healers interviewed used herbal remedies for the treatment of malaria. The reasons for using herbal remedies were that they were cost effective, locally available, and easy to prepare. Healers are of the view that the combination of plants work faster and more effectively in treatment of malaria than the single drug usage.

Traditional usage of anti-malarial plants

A total of 31 plant species in 20 families were reported being used in the preparation of herbal remedies for the treatment of malaria (Table 1). Thirty percent of the herbal remedies contained species belonging to the families Fa-

Table 1. Species of plants used for the preparation of traditional remedies for the management of malaria in the Tumkur district of Karnataka state, India. Habits: climber (C), herb (H), shrub (S), tree (T). Source: cultivated (C), planted (P), market (M), weed (W). Parts used: aerial part (A); B, bark (B); Bu, bulb (U); F, fruit (F); FL, flower (O); latex (X), leaf (L), nut (N), root (R); Ri, rhizome (I); S, seed (S); SA, seed aril (E); St, stem (T); Wp, whole plant (W).

Plant species	Voucher	Kannada name	Habit	Source	Parts used	Methods of preparation / administration	Number of informants
Acanthaceae							
Adhatoda vasica Nees	TAM 10	**Addasara soppu**	S	P	L	Boil leaves with *P. nigrum* and *A. sativum* and drink one cupful of decoction three times daily.	2
Andrographis paniculata (Burm.f.) Nees	TAM 7	**Nelabevu**	H	W	L, W	Grind leaves with *P. nigrum* and *A. sativum*. Consume paste with hot water.	3
Amaryllidaceae							
Allium sativum L.	TAM 16	**Bellulli**	H	M	U	Grind bulbs with *P. nigrum* powder and *L. aspera* leaves. Prepare handmade tablets two times daily.	9

Plant species	Voucher	Kannada name	Habit	Source	Parts used	Methods of preparation / administration	Number of informants
Apiaceae							
Centella asiatica (L.) Urb.	TAM 15	**Ondelaga rasa**	H	W	L	Juice of leaves with *P. nigrum* and juice of *A. sativum*, one time daily until recovered.	1
Cuminum cyminum L.	TAM 18	**Jeerige**	H	M	S	Boil seeds with *Z. officinale* and drink decoction as desired until recovered.	1
Apocynaceae							
Calotropis gigantea (L.) Dryand.	TAM 24	**Bili ekka**	S	W	L, X	One tender leaf with one *P. betle* leaf chew once in early morning.	2
Arecaceae							
Cocos nucifera L.	TAM 17	**Tengina kai**	T	C	N	Burn the nut with salts, remove the shell and consume with honey.	2
Cyperaceae							
Cyperus rotundus L.	TAM 4	**Musta**	H	W	I	About 12 g of root powder with dried leaves of *L. aspera* and whole plant powder of *A. paniculata.* Take one half spoonful of powder with honey for three times daily.	1
Fabaceae							
Acacia concinna (Willd.) DC.	TAM 13	**Seege**	C	W	L	Two spoonfuls of leaf juice with milk one time daily.	1
Glycyrrhiza glabra L.	TAM 14	**Jesta madhu**	H	M	R	Root powder with powder of *P. nigrum*, *P. longum*, *O. tenuiflorum* and *M. fragrans*. Take one half spoonful of powder three times daily with honey.	1
Pongamia pinnata (L.) Pierre	TAM 9	**Honge beeja**	T	W	S	Take about 10 g of seed powder with honey three times daily until recovered.	1
Tamarindus indica L.	TAM 8	**Hunase hannu**	T	C	F	Prepare fruit juice with water (rice washed water) and **jaggery** (palm sugar).	1
Lamiaceae							
Ocimum tenuiflorum L.	TAM 25	**Tulasi**	H	P	L	Boil about 6 g of leaves with seeds of *P. nigrum* and drink one cup of decoction two times daily.	4
Leucas aspera (Willd.) Link	TAM 3	**Tumbe ele**	H	W	L, O	Fresh juice of leaves with honey.	5
Loganiaceae							
Strychnos nux-vomica L.	TAM 11	**Nanjina koradu**	T	W	F, S	Grind with root of *C. longa*. Consume pea size paste two times daily.	1
Meliaceae							
Azadirachta indica A.Juss.	TAM 19	**Bevu**	T	P	B	Boil leaves with seeds of *P. nigrum* and bulbs of *A. sativum* and drink one cup of decoction two times daily.	4
Menispermaceae							
Tinospora cordifolia (Willd.) Miers	TAM 29	**Amrutaballi**	C	W	T	Boil with *P. nigrum* and *A. sativum*. Drink decoction as desired until recovered.	3

Plant species	Voucher	Kannada name	Habit	Source	Parts used	Methods of preparation / administration	Number of informants
Myristicaceae							
Myristica fragrans Houtt.	TAM 28	**Jaikai**	T	M	E	Boil seeds with *P. nigrum*, *P. longum* and *O. tenuiflorum* and drink decoction as desired until recovered.	2
Nyctaginaceae							
Boerhavia diffusa L.	TAM 23	**Kommegida**	H	W	W	Boil whole plant. Drink the decoction as desired until recovered.	1
Piperaceae							
Piper betle L.	TAM 12	**Villedele**	C	C	L	Chew leaves with a tender leaf of *C. gigantia.*	3
Piper longum L.	TAM 2	**Hippali**	C	M	F	Boil with leaves of *O. tenuiflorum* and drink decoction as desired until recovered.	3
Piper nigrum L.	TAM 1	**Menasu**	C	M	F	Boil seeds with bulbs of *A. sativum* and leaves of *A. indica* and drink decoction two times daily.	16
Poaceae							
Cynodon dactylon (L.) Pers.	TAM 26	**Garike**	H	W	A	Boil grass with *A. heterophyllum* root powder and *L. aspera* leaves, two times daily until recovered.	2
Ranunculaceae							
Aconitum heterophyllum Wall. ex Royle	TAM 5	**Ativisha**	H	M	R	Boil about 3 g of root powder boil with 6 g of *C. dactylon* leaves and drink the decoction two times daily.	2
Rutaceae							
Citrus limon (L.) Burm. f.	TAM 22	**Nimbe rasa**	T	C	F	Fresh juice of fruit with juice of *L. aspera* leaves and coconut water two times daily until recovered.	1
Ruta chalepensis L.	TAM21	**Nagadali**	H	P	L	Grind 5 g of leaves with *P. nigrum* and *A. sativum*. Consume paste three times daily with hot water.	1
Solanaceae							
Solanum americanum Mill.	TAM 31	**Ganike gida**	H	W	L	Boil leaves with seeds of *P. nigrum* with **jaggery** (palm sugar). Drink two times daily.	1
Zingiberaceae							
Curcuma longa L.	TAM 6	**Arishina**	H	C	I	Grind root with *Tylophora asthmatica* (L. f.) Wight & Arn. leaves and *P. nigrum*. Prepare pea size tablets. Take two tablets two times daily.	2
Elettaria cardamomum (L.) Maton	TAM 27	**Elakki**	H	M	F	Grind fruit with juice of *A. vasica* leaves and powder of *P. longum*, two times daily.	1
Zingiber officinale Roscoe	TAM 20	**Sunti**	H	C	I	Boil with *P. nigrum* and stem of *T. cardifolia* and drink as desired until recovered.	2

Plant species	Voucher	Kannada name	Habit	Source	Parts used	Methods of preparation / administration	Number of informants
Zygophyllaceae							
Tribulus terrestris L.	TAM 30	**Neggilu**	H	W	A	Boil whole plant with *P. nigrum*, leaves of *O. tenuiflorum*, *A. indica*, *A. paniculata.* Drink decoction as desired until recovered.	1

baceae, Piperaceae, and Zingiberaceae. Herbs made up 55% of the total number of medicinal plants followed by climbers (23%), trees (16%), and shrubs (6%). Most of the species of plants used were wild (42%) and are commonly available in study region. Leaves were the most commonly used plant part although there is much diversity (Figure 2).

The five most frequently cited species were *Piper nigrum* L., *Allium sativum* L., *Leucas aspera* (Willd.) Link, *Azadirachta indica* A. Juss. and *Ocimum tenuiflorum* L. Eight species of plants used in the study area are documented for the first time for their use in the treatment of malaria: *Boerhavia diffusa* L., *Elettaria cardamomum* (L.) Maton, *Cuminum cyminum* L., *Cynodon dactylon* (L.) Pers., *Cyperus rotundus* L., *Glycyrrhiza glabra* L., *Myristica fragrans* Houtt., and *Tribulus terrestris* L.

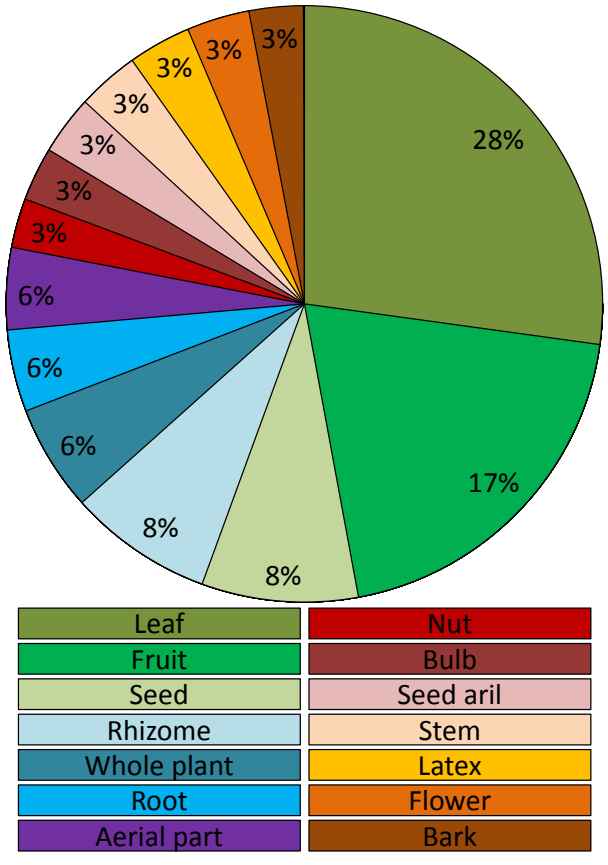

Figure 2. Percent of plant parts used for the preparation of traditional remedies for the management of malaria in the Tumkur district of Karnataka state, India.

Mode of preparation and administration of herbal remedies

The herbal remedies were orally administered, and the majority of them (45%) were decoctions in water. Other forms were fresh juice (16%), herbal paste (16%), powder (10%), tablet (6%), latex (3%), and burned powder (3%). The crude plant extracts or decoctions used for treating malaria were prepared from combinations of plant species (Table 1). Fresh plant material (10-20 g fresh leaves in 1000 ml water) was used for the preparation of decoctions. Oral doses were variable (1 glass twice daily for adults; ½ glass per day for children 12 years and older; 3-5 spoonfuls per day for children below 12 years) and were administered according to the age of the patient until the patient's recovery. The herbal decoction prepared from a combination of *Tinospora cordifolia* (Willd.) Miers, *A. indica*, *P. nigrum*, and *Zingiber officinale* Roscoe was used as malaria prophylaxis and usually consumed during malaria-endemic season.

Forty-two percent of plants used are available in the wild. Other plants are locally cultivated (19%), planted (13%) in home gardens or are plants growing on the premises or compounds. Twenty-six percent of plants were from market sources.

Discussion

The practice of healing using traditional anti-malarial plants is predominant in interior villages where there are poor healthcare facilities. Water soluble extracts of herbal antimalarials were commonly used by healers, and similar observations have been made in anti-malarial herbal remedies of northeast India (Asase *et al*. 2010, Namsa *et al*. 2011).

Species of plants most frequently cited may be more effective and need to be subjected to further scientific investigations (Heinrich *et al*. 2009). For example, *P. nigrum* has been commonly used for the treatment of malaria in

Southern Italy (Tagarelli *et al*. 2010) and northeast India (Namsa *et al*. 2011).

Comparison of ethnopharmacological use with previous studies (antiplasmodial activity and mosquito larvicidal activity)

A literature search was carried out to determine whether the species of plants used by the people in the Tumkur district of Karnataka were already known for their similar ethnobotanical usage from other any other areas (Table 2). Confirmation of plants used elsewhere for similar indications lends support for use of the plants in this area. The eight plants not reported in the literature as being used possibly represent previously undescribed alternatives for malaria-treatment.

The popularity of herbs in traditional medicine has been linked to their higher likelihood of containing pharmacologically active compounds compared to woody plant forms (Thomas *et al*. 2009). This may explain why around half of the plants recorded in the interview are herbs. The tra-

Table 2. Cross-references in published literature on ethnomedical use and antiplasmodial activities of plants used in the Tumkur district of Karnataka state, India.

Species	Selected references with similar ethnomedical use	Selected antiplasmodial activity
Acacia concinna (Willd.) DC.	Sharma *et al*. 2001	-
Aconitum heterophyllum Wall. ex Royle	Chopra *et al*. 1958	-
Adhatoda vasica Nees	Nadkarni 1976; Poonam *et al*. 2009	Dua *et al*. 2011
Allium sativum L.	Adebaya & Krettli 2011; Tagarelli *et al*. 2010	Coppi *et al*. 2006
Andrographis paniculata (Burm.f.) Nees	Najib *et al*. 1999	Najib *et al*. 1999
Azadirachta indica A.Juss.	Adebaya & Krettli 2011; Okumu *et al*. 2007	Joshi *et al*. 1998
Boerhavia diffusa L.	-	-
Calotropis gigantea (L.) Dryand.	Khory & Katrak 1981	Mudi & Bukar 2011
Centella asiatica (L.) Urb.	Muthaura *et al*. 2007	-
Citrus limon (L.) Burm. f.	Ruiz *et al*. 2011	-
Cocos nucifera L.	Cano & Volpato 2004	-
Cuminum cyminum L.	-	-
Curcuma longa L.	Ruiz *et al*. 2011	Reddy *et al*. 2005
Cynodon dactylon (L.) Pers.	-	-
Cyperus rotundus L.	-	Thebtaranonth *et al*. 1995
Elettaria cardamomum (L.) Maton	-	-
Glycyrrhiza glabra L.	-	Esmaeili *et al*. 2009
Leucas aspera (Willd.) Link	CCUM 2000	-
Myristica fragrans Houtt.	-	-
Ocimum tenuiflorum L.	Jayaweera 1981; Namsa *et al*. 2011	-
Piper betle L.	Leaman *et al*. 1995	Al-Adhroey *et al*. 2010
Piper longum L.	Namsa *et al*. 2011; Sharma *et al*. 2001	-
Piper nigrum L.	Namsa *et al*. 2011; Tagarelli *et al*. 2010	Ghiware *et al*. 2007
Pongamia pinnata (L.) Pierre	Nadkami 1982	Simonsen *et al*. 2001
Ruta chalepensis L.	Adams *et al*. 2011	-
Solanum americanum Mill.	Nadkami 1982	-
Strychnos nux-vomica L.	Edmonds & Chweya 1997	Philippe *et al*. 2006
Tamarindus indica L.	Havinga *et al*. 2010	Mesfin *et al*. 2012
Tinospora cordifolia (Willd.) Miers	Poonam & Singh 2009	Singh 2005
Tribulus terrestris L.	-	-
Zingiber officinale Roscoe	Adams *et al*. 2011	-

ditional healers believe that combining more than one plant strengthens the medicine, increasing its effectiveness. Similar findings have been reported in earlier studies (Flatie *et al*. 2009). Combining some plants could have antagonistic or synergistic effects (Rasoanaivo *et al*. 2011). For example, *P. nigrum* and *Curcuma longa* L. are commonly used as components of traditional anti-malarial remedies. Oral bioavailability of curcumin (in *C. longa*) is poor due to glucuronidation in the small intestine. However, piperine (in *P. nigrum* seeds) enhances the bioavailability of curcumin by 2000% in humans due to an inhibition of this glucuronidation and slowing of gastrointestinal transit (Shoba *et al*. 1998).

Systematic ethnomedical studies provide strong clues to the biological activities of particular plant species. Anthropological or ethnographic data, focus group discussions, and community consensus on use and efficacy of practices are productive approaches for generating higher rates of positive laboratory and clinical results (Etkin *et al*. 2004). Some ethnobotanical studies have been conducted in India on herbal remedies used for the treatment of malaria in different communities (Namsa *et al*. 2011). It is also important to note that the combinations of herbal products may enhance overall effectiveness and are expected to have fewer problems of resistance or adverse effects (Azas *et al*. 2002, Gathirwa *et al*. 2008).

Conclusions

The present survey has shown that the ethnomedical knowledge of plants for management of malaria may be found among traditional healers in the Tumkur district of Karnataka, India. A literature search has shown that many of the plants used in the study area have been previously documented elsewhere for their use in the treatment of malaria and some have been confirmed to have positive antiplasmodial activity thus, supporting rationalization for their continued use. Eight species of plants were reported for the first time in this study for the treatment of malaria.

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