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Herbal Plants Used For the Treatment of Malaria- A Literature Review

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Malaria is one of the most common major health problems all over the world. Pharmacotherapy is the most common treatment strategy for the disease. But, the main obstacle behind this is emergence of resistance for many of these drugs. Hence, to overcome this problem, the major option available since ancient times is medicinal plants all over the world. Mankind is blessed with wide range of herbal plants for various ailments with lot of those useful for malaria treatment also. In this review, we have highlighted many of those plants all over the world which are being used since ancient times for the treatment of malaria

Keyword: Herbal plants, Malaria, Anti-malarial activity, Plasmodium

1. Introduction

Malaria is one of the most common major health problem in tropical and developing countries of sub-Saharan Africa and south East Asia including India^[1]. It is major killing disease responsible for the death of millions of children, pregnant women and adults^[1]. Malaria is caused by *Plasmodium* parasites. The parasites are spread to people through the bites of infected *Anopheles* mosquitoes, called "malaria vectors"^[2]. There are four parasite species that cause malaria in humans which are *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae* and *Plasmodium ovale*.² *P.falciparum* and *P. vivax* are the most common species clinically but *P. falciparum* is the most deadly leading to many fatal complications including cerebral malaria^[2]. Clinical symptoms of malaria ranges from acute febrile illness with fever associated with chills, headache, and vomiting to deadly complications like severe anaemia, respiratory distress in

relation to metabolic acidosis, or cerebral malaria which can eventually lead to death^[2].

In 2010, malaria caused an estimated 6,60,000 deaths, mostly among African children^[2]. As per the latest WHO estimates, there are 300-500 million new clinical cases globally and >1 million deaths occur due to malaria each year^[3].

Treatment strategies of malaria aim to terminate the acute blood infection, to cure the clinical symptoms, to clear hypnozoites from the liver to prevent future relapses and to prevent the spread of infection^[4]. Radical treatment and curative treatment comprise main aspects of treatment. Various pharmacological options available for this purpose are *Chloroquine*, *Mefloquine*, *Quinine*, *Primaquine*, *Pyremethamine*, *Artemisinin derivatives like artesunate*, *artemether*, *arteether* and *amino alcohols like Lumefantrine* and *Halofantrine* along with *tetracycline*, *Doxycyclines* and *Sulfadoxime* etc^[3]. The greatest problem associated with this treatment is emergence of drug resistance which

leads to treatment failure in significant number of cases^[4].

2. Use of herbal plants in the treatment of malaria

Apart from the pharmacological treatment, various options are being used since ancient times for many health ailments. Nearly 80 % of the global population still depends upon the herbal drugs for their health care. In India, the use of several medicinal plants to cure specific ailments has been practiced since ancient times. Various cultural traditions are associated with use of wild plants as medicinal herbs. This medico-lore is passed over generations traditionally all over the world. Reliance on plants is primarily due to their safety, effectiveness, cultural preferences, inexpensiveness and abundant availability all the time. The medicinal virtues of plants are identified by instinct/intuition or by trial and errors. Globally, traditional healers are using various medicinal plants for the treatment of

malaria; however, this practice is not really completely recognized by modern medicine.

Knowledge about traditional medicinal practices and plants is currently transmitted from generation to generation principally by word of mouth. Large number of plant species has been identified as anti-malarial medicinal plants. In the present review, extensive literature review was done on the plants, which have been identified as anti-malarial plants and the work done so far in evaluating their anti-malarial potential. A wide variety of plants belonging to several families have been identified through ethnobotanical and ethno pharmacological studies as anti-malarial medicinal plants.

This review is an attempt to present a comprehensive account of numerous medicinal plants used in the treatment of malaria in either forms. A thorough literature survey highlights that plant kingdom has a tremendous resources which can be exploited for unidentified novel compounds anti-malarial activity.

Table 1: Plants Having Anti- Malarial Activities

Sr. No	Botanical Name	Common name/ Vernacular name	Family	Parts used
1	<i>Clerodendrum viscosum</i> Vent ^[5]	Viti, Bhat Pata, Bhati, Vaita, Foksha, Baadbagora.	Lamiaceae	Whole plant
2	<i>Duranta repens</i> L ^[5]	Kata-mehandi, Kata-mehendhe	Verbenaceae	Whole plant
3	<i>Lantana camara</i> L ^[5]	Chaturaangi, Jangoli-janglog	Verbenaceae	Leaf, root, flower
4	<i>Nyctanthes arbor tristis</i> L ^[5]	Shefali, Sheuli, Sheuly-phang	Oleaceae	Leaf
5	<i>Dracaena reflexa</i> Lamk ^[6]	Hasina Pleomele, Song of India	Asparagaceae	Leaf and bark decoction
6	<i>Cinnamosma fragrans</i> H ^[6]	Sakarivohazo,	<i>Canellaceae</i>	A decoction of the leaf and bark
7	<i>Andropogon schoenanthus/nardis</i> L ^[6]	veromanitra	<i>Gramineae</i>	The leaf decoction
8	<i>Desmodium mauritianum</i> D.C ^[6]	Bean of the hare oganana	<i>Leguminosae</i>	A decoction of the leaf and bark
9	<i>Desmodium hirtum</i> Grill and Perr ^[6]	Tsilavindrivotro	<i>Leguminosae</i>	A decoction of the leaf and bark
10	<i>Tristellateia madagascariensis</i> Poir ^[6]	Menahelika	<i>Malpighiaceae</i>	The leaf decoction
11	<i>Ficus megapoda</i> Bak ^[6]	Mandresy	<i>Moraceae</i>	A decoction of the leaf and bark
12	<i>Nymphaea lotus</i> L ^[6]	Voahirana or retsimilana	<i>Nymphaeaceae</i>	A decoction of the leaf and bark
13	<i>Vepris ampody</i> H. Perr ^[6]	Ampody	<i>Rutaceae</i>	A decoction of the leaf and bark
14	<i>Zanthoxylum tsihanimposa</i> Bak ^[6]	Tsihanimposa	<i>Rutaceae</i>	A decoction of the leaf and bark
15	<i>Peddiea involucrata</i> Bak ^[6]	Montana	<i>Thymelaeaceae</i>	A decoction of the leaf and bark

16	<i>E. angolense</i> ^[7]	Mukus, Edinam	<i>Meliaceae</i>	Plant extract
17	<i>P. nitida</i> ^[7]	waboom, blousuikerbos	<i>Apocynaceae</i>	Plant extract
18	<i>T. hensii</i> ^[7]		<i>Thomandersiaceae</i>	Plant extract
19	<i>Shumanniophyton magnificum</i> ^[7]	Sierra Leone Mend	<i>Rubiaceae</i>	Plant extract
20	<i>Rauwolfia vomitoria Afzel.</i> ^[8]	Omuatabusinde/Kinyabusinde	<i>Apocynaceae</i>	The leaves decoction
21	<i>Canarium schweinfurtii Engl</i> ^[8]	Muubani	<i>Burseraceae</i>	The bark scent
22	<i>Zehneria scabra Sond</i> ^[8]	Akabindizi	<i>Cucurbitaceae</i>	The leaves decoction
23	<i>Bridelia micrantha</i> (Hochst.) Baill ^[8]	Mshamako	<i>Euphorbiaceae</i>	Root decoction
24	<i>Tragia furialis Bojer</i> ^[8]	Omugonampili	<i>Euphorbiaceae</i>	The leaves decoction
25	<i>Abrus precatorius L</i> ^[8]	Kaligaligo	<i>Fabaceae</i>	The leaves decoction
26	<i>Dolichos kilimandscharicus Taub</i> ^[8]	Khat	<i>Fabaceae</i>	The leaves
27	<i>Sesbania microphylla</i> E.Phillips & Hutch ^[8]	Msenga, Mbondo	<i>Fabaceae</i>	The leaves
28	<i>Senna occidentalis</i> (L.) Link ^[8]	Omwetanjoka	<i>Fabaceae</i>	The leaves decoction
29	<i>Tetradenia urticifolia</i> (Baker) Phillipson ^[8]	Lwamo	<i>Lamiaceae</i>	The leaves decoction
30	<i>Solanum aculeastrum Dunal</i> ^[8]	Omulembezi, Entobatobe	<i>Solanaceae</i>	Fruits
31	<i>Caesalpinia nuga</i> (L.)W. T. Aiton ^[9]	Krung-khai	<i>Fabaceae</i>	Seed
32	<i>Adansonia digitata L</i> ^[9]	Kattio-daghor	<i>Bombacaceae</i>	Leaf, root, Flower
33	<i>Jatropha gossypifolia</i> ^[9]	Titto-long	<i>Euphorbiaceae</i>	Seed
34	<i>Rauwolfia serpentina Benth</i> ^[9]	Sharpagandha	<i>Apocynaceae</i>	Root
35	<i>Hodgsonia macrocarpa Cogn</i> ^[9]	Keha-pang	<i>Cucurbitaceae</i>	Fruit
36	<i>Erythrina variegata L</i> ^[9]	Mada-kamiama-fang	<i>Fabaceae</i>	Bark
37	<i>Streblus asper Lour</i> ^[9]	Sarwa	<i>Moraceae</i>	Bark
38	<i>Clerodendrum viscosum Vent</i> ^[9]	Kung-sroi-ma	<i>Verbenaceae</i>	Leaf
39	<i>Amaranthus spinosus</i> ^[9]	Kang-chuo	<i>Amaranthaceae</i>	Root
40	<i>Mussaenda corymbosa</i> A.L. de Jussieu ^[9]	Mok-ae	<i>Rubiaceae</i>	Leaf
41	<i>Scoparia dulcis</i> ^[9]	Tapra-amkanlu	<i>Scrophulariaceae</i>	Leaf
42	<i>Ocimum sanctum</i> Linn. ^[10]	Tulsi	<i>Lamiaceae</i>	Plant extract
43	<i>Cryptolepis Sanguinolenta</i> ^[11,12]	Nibima	<i>Apocynaceae</i>	aqueous extract
44	<i>Artemisia annua</i> ^[11,12,13]	sweet wormwood	<i>Asteraceae</i>	aqueous extract
45	<i>Dichroa Febrifuga</i> ^[11]	Gigil,Tataruman	<i>Hydrangeaceae</i>	aqueous extract
46	<i>Kalanchoe pinnata</i> ^[12]	Air Plant, Life Plant	<i>Crassulaceae</i>	Leaf
47	<i>Esenbeckia febrifuga</i> (A.St.-Hil.) A.Juss. ex Mart ^[13]	Três folhas	<i>Rutaceae</i>	Hexane/ethanolic extracts
48	<i>Boerhavia hirsuta</i> ^[13]	Pega Pinto	<i>Nyctaginaceae</i>	Hexane/ethanolic extracts
49	<i>A. austral</i> ^[13]	Carrapicho	<i>Cerambycidae</i>	Hexane/ethanolic extracts
50	<i>Tachia guianensis</i> ^[13]	Caferana	<i>Gentianaceae</i>	Hexane/ethanolic extracts
51	<i>Cecropia glaziouvi</i> ^[13]	Umbauba	<i>Urticaceae</i>	Plant
52	<i>Bidens pilosa</i> ^[13]	Cobbler's Pegs or Spanish Needle	<i>Asteraceae</i>	Extracts and fractions of plants
53	<i>A.amazonicus Ducke</i> ^[13]	Indian beer	<i>Rhamnaceae</i>	Dried Ground roots
54	<i>Alstonia scholaris</i> (L.) R.Br ^[14]	Yaknalae's Ita	<i>Apocynaceae</i>	Leaves and bark
55	<i>Aristolochia indica</i> L. ^[14]	Yaki'litchale	<i>Meliaceae</i>	Leaves and bark decoction
56	<i>Maclura</i> sp. ^[14]	Iveriate	<i>Moraceae</i>	Leaves
57	<i>Polygala paniculata</i> L. ^[14]	Nuva gihi	<i>Polygalaceae</i>	Leaves and fruits
58	<i>Polyscias filicifolia</i> ^[14]	Iriduki'lmetchale	<i>Araliaceae</i>	Leaves
59	<i>Setaria</i> sp. ^[14]	Nomu suva	<i>Poaceae</i>	whole plant
60	<i>Tasmannia piperita</i> (Hook. f.) Miers. ^[14]	Iridukichale	<i>Winteraceae</i>	Leaves
61	<i>Tristiropsis</i> sp. ^[14]	Longola	<i>Sapindaceae</i>	Soft Leaves
62	<i>T. herba-barona</i> ^[15]	Caraway thyme	<i>Lamiaceae</i>	Aerial parts

63	<i>S. thymbra</i> ^[15]	Thyme-leaved savory	<i>Lamiaceae</i>	Aerial parts
64	<i>M. communis</i> ^[15]	Myrtle	<i>Myrtaceae</i>	Aerial parts
65	<i>Cymbogon citratus</i> ^[15]	Lemon grass, oil grass	<i>Poaceae</i>	Vapours of a decoction
66	<i>Ocimum gratissimum</i> ^[15]	Clove Basil, African Basil	<i>Lamiaceae</i>	Vapours of a decoction
67	<i>Cuviera longiflora</i> ^[16]	-	<i>Rubiaceae</i>	Leaves
68	<i>Dacryodes edulis</i> ^[16]	Zo'o	<i>Burseraceae</i>	Leaves
69	<i>Eucalyptus globules</i> ^[16]	Klatusse	<i>Myrtaceae</i>	Leaves
70	<i>Kotschya speciosa</i> ^[16]	Hepper	<i>Leguminoceae</i>	Whole plant
71	<i>Coula edulis</i> ^[16]	Walnut	<i>Olacaceae</i>	Stem bark
72	<i>Vernonia amygdalina</i> ^[16]	Bitter leaf	<i>Asteraceae</i>	Leaves, root bark
73	<i>Vismia guinensis</i> ^[16]	-	<i>Asteraceae</i>	Stem bark
74	<i>Nauclea latifolia</i> ^[17]	Pin cushion tree	<i>Rubiaceae</i>	stems and roots
75	<i>Pseudocedrela kotschy</i> ^[17]	Dry zone cedar; Hard cedar-mahogany	<i>Meliaceae</i>	Leaves
76	<i>Prosopis africana</i> ^[17]	African mesquite	<i>Fabaceae</i>	Plant
77	<i>Trichilia emetica</i> ^[17]	Natal Mahogany	<i>Meliaceae</i>	Plant
78	<i>Diospyros quaesita</i> Thw. ^[18]	Calamander	<i>Ebenaceae</i>	Leaf and stem
79	<i>Gongronema napalense</i> (Wall.) Decne. ^[18]	-	<i>Asclepiadaceae</i>	Whole flower(wine)
80	<i>Nauclea orientalis</i> (L.) ^[18]	yellow cheesewood	<i>Rubiaceae</i>	Dried plant/stem
81	<i>Rourea minor</i> (Gaertn.) Aubl. ^[18]	A woody vine	<i>Connaraceae</i>	Dried stem
82	<i>Amaranthus hybridus</i> ^[19]	Slim amaranth	<i>Amaranthaceae</i>	Leaves
83	<i>Uvaria scheffleri</i> Diels ^[19]	Mukukuma	<i>Annonaceae</i>	Leaves
84	<i>Carissa edulis</i> (Forssk.) ^[19]	Simple-spined num-num	<i>Apocynaceae</i>	Root bark
85	<i>Landolphia buchananii</i> (Hallier f.)Stapf ^[19]	Apricot vine	<i>Apocynaceae Juss</i>	Leaves
86	<i>Rauwolfia</i> Cothen. ^[19]	-	<i>Apocynaceae Juss.</i>	Root bark
87	<i>Vernonia amygdalina</i> A. Chev. ^[19]	Ewuro	<i>Asteraceae</i>	Leaves
88	<i>Tridax procumbens</i> L. ^[19]	lilac tassel flower	<i>Asteraceae</i>	Whole plant
89	<i>Commiphora schimperi</i> (O.Berg)Engl. ^[19]	Glossy-leaved corkwood	<i>Burseraceae Kunth</i>	Roots, stem bark
90	<i>Combretummolle</i> Engl. & Diels ^[19]	Velvet bush willow	<i>Combretaceae</i>	Leaves
91	<i>Gerrardanthus lobatus</i> C. Jeffrey ^[19]	Cogniaux	<i>Cucurbitaceae</i>	Roots
92	<i>Momordica foetida</i> Schumach. ^[19]	Concombre sauvage	<i>Cucurbitaceae Juss</i>	Leaves
93	<i>Ricinus communis</i> L. ^[19]	Castor Bean	<i>Euphorbiaceae</i>	Roots, leaves
94	<i>Suregada zanzibariensis</i> Baill. ^[19]	Prota	<i>Euphorbiaceae Juss</i>	Root bark
95	<i>Albizia anthelmintica</i> Brongn. ^[19]	Kyoa	<i>Fabaceae</i>	Stem bark
96	<i>Acaciaseyal</i> Delile ^[19]	Shittimwood	<i>Fabaceae</i>	Roots
97	<i>Dichrostachys cinerea</i> (L.) Wight&Arn. ^[19]	Sickle bush	<i>Fabaceae</i>	Roots
98	<i>Tamarindus indica</i> L. ^[19]	Tamarind	<i>Fabaceae Lindl</i>	Roots, leaves
99	<i>Harungana madagascariensis</i> Lam. Ex Poir. ¹⁹	Praying hands	<i>Hypericaceae Juss.</i>	Root bark, stem bark
100	<i>Hoslundia opposita</i> Vahl ^[19]	Orange bird berry	<i>Lamiaceae</i>	Roots
101	<i>Ocimum gratissimum</i> L. ^[19]	African basil	<i>Lamiaceae</i>	Leaves
102	<i>Clerodendrum myricoides</i> R. Br. ^[19]	Bandamuchenene	<i>Lamiaceae</i>	Root bark
103	<i>Adansonia digitata</i> L. ^[19]	Baobab, Dead-Rat Tree	<i>Malvaceae</i>	Leaves
104	<i>Grewia hainesiana</i> Hole ^[19]	Phalsa	<i>Malvaceae Juss.</i>	Leaves
105	<i>Grewia trichocarpa</i> Hochst.exA.Rich. ^[19]	Ecol. Status	<i>Malvaceae Juss.</i>	Roots
106	<i>Azadirachtaindica</i> A. Juss. ^[19]	Neem	<i>Meliaceae</i>	Roots, stem bark, leaves
107	<i>Cissampelos mucronata</i> A. Rich. ^[19]	Heart-leaved vine	<i>Menispermaceae Juss</i>	Root bark
108	<i>Ficus bussei</i> Warb.ex Mildbr.& Burret ^[19]	Rudraksha	<i>Moraceae</i>	Roots
109	<i>Securidaca longifolia</i> Poepp. ^[19]	-	<i>Polygalaceae</i>	Roots
110	<i>Canthium glaucum</i> Hiern ^[19]	Bluish-Green, Glaucous	<i>Rubiaceae</i>	Fruits
111	<i>Pentas longiflora</i> Oliv. ^[19]	Golden Shrimp Plant	<i>Rubiaceae</i>	Root bark
112	<i>Clausena anisata</i> (Willd.) Hook. f.	Horsewood	<i>Rutaceae</i>	Leaves

	ex Benth ^[19]			
113	<i>Zanthoxylum chalybeum</i> Engl. ^[19]	Bemba	<i>Rutaceae</i>	Root bark
114	<i>Toddalia asiatica</i> (L.) Lam. ^[19]	Orange climbe	<i>Rutaceae</i>	Root bark
115	<i>Fagaropsis angolensis</i> (Engl.) Dale ^[19]	Caper-bush	<i>Rutaceae Juss.</i>	Leaves
116	<i>Teclea simplicifolia</i> (Engl.) I. Verd. ^[19]	Teclea nobilis	<i>Rutaceae Juss.</i>	Roots
117	<i>Flacourtia indica</i> (Burm.f.) Merr. ^[19]	Governor plum	<i>Salicaceae</i>	Roots
118	<i>Lantana camara</i> L. ^[19]	Shrub verbenas	<i>Verbenaceae</i>	Leaves
119	<i>Aloe vera</i> L. ex Webb ^[19]	English musambra aloe	<i>Xanthorrhoeaceae</i>	Leaves
120	<i>Hypericum lanceolatum</i> ^[20]	Curry bush	<i>Hypericaceae</i>	Stem bark
121	<i>Caesalpinia pluviosa</i> ^[21]	Sibipiruna	<i>Fabaceae</i>	Crude extract
122	<i>Icacina senegalensis</i> A. Juss. ^[22]	Bankanas, False yam	<i>Icacinaceae</i>	Leaf extracts
123	<i>Holarrhena antidysenterica</i> ^[23]	Bitter Oleander	<i>Apocynaceae</i>	Plant extracts
124	<i>Viola canescens</i> ^[23]	Viola serpens var.	<i>Violaceae</i>	Plant
125	<i>Aframomum</i> sp ^[24]	Grains of paradise	<i>Zingiberaceae</i>	Plant
126	<i>Vernonia guineensis</i> ^[24]	Ginseng	<i>Asteraceae</i>	Plant
127	<i>Spilanthes oleracea</i> ^[24]	Toothache Plant	<i>Asteraceae</i>	Plant
128	<i>Alstonia boonei</i> ^[24]	Alstonia, Cheesewood	<i>Apocynaceae</i>	Plant
129	<i>Ambrosia Maritima</i> ^[25]	Damsisa	<i>Asteraceae</i>	Whole plant
130	<i>Aristolochia Bracteolata</i> ^[25]	Um Galagel	<i>Aristolochiaceae</i>	Leaves
131	<i>Citrullus colocynthis</i> ^[25]	El-Handal	<i>Cucurbitaceae</i>	Seed
132	<i>Croton zambesicus</i> ^[25]	Um-Geleigla	<i>Euphorbiaceae</i>	Fruit
133	<i>Nigella sativa</i> ^[25]	Kamun-Aswad	<i>Ranunculaceae</i>	Seed
134	<i>Solenostema argel</i> ^[25]	El-Hargel	<i>Ascepiadaceae</i>	Leaves
135	<i>Allium sativum</i> L. ^[26]	Sunkurtae	<i>Alliaceae</i>	Fresh or dry fruits
136	<i>Artemisia afra</i> Jack. ex Wild ^[26]	Chugughee	<i>Asteraceae</i>	Fresh/dry leaves
137	<i>Lepidium sativum</i> L. ^[26]	Feaxxo	<i>Brassicaceae</i>	Seeds
138	<i>Croton macrostachyus</i> Del. ^[26]	Bissano	<i>Euphorbiaceae</i>	Fresh/dry leaves
139	<i>Phytolacca dodecandra</i> L'Herit ^[26]	Phytolaceae	<i>Indoodae</i>	Fresh/dry leaves

3. Discussion

The present article brings out information on different medicinal plants used in various parts of world for the treatment of malaria. One hundred thirty nine medicinal plants have been recorded here in for their use as anti-malarials. Although traditional remedies are widely used to treat malaria, and are often more available and affordable than Western drugs, they are not without limitations. Some of the limitations include unpredictable efficacy, non-established dosage and the short and long term safety are not known.

The development of new antimalarials from the highly active natural products, which have already been discovered, is crucial in order to overcome the increasing resistance of *Plasmodium* to available antimalarial drugs. Therefore, there is a need to advance the work on plants which have already been shown to have antimalarial activity through further *in vitro* and *in vivo* testing in animal models of malaria

followed by sub-acute and chronic toxicity tests. This is likely to reveal suitable candidate molecules which may serve as leads which can be optimized followed by development into new antimalarials. This task will require capacity building in the various facets of such an approach, which capacity is inadequate at the moment. This strategy if pursued from drug discovery research on to preclinical followed by clinical studies will certainly yield the much desired highly efficacious and safe antimalarials. However, further studies including controlled clinical trials are necessary before specific traditional remedies can be recommended on a large scale.

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