



# Credibility of Folklore Claims on the Treatment of Malaria in North-East India with Special Reference to Corroboration of their Biological Activities

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## Abstract

Malaria is one of the major causes of mortality and morbidity throughout the developing countries. In spite of considerable advances made in the development of anti-malarial drugs to combat the disease, appearance of the malaria parasite resistance to the drugs one after another, has triggered the researchers to search for alternative agents of better quality. In view of the fact that plant folk medicines have immense value in providing clue for development of drug, an ethnobotanic survey of medicinal plants practiced for the treatment of malaria in North-East India, followed by the validity of folklore claims of the plant species was conducted based on the review of reported literatures. Seventy four plant species under 67 genera and 41 families used for the preparation of recipes to treat the disease were included in this communication. For each plant species, botanical and vernacular name, part(s) used, method of preparation and mode of administration of the herbal remedies were provided. Biological activities corroborative of folklore medicinal claims of the plant species were also indicated for the credibility of these folklore claims.

**Keywords:** Biological Activities, Folk Medicine, Malaria, North East India, Review, Validation

## 1. Introduction

Malaria, caused by *Plasmodium* species is one of the most severe diseases in the world that kills over 1 million people every year with some 3.2 billion people living in 107 countries or territories currently at risk<sup>1</sup>. The main reasons that explain this worsening situation

are resistance to the current anti-malarial drugs by *Plasmodium* strains<sup>2</sup>, lack of new therapeutic targets<sup>3</sup> and unavailability and un-affordability of anti-malarial drugs<sup>4, 5</sup>. The North-East India has been described and classified as a highly endemic region of the world for malaria, claiming an estimated 500 lives annually<sup>1, 6</sup>. Drug discovery from plants involves a multidisciplinary

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approach combining botanical, ethnobotanical, phytochemical and biological techniques. Plants continue to provide us new chemical entities (lead molecules) for the development of drugs against various pharmacological targets, including malaria<sup>7</sup>. Since the discovery of quinine, a number of anti-malarial agents both of plant origin and synthetic have been developed. However, appearance of *Plasmodium* strains, resistance to these drugs one after another, has made the problem most critical one and triggered intensive efforts on the part of researcher world over to search for alternative agents of better quality on one hand, and to develop potentiating combinations of the currently used drugs, to prevent the situation from further deterioration, on the other<sup>8-10</sup>. At the same time the ethnopharmacology approach used in search for new anti-malarial compounds appears to be predictive<sup>11</sup>.

The North-East region of India situated between 21°34' N to 29°50' N latitude and 87°32' E to 97°52' E longitudes and covers an area of about 262060 sq km.<sup>12</sup>. The area known for its rich flora<sup>13</sup> comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim which includes hills and plains and extends from sea level to snow line, holds approximately 50 percent of the total flora of India with the number of species ranging from 6000-7000<sup>14</sup>. This area of India is also homeland of people belonging to more than 150 ethnic groups (tribal or tribal in origin), including 22 percent aboriginal people<sup>15</sup>. About 90 percent of the total population of the region has a rural background and most of them still live in remote, isolated areas, maintaining individual identities and a primitive economic life<sup>16</sup>. Traditional agriculture is the primary live hood of these people and these people depend mostly upon surrounding plant resources for day to day needs including medicaments.

Over the last few decades, a large number of ethno-medico-botanical explorations has been conducted in the region and information has been collected on the local use of a large number of plants for the treatments of a large number of diseases including malaria<sup>10, 17-21</sup>. Unfortunately the information has been scattered in a wide range of professional journals and periodicals, making the data mostly not easily accessible to researchers. The present communication is a review based on the plant species from Northeastern India

used for the treatment of malaria and related diseases reported from the region.

## 2. Materials and Methods

Ethno-medico-botanical case studies reported from North-East India up to the year 2008 were reviewed and the reports on prescriptions using plant species for the treatment of malaria were collected. These references are critically examined for the prescriptions referred for the treatment of malaria and not to include general antipyretic plants. A review of literatures pertaining to biological activities of these the plant species was also conducted to verify the validity of the folklore claims and to find out direct or indirect corroboration with the biological activities; so that pharmacological evaluation of those plant species against *Plasmodium* strains may be prioritized, for which no direct corroboration was found and for which reports are scarcely available.

## 3. Results

The plant species with their ethnic uses are arranged prescription wise. For each plant species described, the botanical name followed by family, vernacular name and the name of ethnic community who uses the plant species are provided. Parts of the plant used, method of preparation or formulation and mode of administration along with dosage of folk medicines are listed in Table 1 with their respective references. In Table 2, corroborative biological activities i.e., anti-malarial activity of the cited medicinal plant species available are also given. The table includes only those species whose anti-malarial activity was reported.

## 4. Discussion and Conclusion

The present study has brought into light 64 prescriptions of plant folk medicines represented by 74 plant species under 67 genera and 42 families, which have been in use among the ethnic communities in North-East India, for the treatment of malaria and related diseases. Most of the drugs (87.5%) are prepared using single plant species; however, plant species used in combinations are also accounted for 12.5% of the formulations. Most of the preparations are orally administered either as extract, juice and decoction or infusion. The harder

**Table 1:** Ethno-medico-botanic prescriptions for treatment of Malaria in North-East India

Sl. No.	Plants used with local name	Parts used	Method of preparation or Formulation	Mode of administration	Tribe involved; Area of Report
1	<i>Acacia concina</i> DC. (Mimosaceae); Khangthur	Leaves	Leaves are soaked in water for overnight and made infusion	5-15 ml is taken orally 4-5 times a day	Mizo; Mizoram <sup>22</sup>
2	<i>Acorus calamus</i> Linn. (Araceae); Bet, Krah-Phiang	Roots	Roots are pounded to make juice	2-3 teaspoonfuls are given orally 3-4 times a day	Garos and Khasis; Meghalaya <sup>23,24</sup>
3	<i>Adhatoda vasica</i> Nees. (Acanthaceae); Kawldawi, Teise	Leaves and roots	Leaves and roots are taken together in equal amounts and boiled in water to make decoction	5-15 ml is taken orally 2-3 times a day	Mizo; Mizoram <sup>22</sup> and Angami Naga; Nagaland <sup>25</sup>
4 *	<i>Ageratum conyzoides</i> L. (Asteraceae); Bormadari <i>Momordica charantia</i> L. (Cucurbitaceae); Odasi <i>Alstonia scholaris</i> . (L.) R. Br. (Apocynaceae); Sataona	Tender roots Tender roots Dried powdered stem bark	Extracted tender roots of <i>Ageratum conyzoides</i> L. and <i>Momordica charantia</i> L. are mixed with 50 gm of dried powdered stem bark of <i>Alstonia scholaris</i> . (L.) R. Br. in 200 ml of warm water	Two teaspoonfuls of the filtrate are given twice a day for 10 days	Bodo; Assam <sup>19</sup>
5 *	<i>Alstonia scholaris</i> R.Br. (Apocynaceae); Thuamriat, Chhation	Bark	Decoction of the bark	10 ml is given orally in 2-4 times a day	Mizo; Mizoram <sup>22</sup> and Plain tribe; Assam <sup>26</sup>
6 *	<i>Andrographis paniculata</i> Nees. (Acanthaceae); Chirata, Kalmegh	Leaves	Leaves are made into paste and 2-3 gm of the paste mixed with water	Given orally once or twice a day	Plain tribe; Assam <sup>27</sup>
7	<i>Artemisia nilagirica</i> Clarke (Asteraceae); Sai	Leaves	Decoction of the leaves	5-10 ml is given orally 3-4 times a day	Mizo; Mizoram <sup>22</sup>
8 *	<i>Azadirachta indica</i> A. Juss. (Meliaceae); Dieng-jarasang	Leaves and fruits	Leaves and fruits either singly or in combination are ground to fine paste and 2-3 gm of the paste mixed with water	orally twice a day	Khasi; Meghalaya <sup>28</sup>
9	<i>Begonia inflata</i> Clarke (Begoniaceae); Sekhupthur	Rhizome	Decoction of the rhizome	5-10 ml is prescribed orally 2-3 times a day	Mizo; Mizoram <sup>22</sup>
10	<i>Brucea mollis</i> (Simroubaceae); Kaunine	Seed powder	Seed powder (50 gm) mixed with a cup of water	orally once or twice a day	Khasi; Assam <sup>29,30</sup>
11 *	<i>Caesalpinia bonduc</i> L. (Caesalpinaceae); Leta guti	Tender twigs and seeds	Tender twigs and seeds either singly or in combination are ground to paste and made into small pills of about 1 to 2gm each	Two pills twice a day are prescribed orally for 3-5 days	Dimasa; Meghalaya <sup>31</sup>
12	<i>Calotropis gigantea</i> (L.) R. Br. ex Ait. (Asclepiadaceae); Akom-aring	Fresh leaves	Fresh leaves are pounded	one teaspoonful of extract is given orally thrice a day	Garos; Meghalaya <sup>32</sup>
13	<i>Cardiospermum halicacabum</i> L. (Sapindaceae); Kopal-phuta	Leaves	are made in to paste adding a pinch of salt and about 10 mg of the paste mixed with water	given orally once a day	Mahahi; Assam <sup>33</sup>

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14 *	<i>Cassia occidentalis</i> L. (Caesalpinaceae); Herashi	Roots	Roots are pounded adding little amount of water	a tea cup of extracted juice is given orally once a day	Rajbanshi; Assam <sup>34</sup>
15	<i>Cissampelos pareira</i> L. (Menispermaceae); Ranchsang-sata-phumru	Leaves	Decoction of the leaves	prescribed orally twice a day	Naga; Arunachal Pradesh <sup>35</sup>
16	<i>Citrus medica</i> L. (Rutaceae); Chufu	Fruit	Fruit juice mixed with powder of a kind of sea shell (locally known as 'kechu')	taken orally once or twice a day	Angami Naga; Nagaland <sup>25</sup>
17	<i>Clerodendrum colebrookianum</i> Walp. (Verbenaceae); Oremoatong	Bark and leaves	Bark and leaves in the form of decoction	given orally 2-3 times a day	Naga; Nagaland <sup>36</sup>
18 *	<i>Clerodendrum infortunatum</i> L. (Verbenaceae); Mukhnabilai, Sakai-yu-fa	Tender shoots	Fresh juice of the crushed tender shoots	given orally one teaspoonful twice a day	Bodo and Dimasa; Assam <sup>37</sup>
19 *	<i>Coptis teeta</i> Wall (Ranunculaceae); Aru, Rinko	Rhizome	Rhizome is cut into 2 mm thick slices and three slices are soaked in water overnight and made infusion	given orally once a day in the morning	Mishimi and Adi; Arunachal Pradesh <sup>38,39</sup>
20	<i>Cyclea peltata</i> Hook.f. & Thoms. (Menispermaceae); Rekong-bong-long	Leaves	Leaves are pounded	a tea cup of extract is given orally once or twice a day	Karbi; Assam <sup>40</sup>
21 *	<i>Cyperus rotundus</i> L. (Cyperaceae); Mutha <i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex G.Don. (Apocynaceae); Doukhri <i>Tinospora cordifolia</i> (Menispermaceae); Amar	Dry tubers Dry seeds Stem juice	About 25 gm dry tubers of <i>Cyperus rotundus</i> L. are ground mixed with equal amount of the dry seeds of <i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex G.Don. and added to it about 100 ml of extracted stem juice of <i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. & Thoms. Then about 250 ml of warm water is added to the whole mixture and filtered.	20 ml of the filtrate is prescribed orally thrice a day for 10 days	Bodo; Assam <sup>19</sup>
22	<i>Dicentra scandens</i> (D.Don) Walp. (Fumaraceae); Rhoodo	Fresh leaves or tender stem	Decoction is prepared from fresh leaves or tender stem	About 3 teaspoonfuls of decoction are taken orally thrice a day	Chakhesang; Nagaland <sup>41</sup>
23 *	<i>Dichroa febrifuga</i> Lour. (Sexifragaceae); Khawsik-damdawi	Roots	Decoction of the roots	prescribed orally 2-5 times a day	Mizo; Mizoram <sup>22</sup>
24	<i>Emilia sonchifolia</i> DC. (Asteraceae); Sher-ja mento	Roots	Roots are pounded adding little amount of water	a tea cup of the extract is given orally once a day	Mon; Arunachal Pradesh <sup>42</sup>
25 *	<i>Eucalyptus globulus</i> Labill. (Myrtaceae); Tephisei	Leaves and bark	Decoction of the leaves and bark	given orally once or twice a day. The decoction is also used by the patients for bath	Angami Naga; Nagaland <sup>25</sup>

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26	<i>Eupatorium adenophorum</i> (Asteraceae); Aza tesenba	Leaves	Infusion of the leaves	prescribed orally once a day	Naga; Nagaland <sup>36</sup>
27	<i>Exacum tetragonum</i> Roxb. (Gentianaceae); Churokidaru	Whole plant	Whole plant is boiled in water to prepare decoction	given orally once or twice a day	Angami Naga; Nagaland <sup>25</sup>
28	<i>Helianthus annuus</i> L. (Asteraceae); Numitlei	Leaves and flowers	Leaves and flowers are boiled in water and the decoction mixed with honey	given orally 2-3 times a day	Manipuri; Manipur <sup>43</sup>
29	<i>Impatiens racemosa</i> Hook.f. (Balsaminaceae); Nyong-shu	Whole plant	Decoction of the whole plant	taken orally 2-3 times a day	Mon; Arunachal Pradesh <sup>42</sup>
30	<i>Lactuca serriola</i> L. (Asteraceae); Khuhuta	Leaves	Leaf juice	orally as tonic after malarial fever	Apatani; Arunachal Pradesh <sup>44</sup>
31 *	<i>Lantana camara</i> L. (Verbenaceae); Play-Play, Shilong-flamgsam	Bark or whole plant	Either barks or whole plant are boiled in water to prepare decoction	A tea cup of the decoction is given orally 2-5 times a day	Karbi; Assam <sup>40</sup> and Mizo; Mizoram <sup>22</sup>
32	<i>Leonotis nepetifolia</i> R. Br. (Lamiaceae); Hejura	Seed powder	A teaspoonful of seed powder is mixed with water	given orally once or twice a day	Monpa; Arunachal Pradesh <sup>44</sup>
33	<i>Lepionurus sylvestris</i> Blume (Opiliaceae); Nanboka	Leaves	Leaves are mixed with ginger are made into paste	2-3 gm of the paste mixed with water is prescribed orally once a day	Karbi; Assam <sup>45</sup>
34	<i>Leucas zeylanica</i> Br. (Lamiaceae); Bong-soop, Chuphou	Young leaves	Young leaves are pounded adding some amount of water	a tea cup of extract is given orally once a day	Karbi, Angami Naga; Nagaland <sup>25</sup>
35 *	<i>Mentha arvensis</i> L. (Lamiaceae); Pudina	Herb	About 100 gm fresh herb of <i>Mentha arvensis</i> L. are pounded with equal amount of the fresh leaves of <i>Ocimum tenuiflorum</i> (L.) Burm.f. The extracted juice mixed with 25 ml. of the fruit juice of <i>Citrus limon</i> L.	prescribed orally once a day for one month	Bodo; Assam <sup>19</sup>
	<i>Ocimum tenuiflorum</i> (L.) Burm.f. (Lamiaceae); Tulsi	Fresh leaves			
	<i>Citrus limon</i> L. (Rutaceae); Gol-nemu	Fruit juice			
36	<i>Mesua indica</i> Wall. (Clusiaceae); Polanpot, Mandok	Leaves	Leaves are crushed, ground and the paste (3-5 gm) is mixed with water	prescribed orally once or twice a day	Garo; Meghalaya <sup>46</sup>
37	<i>Mikania micrantha</i> H.B.K. (Asteraceae); Japan-hlo	Leaf	Leaf juice	given orally 2-4 times a day	Mizo; Mizoram <sup>22</sup>
38	<i>Murraya koenigii</i> (L.) Spreng. (Rutaceae); Sam-daukhi	Leaves	Leaves are crushed and soaked in water for 3-4 hr and made infusion	given orally 2-3 times a day	Dimasa; Meghalaya <sup>31</sup>
39	<i>Myrica esculenta</i> Buch.-Ham. (Myricaceae); Meza	Bark	Bark is cut into pieces and boiled in water to make decoction	given orally 2-3 times a day	Angami Naga; Nagaland <sup>25</sup>
40 *	<i>Nyctanthes arbor-tristis</i> L. (Oleaceae); Sewali-phul	Leaves	About 250ml of decoction obtained by boiling the leaves (200 gm) in one liter of water, is stored in a bottle. One tea cup of the decoction mixed with ½ to 1 teaspoonful of sugar	given orally once a day in the morning on empty stomach	Dimasa; Assam <sup>46</sup>

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41 *	<i>Ocimum tenuiflorum</i> L. (Lamiaceae); Thulsi	Leaves	A decoction prepared by boiling the leaves of <i>Ocimum tenuiflorum</i> L., <i>Nyctanthes arbor tristris</i> L. and <i>Ananas comosus</i> (L.) Merrill in 250 gm, 150 gm and 100 gm quantities respectively in one liter of water for half an hour adding bulbs (8-10nos) of <i>Allium sativum</i> L., seed powder (10 gm) of <i>Piper nigrum</i> L. and rhizome (4 thin slices) of <i>Zingiber officinale</i> Rosc.	prescribed orally one tea cup a day on empty stomach	Tiwa; Assam <sup>19</sup>
	<i>Nyctanthes arbor tristris</i> L. (Oleaceae); Sewali	Leaves			
	<i>Ananas comosus</i> (L.) Merrill (Bromeliaceae); Khajari Khandal	Leaves			
	<i>Allium sativum</i> L. (Liliaceae); Rochun	Bulbs			
	<i>Piper nigrum</i> L. (Piperaceae); Sathi-chaluk	Seed powder			
	<i>Zingiber officinale</i> Rosc. (Zingiberaceae); Hajing	Rhizome			
42	<i>Passiflora nepalensis</i> Wall. (Passifloraceae); Nau-awimu	Roots	Decoction of root	taken orally 2-3 times a day	Mizo; Mizoram <sup>22</sup>
43	<i>Phlogacanthus tubiflorus</i> Nees. (Acanthaceae); Titaphul	Leaves	Leaf extract	taken orally 2-3 times a day	Karbi; Assam <sup>47</sup>
44	<i>Piper longum</i> L. (Piperaceae); Voko-hrui	Fruits	Decoction (10-20 ml) of the fruits obtained with a small amount of ginger	is given orally with sugar 3-4 times a day	Mizo; Mizoram <sup>22</sup>
45	<i>Plantago major</i> L. (Plantaginaceae); Kelbe-an	Roots	Decoction (20 ml.) of the roots	given orally thrice a day	Mizo; Mizoram <sup>22</sup>
46	<i>Pogostemon benghalense</i> (Burm.f.) Kuntze (Lamiaceae); Suklati	Leaves	Infusion (100 ml) of the leaves	given orally twice a day	Deori; Assam <sup>48</sup>
47	<i>Polygala parsicariaefolia</i> Candolle (Polygalaceae); Sherita	Whole plant	Whole plant is boiled with water and made decoction	prescribed orally 2-3 times a day	Khasi; Meghalaya <sup>23</sup>
48	<i>Potentilla albifolia</i> Wall. (Rosaceae); Lo-li	Roots	Roots either alone or mixed with other herb in warm water	prescribed orally 2-3 times a day	Mon; Arunachal Pradesh <sup>42</sup>
49	<i>Prunus cerasoides</i> D. Don. (Rosaceae); Tlaizang	Bark	Decoction of the bark	taken 2-3 times a day	Mizo; Mizoram <sup>22</sup>
50	<i>Prunus communis</i> Hudson (Rosaceae); Ahom-bogori	Root bark	Infusion (200ml) of the root-bark of <i>Prunus communis</i> Hudson and the leaves of <i>Stereospermum chelonoides</i> (L. f.) DC. either singly or in combination of both in equal proportions	given orally twice a day	Tangsa; Arunachal Pradesh <sup>49</sup>
	<i>Stereospermum chelonoides</i> (L. f.) DC. (Bignoniaceae); They	Leaves			
51	<i>Rauvolfia serpentina</i> (Apocyanaceae); Sarpagandha	Roots	Decoction of roots	Given orally 2-3 times a day	Plain tribe; Assam <sup>50</sup>
52	<i>Rubus ellipticus</i> Sm. (Rosaceae); Mydyha	Roots	Decoction is prepared by boiling the roots of both the plants	prescribed orally 2-3 times a day	Angami Naga; Nagaland <sup>25</sup>
	<i>Leucas zeylanica</i> Br. (Lamiaceae); Durun	Roots			
53	<i>Semecarpus anacardium</i> L. f. (Anacardiaceae); Bholaguti	Seeds	Seed oil	is applied on the nail tip to prevent the disease	Mizo; Mizoram <sup>22</sup>

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54	<i>Scutellaria glandulosa</i> Coleb.(Lamiaceae); Seikkhanha	Leaves	Decoction of leaves	Given orally 2-3 times a day	Angami Naga; Nagaland <sup>25</sup>
55	<i>Solanum anguivi</i> Lamk. (Solanaceae); Thesokeyee	Seeds	Raw seeds	is eaten raw	Karbi; Assam <sup>45</sup>
56	<i>Solanum kurzii</i> Brace ex Prain (Solanaceae); Longkoku	Fruits	Infusion is prepared from fresh fruits	Taken once a day	Naga; Nagaland <sup>24</sup>
57	<i>Stereospermum chelonoides</i> DC. (Bignoniaceae); Longkoku	Bark	Bark is ground and mixed with water	given orally once a day	Naga; Nagaland <sup>51</sup>
58 *	<i>Terminalia bellerica</i> (Gaertn.) Roxb. (Combretaceae); Baora	Fruits	5-6 fresh fruits of <i>Terminalia bellerica</i> (Gaertn.) Roxb. mixed with 10-12 fresh fruits each of <i>Terminalia chebula</i> Retz. and <i>Phyllanthus emblica</i> L. and 15-20 fresh shoots of <i>Phyllanthus fraternus</i> Webster. are ground together and the extracted juice mixed with 250 ml of water is boiled for few minutes and then allowed to cool	Two teaspoonful of mixture is prescribed thrice a day for 15 days	Bodo; Assam <sup>19</sup>
	<i>Terminalia chebula</i> Retz. (Combretaceae); Silikha	Fruits			
	<i>Phyllanthus emblica</i> L. (Euphorbiaceae); Amlai	Fruits			
	<i>Phyllanthus fraternus</i> Webster. (Euphorbiaceae); Cathian amlai	Shoots			
59 *	<i>Tinospora cordifolia</i> (L.) Miers. (Menispermaceae); Amar	Stem	Infusion of about 50 gm. each of the dried stem of <i>Tinospora cordifolia</i> (L.) Miers. and the dried leaves and stem of <i>Andrographis paniculata</i> (Burn.f) Wall. ex Nees. soaked overnight in a glass of water	given alternately on empty stomach in morning	Bodo; Assam <sup>37</sup>
	<i>Andrographis paniculata</i> (Burn.f) Wall. ex Nees. (Acanthaceae); Sirata	Leaves and stem			
60 *	<i>Toddalia asiatica</i> (L.) Lam. (Rutaceae); Soh-sat-khlaw	Root bark	Decoction of the root bark	given orally once a day	Khasi; Meghalaya <sup>28</sup>
61	<i>Vandellia sessiliflora</i> Benth. (Scrophulariaceae); Nyonshu	Whole plant	Decoction of the whole plant	given orally twice a day	Mon; Arunachal Pradesh <sup>42</sup>
62	<i>Verbena officinalis</i> L. (Verbenaceae); Shunutamtsu	Herb	An amount of 5-10 gm herb is macerated with approximately 50 ml of water,	strained extract is given orally once a day	Naga; Nagaland <sup>52</sup>
63	<i>Vitex peduncularis</i> Wall. ex Schauer (Verbenaceae); Thingkhawi-hlu	Leaves, root and bark	Decoction of the leaves, root and bark is prepared	10-15 ml. is given orally 2-3 times a day	Mizo; Mizoram <sup>22</sup>
64	<i>Zanthoxylum hamiltonium</i> Wall. (Rubiaceae); Ombeng	Roots and stem bark	Decoctions of the root and stem bark	given orally twice a day	Adi; Arunachal Pradesh <sup>38</sup>

N.B. \* in the serial no. of prescription indicates having direct or indirect corroboration with reported biological activities

parts of the species such as roots and bark are generally prescribed in the form of a decoction. Among the total plant species enumerated in this communication, positive correlation between folklore use and biological activities has been recorded for 18 plant species, although ethnic use of plant parts and parts possessing corroborative biological activities are different for a few species like *Cassia occidentalis*, *Azadirachta indica* and

*Clerodendrum infortunatum*. In *Cassia occidentalis* folk claim is obtained for roots only having antimalarial activity in leaves or in combination with other plant species. In *Azadirachta indica* leaves have antimalarial properties, but folk claim is obtained for fruits also along with leaves. Likewise in *Clerodendrum infortunatum* tender shoots are used by the folk healers, but only leaf extract is reported to possess antimalarial activity.

**Table 2:** Corroborative Biological activities of folk claimed plant species

Plant species	Parts used in folk claims	Reported Biological activities
<i>Momordica charantia</i>	Tender roots	Extract of the entire plant of shows antimalarial action against in vitro cultured <i>Plasmodium falciparum</i> <sup>53</sup>
<i>Alstonia scholaris</i>	Stem bark	Echitamine chloride isolated from bark exhibits antimalarial activity in a rodent system infected with <i>Plasmodium berghei</i> . Methanolic extracts of the plant parts also shows pronounced antiplasmodial activity <sup>54,55</sup>
<i>Andrographis paniculata</i>	Leaves	Ethanollic and Choloform extracts of show antimalarial activity <sup>56,57</sup>
<i>Azadirachta indica</i>	Leaves and fruits	Leaf extract found to have antimalarial activity. Oral administrations of 0.1 and 0.2 gm/kg of the water extracts of leaves in albino mice are also reportedly found active against acute <i>Plasmodium yoelli nigeriensis</i> infection <sup>58,59</sup>
<i>Caesalpinia bonduc</i>	Tender twigs and seeds	Beta-caesalpin isolated from the plant parts and the seed extracts exhibit antimalarial activity in a rodent test system with <i>Plasmodium berghei</i> <sup>54</sup>
<i>Cassia occidentalis</i>	Roots	Mixture of five plants of a traditional antimalarial formulation including roots of <i>Cassia occidentalis</i> exhibits antimalarial activity. The ethanolic extracts of leaves of <i>C. occidentalis</i> also exhibit antimalarial activity <sup>60,61</sup>
<i>Clerodendrum infortunatum</i>	Tender shoots	Leaf extracts possess antimalarial activity. The most potent dose has been reported to be 150mg/kg bw <sup>62</sup>
<i>Coptis teeta</i>	Rhizomes	Rhizome extract shows antimalarial activity. Berbarine isolated from the rhizome also possess antimalarial activity <sup>13,63</sup>
<i>Cyperus rotundus</i>	Tuber	Tubers possess antimalarial activity <sup>64</sup>
<i>Tinospora cordifolia</i>	Stem juice	Both stem and roots possess antimalarial activity. Berberine isolated from aerial parts of the plants also exhibits antiprotozoal activity <sup>65,66</sup>
<i>Dichroa febrifuga</i>	Roots	The alkaloid, febrifugin isolated from the root and leaves shows 100 times as active as compared to quinine, against <i>Plasmodium lophurae</i> <sup>8</sup>
<i>Eucalyptus globulus</i>	Leaves and stem bark	Essential oil possesses in vitro antimalarial activity on two strains of <i>Plasmodium falciperum</i> <sup>67</sup>
<i>Lantana camara</i>	Bark or whole plant	Extract exhibits antimalarial activity <sup>64</sup>
<i>Ocimum tenuiflorum</i>	Leaves	Aqueous extracts of the leaves tested in vivo against <i>Plasmodium berghei</i> show antimalarial activity. Inhalation therapy to cure <i>Plasmodium vivax</i> and <i>Plasmodium falciperum</i> infections has also been suggested <sup>68,69,70</sup>
<i>Nyctanthes arbor-tristis</i>	Leaves	Ethanolic extracts of aerial parts shows antimalarial activity <sup>71</sup>
<i>Terminalia bellerica</i>	Fruits	A bioactivity -guided fractionation of an extract of fruit rind led to the isolation of two new lignans named termilignan and thannilignan, together with 7-hydroxy-3',4'-(methylenedioxy) flavan and anolignan B. These compounds possess antimalarial activity in vitro <sup>72</sup>
<i>Phyllanthus fraternus</i>	Shoots	Aquous extracts of whole plant was tested in vivo against <i>Plasmodium berghei</i> following Perter's 4 day test. It shows antimalarial activity <sup>68</sup>
<i>Toddalia asiatica</i>	Root bark	A coumarin (5, 7-dimethoxy -8-(3'-hydroxy-3' methyl-1-butene)-coumerin) isolated from the roots shows antiplasmodial activity <sup>73</sup>



These shows indirect close correlation with the claims. Further, reports on related biological activities of some important plant species like *Begonia inflata*, *Dicentra scandens*, *Impatiens racemosa*, *Lepionurus sylvestris*, *Passiflora nepalensis*, *Phlogacanthus tubeflorus*, *Polygala parsicariaefolia*, *Potentilla albiflora* and *Solanum kurzii* are scarcely available and their correlation with the folk claims could not be ascertained in the present study and hence, pharmacological evaluation of these plant species against *Plasmodium* strains may be prioritized.

## 5. Acknowledgement

Authors are grateful to Director General, Central Council for Research in Ayurvedic Sciences (CCRAS), New Delhi, India and Department of Bio-technology, Govt. of India for their keen interest in the present work and necessary facilities provided.

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