

Ethnomedicinal plants used in malaria in tribal areas of Odisha, India

H Singh*, P A Dhole, G Krishna, R Saravanan and P K Baske

Central Botanical Laboratory, Botanical Survey of India, Howrah 711103, West Bengal, India

Received 18 July 2017; Revised 27 May 2018

The present paper deals with 38 ethnomedicinal plant species belonging to 37 genera and 24 families used for prevention and treatment of malaria by the tribal and indigenous non-tribal communities of Sundargarh, Mayurbhanj, Angul, Balangir, Deogarh and Nuapada districts of Odisha. This first-hand ethnomedicinal information for their therapeutic use against malaria was collected directly from a field survey of 404 remote tribal villages and forest areas of these 6 districts during 2006-2017. Additionally, uses of other 6 plants for the treatment of the same diseases were also recorded from the already published literature on these districts. These plant species are arranged in alphabetical order followed by family, habit, local name(s), locality(ies), field number(s) along with a method of preparation and mode of ethnomedicinal uses in detail.

Keywords: Angul, Balangir, Deogarh, Malaria, Mayurbhanj, Nuapada, Odisha, Sundargarh.

IPC code; Int. cl. (2015.01) — A61K 36/100; A61P 33/06

Introduction

Malaria was first identified as a disease caused by a parasitic infection in the year 1880. The word malaria comes from the Italian word 'mal' and 'aria', meaning "bad air". Malaria is a life-threatening blood disease caused by *Plasmodium* parasites transmitted to humans through the bite of the *Anopheles* mosquito. Once an infected mosquito bites a human and transmits the parasites, those parasites multiply in the host's liver before infecting and destroying red blood cells. Symptoms of simple malaria are the sensation of cold, shivering, fever, headache, vomiting, sweats followed by a return to normal temperature with tiredness. However, symptoms of severe malaria include fever and chills, impaired consciousness, prostration, multiple convulsions, deep breathing and respiratory distress, abnormal bleeding and signs of anaemia, clinical jaundice and evidence of vital organ dysfunction.

People living in villages and far-flung areas of the country depend completely on forest resources for maintaining their health and curing various diseases and disorders based on folk beliefs, the traditional way of treatment from generation to generation^{1,3}. This knowledge is, however, rapidly dwindling due to modernization and less interest of younger generation

towards traditional beliefs. Likewise, the rural and tribal people of the Odisha also depend on the traditional ethnomedicine for their day-to-day primary health care. The authors are engaged in ethnobotanical studies of Odisha on various aspects since last one decade⁴⁻¹². About 130 research papers have already been published on documentation of various ethnobotanical folklores from different areas of Odisha from 1942 to 2011¹³. However, only few research papers have been published particularly on ethnomedicinal uses for the treatment of malaria in Odisha. Odisha records the highest number of malaria cases followed by Chhattisgarh. Also, it ranks second in reported deaths due to malaria. Odisha contributes to 25% of total case load and 30 % of total deaths due to malaria in India^{3,14}. Even 43 % of total PF cases are reported from Odisha. More than two third of case load is reported from 10 Southern districts which are mostly backward and tribal areas¹⁵⁻¹⁶. Therefore, an attempt has been made to document the traditional phyto-therapeutic uses from field and literature for the prevention and treatment of malaria (*Palijar*) by the different tribal communities (Khond, Saora, Matya, Oraon, Munda, Kisan, Gond, Bhuinya, Paudia Bhuinya, Kolho, Khadia, Shabar, Binjhal, Kandho etc.) of Sundargarh, Mayurbhanj, Angul, Balangir, Deogarh and Nuapada districts of Odisha. All tribal groups are residing in common villages/areas with mix culture and tradition and they generally speak

*Correspondent author

Email: harish_bsi@yahoo.co.in

Phone: 033 26687574, 09830217884

common *Odiya* language. Their areas are not fully connected with modern communication and transportation system. The total literacy percentage in Odisha is 72.9 %, while literacy among tribal people is less than 50 % as per Census 2011. Though modern medical facilities are available in urban areas, tribal people are still dependent and using available plant parts for the treatment of malaria in the interior areas.

Materials and Methods

Field tours have been undertaken in 404 remote tribal villages and forest areas of Sundargarh, Mayurbhanj, Angul, Balangir, Deogarh and Nuapada districts amongst 36 tribal groups and other rural people during 2006-2017 and collected 2456 ethnomedicinal uses for the treatment of 95 different diseases, disorders and ailments. Of these, 38 plant species are being used for the prevention and treatment of malaria and also to repel mosquitoes in these districts. Old experienced men, women, and medicine men (*Vaidya*, *Kaviraj*) were interviewed for the first-hand information on ethnomedicinal uses for a particular disorder and repeated and cross queries were also done for confirmation and verification of the information. The collected plant specimens were identified with the help of keys and botanical description described in regional floras¹⁷⁻²⁰. The latest botanical nomenclature has been checked with world-renowned and widely accepted website <http://www.theplantlist.org>²¹. After matching with the authentic specimens housed in Central National Herbarium (CAL), these voucher specimens have been deposited in Ethnobotanical Herbarium of Central Botanical Laboratory (CBL), Howrah. These plant species are enumerated in alphabetical order with their family in parenthesis followed by habit, local name(s), locality (ies), voucher number (s), along with the mode of preparation and method of ethnomedicinal uses for prevention and treatment of malaria. The synonyms of 9 plants are also supplemented in this communication.

Results and Discussion

In this paper, an attempt has been made to collect and document traditional uses of plants, a method of preparation and mode of administration for prevent (including mosquito repellent) and treatment of malaria in 6 districts of Odisha. This survey provides first-hand information on 38 medicinal plant species belonging to 24 families from field observation of 6 different districts of Odisha state which are being

used for the treatment of malaria (Table 1). Apart from these field data, published literature also revealed that the root decoction of *Asparagus racemosus* is taken in the treatment of malarial fever in Nuapada district²³; stem bark extract of *Alstonia scholaris* is given in the treatment of malaria in Mayurbhanj district²⁵; seed pulp of *Bixa orellana* is smeared on the body to prevent mosquito bite in Balangir district²⁶; Paste of root and seeds of *Symphorema polyandrum* is given with black pepper in single dose as an antidote mosquito-bite in Balangir district²⁷⁻²⁸; flower powder of *Dendrophthoe falcata* is given in the treatment of malarial fever in Balangir district²⁹; powdered root bark of *Thespesia lampas* is given (5 g twice a day) with a pinch of salt for malarial fever in Nuapada district²³. It was also reported earlier from Odisha that bark powder of *Holarrhena pubescens* is given in malaria²²; leaf decoction of *Nyctanthes arbor-tristis* is mixed with black pepper and taken to cure malarial fever²³ and the bark of *Vitex negundo* is given in malaria²⁴, which verified and authenticated the present tribal claims. Maximum numbers of folk claims for the treatment of malaria were recorded from Angul (12) and Mayurbhanj (12) districts followed by Deogarh (9), Balangir (8), Nuapada (8) and Sundargarh (3) districts. It has already proven that antimalarial compound like andrographolide occurs in *Andrographis paniculata*³⁰ and renyolone is found in *Nyctanthes arbor-tristis*³¹ which is responsible for the antimalarial activity against *Plasmodium falciparum*. Therefore, these plants are used frequently in a number of regions and effective for the treatment of malaria. It is observed that the maximum number of species contributed under families Lamiaceae (5), Leguminosae (4), compositae (3), Acanthaceae (2), Rutaceae (2), Meliaceae (2), Menispermaceae (2) and Apocynaceae (2). It is already reported that the maximum number of species under Compositae family is used against malaria in Odisha¹⁴. It is found that mostly they used plant parts like leaf, root, bark, stem, flower, seed, oil, resin, and whole plants in the form of paste, powder, extract, decoction etc. for the treatment of malaria. Unfortunately, this kind of valuable traditional knowledge is depleting day by day from the area due to less interest of the younger generation towards a traditional system of treatment. Therefore, this kind of valuable information must be documented before their complete extinction, which may be used as a source of information for further research in future.

Table 1 — Ethnomedicinal plants used in malaria

S. No.	Botanical name; Family; Local name	Life form	Locality with voucher no.	Ethnomedicinal uses
1	<i>Achyranthes aspera</i> L. (Amaranthaceae); Aphamarga, Kukurdanti	Herb	Balangir: Banka Bihar, Rampali (CBL-30006), Guni Munda, Muri Bahal, Bija Mal, Negipali (CBL-31380)	Roots are pasted with the whole plant of <i>Solanum virginianum</i> , <i>Andrographis paniculata</i> , leaves of <i>Justicia adhatoda</i> and <i>Vitex negundo</i> and boiled with water. The decoction (100 g) is taken in morning and evening with honey for 3 days in the treatment of malaria.
2	<i>Acorus calamus</i> L. (Acoraceae); Bach, Bachh, Gad, Krishna Bachh, Guda /Ghoda Bacch	Herb	Sundargarh: Swapnabira Hills, Ujjalpur (CBL-12248)	Rhizome is pasted and applied to the entire body to cure malarial fever. The odorous fresh rhizomes are kept in their huts as a mosquito repellent.
3	<i>Agave americana</i> L. (Asparagaceae); Muraba, Murga	Shrub	Deogarh: Chhuri Bahal (CBL-33270)	Roots are pasted with an Ayurvedic formulation called 'Mahasudarsan Churna' and given (1 spoonful) orally in the treatment of malarial fever for 21 days.
4	<i>Ageratum conyzoides</i> (L.) L. (Compositae); Gandhri, Pukhu-sungha, Pura	Herb	Angul: Khuludi, Jamardihi, Nizgarh (CBL-30455)	The whole plant is boiled for 30 minutes and the resultant decoction is given (1 spoonful) orally twice a day in the treatment of malaria. Leaf juice (1 spoonful) is given orally with honey for 1 week in the treatment of cerebral malaria.
5	<i>Andrographis paniculata</i> (Burm.f.) Nees (Acanthaceae); Bhuin Neem, Bhuin Nimb, Kari Bahu, Kalibahu, Bhuin Limb, Chiraita, Kal Megh, Bhuin Kadam	Herb	Mayurbhanj: Ramtirtha (CBL-11770), Badam Pahar (CBL-11848), Hathikot (CBL-19718); Angul: Purunakote, Mangalpur, Parwatipur (CBL-34123), Kerjenga, Jamardih, Nizgarh, Chhendipada (CBL-30420); Sundargarh: Sinduria, Sarsara (CBL-12305); Balangir: San Babjuri, (CBL-30117), Barni, Mathan Pala, Tikhari (CBL-31307); Deogarh: Balam (CBL-33205), Kelda, Autad (CBL-36124); Nuapada: Mathia Padar, Ranidongri, (CBL-39103); Dhingiamunda, Adipita, Jamali Padar, Mathia Padar, Belgarh, Matagudi (CBL-38906), Golabandh (CBL-38012)	The whole plant is dried and made into powder. The powder (one teaspoonful per day) is given orally to all members of the family continuously for 30 days to prevent malaria. Leaves are pasted with the leaves of <i>Azadirachta indica</i> and given with water orally for 7 days in empty stomach to prevent malaria. All parts of the plant (preferably leaves) are pasted with water and the extract (10 ml) is given after filter through a cotton cloth in the empty stomach twice a day for 3 days in the treatment of malarial fever. The Leaves are pasted with leaves of <i>Azadirachta indica</i> , <i>Nyctanthes arbor-tristis</i> , <i>Madhuca longifolia</i> and the root of <i>Cissampelos pareira</i> and <i>Asparagus racemosus</i> and the preparation is given in the treatment of malaria up to cure. The leaf decoction is taken for 3 days in an empty stomach in the treatment of general malaria and brain/cerebral malaria. Leaves or all parts of the plant are ground with water and made pills (Gram seed size). Two pills are given in the morning and evening for 2 to 4 days in the treatment of malaria. Leaves /roots are powdered with black pepper and given two times after breakfast in the treatment of malaria. Sour food should be restricted during the treatment.

(Contd.)

Table 1 — Ethnomedicinal plants used in malaria (*Contd.*)

S. No.	Botanical name; Family; Local name	Life form	Locality with voucher no.	Ethnomedicinal uses
6	<i>Azadirachta indica</i> A. Juss. (Meliaceae);Neem	Tree	Balangir: Patnagarh, Barhampura (CBL-30095)	Wood or branches with leaves are burnt and the smoke is used to ward off the mosquitoes from their huts/premises.
7	<i>Baccharoides anthelmintica</i> (L.) Moench Syn. <i>Vernonia anthelmintica</i> (L.) Willd. (Compositae); Somraj, Kala Zeera, Sonyaraj, Udasmari, Bakuchi, Parwat Jeera	Shrub	Mayurbhanj: Beldihi (CBL-11845); Angul: Khuludi, Samala Gudapada (CBL-30453); Balangir: Barhampura, Patnagarh (CBL-30002)	Seed paste/powder (1 g) is given with honey (1 g) twice a day for one week as a prevention of malaria. It is claimed that these diseases will not further affect the concerned person for up to one year. Leaves are dried and burnt to kill mosquitoes from their huts and premises.
8	<i>Chloroxylon swietenia</i> DC. (Rutaceae); Bheru, Bharun, Bhusan, Bherunwa	Small Tree	Angul: Mangalpur (CBL-34206); Balangir: Barni, Suna Adki, (CBL-31317); Deogarh: Dudhapasi (CBL-33319), Mandashila (CBL-36143)	Green leaves are placed over the burning coal to kill /repel mosquitoes due to specific odour.
9	<i>Cissampelos pareira</i> L. (Menispermaceae); Akalbindu, Patha, Guapat, Guapada, Akand Bindo	Climber	Nuapada: Dhingiamunda, Adipita, Bhuliabhata, Tikarapada, Chaul Machhi, Matagud (CBL-38915), Maraguda (CBL-37978)	Roots are washed properly and soaked in unboiled milk and given (5 g) daily in the treatment of malarial fever. Leaf juice (1 spoonful) is also given twice a day to a patient of malaria till relieved.
10	<i>Clausena excavate</i> Burm.f. (Rutaceae); Agnijhad, Agnijada, Agnijhada, Agnimukh	Small Tree	Mayurbhanj: Sundivilla, Beldihi (CBL-11739)	Roots are ground along with root of <i>Cotula anthemoides</i> and made pills and given daily in empty stomach in the treatment of malaria.
11	<i>Clitoria ternatea</i> L. (Leguminosae); Vishnu Kranta, Swet Aparajita	Climber	Deogarh: Balam, Bhitarpad (CBL-33218, 33479), Van Durga mandir (CBL-36207)	Leaf extract (2 drops) is poured into nostrils of the victim in the treatment of malaria fever.
12	<i>Corchorus oltorius</i> L. (Malvaceae); Ghas Kadodiya, Bano Kadodiya	Herb	Angul: Pallahara (CBL-30504)	Seeds are pasted with water and the preparation is given (¼ spoonfuls) for 3-4 days in the treatment of malaria.
13	<i>Crinum asiaticum</i> L. (Amaryllidaceae); Jangli Pyaz, Sudarsan, Ban Pyaj, Masan Will	Herb	Nuapada: Dhingiamunda, Adipita (CBL-38916), Belgarh (CBL-39208)	Tubers are extracted and given (half spoon) orally in the treatment of malaria up to cure.
14	<i>Curculigo orchioides</i> Gaertn. (Hypoxidaceae); Chota Kitla, Kaukanda, Talamuli, Bazrakapti, Krishna Musali, Tadamuli, Tadmudi, Borha Konda, Badia Konda	Herb	Mayurbhanj: Ramatirtha, Gurguria (CBL-11718)	Rhizomes are ground and given (1 spoonful) to children (up to 10 years old) for 3 days in the treatment of malaria.
15	<i>Elephantopus scaber</i> L. (Compositae); Mejojhuti, Mayurchuda, Morchuda, Mayurjhuti, Brahma-dandi, Mayurchudiya, Ishwarjata, Marchudia, Amtodiachera	Herb	Mayurbhanj: Ramatirtha (CBL-11723)	Leaves are pasted and taken with water in empty stomach daily in the treatment of malarial fever.
16	<i>Ficus racemosa</i> L. (Moraceae); Janga Dumer, Dimari	Tree	Deogarh: ChhuriBahal (CBL-33289), Kelda (CBL-36122)	The bark is mixed with different parts of 40 other plants (probably all plants mentioned in this paper) and made a remedy, which is given (1 spoonful) daily up to cure in the treatment of malaria.

(Contd.)

Table 1 — Ethnomedicinal plants used in malaria (Contd.)

S. No.	Botanical name; Family; Local name	Life form	Locality with voucher no.	Ethnomedicinal uses
17	<i>Gloriosa superba</i> L. (Colchicaceae); Bandriya Phool, Nahnugudia, Islagudia, Orga Baha, Kalihari, Agnishika, Jhagdayee, Loh Langudiya, Endkera- gachho, Lahlangia, Lagulagudia, Nauriya, Andkira, Korali-konda	Climbing Herb	Mayurbhanj: Ramatirtha, Gurguria (CBL-11722)	The rhizomes are pasted after repeated detoxification and only half spoon is given in the treatment of malaria.
18	<i>Holarrhena pubescens</i> Wall. ex G. Don Syn. <i>H. antidysenterica</i> (L.) Wall. ex DC. (Apocynaceae); Gulchi, Hat Dare, Kudchi, Kuchudi, Kurachi Phal, Bhalupadi Fula, Kurmi, Indrajau, Kurayee, Pitta Karua, Kutaz, Indrajauta	Small Tree or Shrub	Mayurbhanj: Ramatirtha, Gurguria (CBL-11735), Badam Pahar, Manchabanda, Devkund, Bhurudbani (CBL-19638)	Seed oil (half spoon) is taken orally for 5 days in the treatment of malarial fever.
19	<i>Indonesiella echioides</i> (L.) Sreem. Syn. <i>Andrographis echioides</i> (L.) Nees (Acanthaceae); Bhuen Limb	Herb	Angul: Nizgarh, Pallahara (CBL-30538)	Leaf powder (1 spoonful) is given with water for 2 days in the treatment of malaria.
20	<i>Leucas aspera</i> (Willd.) Link (Lamiaceae); Dron Puspi, Goins Sag	Herb	Deogarh: Dantari, Baghmunda (CBL-33380)	Whole plant extract (1 spoonful) is given with honey in the treatment of malarial fever with a migraine.
21	<i>Madhuca longifolia</i> var. <i>latifolia</i> (Roxb.) A. Chev. Syn. <i>M. Indica</i> J.F. Gmel. (Sapotaceae); Tol Gachh, Mahuli Gachh	Tree	Balangir: Harishankar, Kendu Bahali (CBL-30040)	Seed oil is applied immediately on mosquito bitten part of the body to avoid malaria.
22	<i>Mimosa pudica</i> L. (Leguminosae); Lajkudi, Janoppi, Najkudi	Herb	Mayurbhanj: Sundivilla, Gurguria (CBL-11733)	A piece of root is tied with thread on the neck of the patient to cure malaria.
23	<i>Nyctanthes arbor-tristis</i> L. (Oleaceae); Ganga Sheuli, Sapparam, Har Singar, Singarhar, Gaud Kharika, Gutti Khadika, Sankharika, Kharsel, Ganga Siwadi, Kukuda Had	Shrub	Mayurbhanj: Ramatirtha (CBL-11731), Gurguria, Manchabanda, Karatbasa, Bhurudbani (CBL-19611); Angul: Purunakote (CBL-34104), Handapa, Tentuli (CBL-34241), Kerjenga, Jamardih, Pallahara, Bhurkibhora, Sankerjang Pansai (CBL-30448); Sundargarh: Sinduria, Sarsara (CBL-12313); Balangir: Harishankar (CBL-30048), Barni, Guni Munda, Bija Mal (CBL-31364); Deogarh: Balam (CBL-33260), Autad, Bichha Khani, Paudi, Deri-chuwa (CBL-36171); Nuapada: Dhingiamunda, Adipita, Ramgarh, Khurut Sikwan (CBL-38934), Pandripani (CBL-37924)	Leaves extract (2 spoonfuls) is taken twice a day for 7 days as a preventive measure of malaria. Leaves are boiled with black pepper, clove and cardamom and the decoction (1 spoonful) is given twice a day up to 7 days in the prevention of malarial fever. Twigs with leaves are cut into small pieces and boiled with water in an earthen pot till water remain 1/8 part. The prepared decoction (2-3 spoons) is given for 2-3 days in the treatment of malaria or another type of fever. It is also taken as preventive measures twice in a month for malaria. Leaves are pasted with water and the extract (100 ml) is given daily in the morning for 3-4 days in the treatment of malaria. Leaf extract is also given with leaves of <i>Ocimum sanctum</i> in empty stomach for twice a day for 7 days in the treatment of malaria. Leaves are boiled with water till it remains 1/5 part. It is given with black pepper, dried ginger, and honey for 2-3 days in malaria fever with a headache. Leaves are mixed with leaves of <i>Andrographis paniculata</i> and boiled with water; the prepared decoction (2-4 spoons) is given in empty stomach for 4-6 days in malaria.

(Contd.)

Table 1 — Ethnomedicinal plants used in malaria (*Contd.*)

S. No.	Botanical name; Family; Local name	Life form	Locality with voucher no.	Ethnomedicinal uses
				Leaves (7) are pasted with black pepper (7) and a spoonful is given twice daily for 7 days in the treatment of malarial fever with high blood pressure. Leaves powder is given for 2-3 days in the treatment of malarial fever and brain malaria.
24	<i>Ocimum tenuiflorum</i> L. Syn. <i>O. sanctum</i> L. (Lamiaceae); Tulsi	Herb	Angul: Kumbhia (CBL- 34273), Pallahara (CBL-30494)	Leaves (7) are given with honey for one month constantly in empty stomach in the treatment of malaria.
25	<i>Pongamia pinnata</i> (L.) Pierre (Leguminosae); Karanj	Tree	Deogarh: Chhuri Bahal (CBL-33268, 36375)	Flowers are extracted and given in the treatment of malaria. Seed are fried with rectified butter and given with an Ayurvedic formulation 'Mahasudarsan Churna' in the treatment of malaria.
26	<i>Rauwolfia tetraphylla</i> L. (Apocynaceae); Patalgarud, Patalgarudi, Patalgorur	Shrub	Mayurbhanj: Sundivilla, Gurguria (CBL-11769)	Roots are pasted and given (2 g) two times only in the treatment of malaria.
27	<i>Rothea serrata</i> (L.) Steane & Mabb. Syn. <i>Clerodendrum serratum</i> (L.) Moon (Lamiaceae); Samarkand, Saram Nutur	Shrub	Mayurbhanj: Ramatirtha, Gurguria (CBL-11781)	Roots are pasted and given (1 spoonful) with water in the treatment of malarial fever up to relieved.
28	<i>Sesamum indicum</i> L. Syn. <i>S. orientale</i> L. (Pedaliaceae); Safed Til, Maghirasi, Rashi	Herb	Angul: Pallahara (CBL-30502)	Seeds are boiled and the decoction (1 spoonful) is given orally in the treatment of malaria up to cure. The plant is boiled with leaves of <i>Nyctanthes arbor-tristis</i> , <i>Azadirachta indica</i> , <i>Tinospora cardifoila</i> , <i>Justicia adhatoda</i> , <i>Vitex negundo</i> , <i>Andrographis paniculata</i> , <i>Ageratum conyzoides</i> (100 g each) with 4 kg water until it remains 500 g. It is mixed with 500 g honey and given (one spoon) twice a day for 3 days in the treatment of malaria and brain malaria.
29	<i>Schleichera oleosa</i> (Lour.) Merr. Syn. <i>S. oleosa</i> (Lour.) Oken (Sapindaceae); Kusum, Kusam	Tree	Balangir: San Babejuri (CBL-30105), Barni, Bija Mal (CBL-31349)	Seed oil is applied to the body as a mosquito repellent.
30	<i>Scoparia dulcis</i> L. (Plantaginaceae); Ghar-podiya, Dalchini, Ghar Pudiya; Badi Awala, Surja Rashi	Herb	Deogarh: Balam (CBL-33262), Kelda, Medh (CBL-36102); Nuapada: Dhingiamunda, Adipita, Ramgarh (CBL-38944), Sanumaheshwar, Tikarapada (CBL-39045), Dharam bandha (CBL-38074)	Whole plant (<i>Panchang</i>) is given orally in the treatment of malarial fever for 15 days. Plant decoction (30 mL) is given in the treatment of malaria with jaundice. Whole plant extract (1 spoonful) is given 7 days for the treatment of malarial fever.
31	<i>Shorea robusta</i> Gaertn. f. (Dipterocarpaceae); Sarjam, Sal, Sarjom	Tree	Angul: Kendu Mundia, Takoba (CBL-34181)	Resin (<i>Jhuna/ Jhunda</i>) is collected and burnt to repel mosquitoes from their huts and premises.
32	<i>Soymida febrifuga</i> (Roxb.) A. Juss. (Meliaceae); Rohini	Tree	Nuapada: Gurudungar, Khurutsikwan (CBL-39164), Belardana (CBL-37946), Michhapali (CBL-38051)	Bark powder (20 g) is given orally in the treatment of malarial fever up to cure.
33	<i>Syzygium jambos</i> (L.) Alston (Myrtaceae); Chare Jam	Tree	Nuapada: Chhatta (CBL-39113)	Seeds are given to chew to all family members for prevention of malaria for up to one year.

(Contd.)

Table 1 — Ethnomedicinal plants used in malaria (Contd.)

S. No.	Botanical name; Family; Local name	Life form	Locality with voucher no.	Ethnomedicinal uses
34	<i>Terminalia alata</i> Roth Syn. <i>T. tomentosa</i> (Roxb.) Wight & Arn. (Combretaceae); Asana, Asan	Tree	Angul: Hathigiriya (CBL-34155), Kumbhia, Tentuli (CBL-34199)	Fresh leaves are boiled with water and the resultant hot water is sprayed on cow shed as a mosquito repellent. One spray will remain effective for about one month.
35	<i>Tinospora sinensis</i> (Lour.) Merr. (Menispermaceae); Gudchi, Gudach, Giloi, Amrita, Gulachi, Amruta	Woody Climber	Deogarh: Balam (CBL-33244), Bhitarpad (CBL-36220); Nuapada: Bahal Padar, Belgarh (CBL-39196), Kholigaon (CBL-38031)	The stem is cut into small pieces and kept in an earthen pot for 2 weeks. The resultant extract (1 spoonful) is given daily in the treatment of malaria. Fresh extract of the stem is also taken for 4-7 days in malaria.
36	<i>Uraria lagopodoides</i> (L.) DC. (Leguminosae); BhaloLangor, Salparni, Krishnaparni	Herb	Angul: Kerjenga, Jamardihi, Nizgarh, Pallahara (CBL-30444)	The whole plant is powdered with the bark of <i>Aegle marmelos</i> , <i>Oroxylum indicum</i> , <i>Gmelina arborea</i> , <i>Stereospermum suaveolens</i> , <i>Clausena excavata</i> ; the root of <i>Desmodium gangeticum</i> and whole plant of <i>Solanum virginianum</i> and <i>Tribulus terrestris</i> and given to all villagers as a preventive measure for malarial fever. Root is mixed with different parts of above said 9 plants and the prepared recipe is given daily in the treatment of malaria with fever and cold.
37	<i>Vitex altissima</i> L.f. (Lamiaceae); Chadaigudi	Shrub	Balangir: Kendu Mundia (CBL-34180)	Leaves are pasted with the leaves of <i>Phyllanthus fraternus</i> , <i>Andrographis paniculata</i> and the seed of fenugreek and boiled with water. This decoction (half spoon) is given with honey in the treatment of malaria.
38	<i>Vitex negundo</i> L. (Lamiaceae); Baigunia, Sinduri, Baigana, Sinduwar, Niringundi, Chinwar	Shrub	Mayurbhanj: Manchabanda, Karatbasa (CBL-19691)	Dried leaves are burnt with the leaves of <i>Azadirachta indica</i> to ward off the mosquito from their huts and premises.

Conclusion

During this investigation, 38 traditionally used ethnomedicinal plants were reported for the treatment and prevention of malaria from tribal areas of Odisha. *Andrographis paniculata* and *Nyctanthes arbor-tristis* have already proven the presence of the anti-malarial compound, which are responsible against *Plasmodium falciparum*. Hence, it is suggested that the remaining reported ethnomedicinal data of 36 plants against malaria should also be analyzed chemically for scientific validation of tribal claims as well as for identification of their active constituents responsible against malaria followed by giving a lead to the development of the new anti-malarial herbal drug.

Acknowledgement

The authors are thankful to the Director, Botanical Survey of India, Salt Lake City, Kolkata for providing all the necessary facilities. We are also grateful to all forest officials of Sundargarh, Mayurbhanj, Angul, Balangir, Deogarh and Nuapada districts for their

co-operation rendered during the field survey. We express our deep sense of gratitude to those numerous tribal informants, who freely discussed during the field survey, without their cooperation, this work would not have been possible.

References

- Shankar R, Deb S and Sharma B K, Antimalarial plants of northeast India: An overview, *J Ayurveda Integr Med*, 2012, 3(1), 10-16.
- Choubey V and Dubey P, Some antimalarial plant of tribal regions of M.P, *IOSR J Environ Sci Toxicol Food Technol*, 2015, 1(5), 42-45.
- Kumar A, Valecha N, Jain T and Dash A P, Burden of malaria in India: Retrospective and prospective view, *Am J Trop Med Hyg*, 2007, 6, 69-78.
- Singh H, Less known ethnomedicinal uses of some plants from Sundargarh, Mayurbhanj, Angul and Balangir districts of Odisha, India, *Nelumbo*, 2012, 54, 172-181.
- Singh H, Comparative study on ethnomedicinal uses practiced by the ethnic groups of Sundargarh, Mayurbhanj, Angul, Balangir and Deogarh districts, Odisha, India, in *Conservation, Cultivation, diseases and therapeutic importance of medicinal and aromatic plants*, edited by HK

- Chourasia & AK Roy (Today & Tomorrows printers and publishers, New Delhi, India), 2016, 43-84.
- 6 Singh H and Krishna G, Unreported ethnomedicinal uses of some plants in Angul district, Odisha (India), *Ethnobotany*, 2012, **24**(1 & 2), 86-91.
 - 7 Singh H and Krishna G, Ethnobotanical observations on Angul District of Odisha, India, *J Econ Taxon Bot*, 2012, **36**(4),781-808.
 - 8 Singh H, Srivastava S C, Krishna G and Kumar A, Comprehensive ethnobotanical study of Sundargarh district, Orissa, India, in *Ethnic Tribes and Medicinal Plants*, edited by PC Trivedi (Pointer publishers, Jaipur), 2010, 89-106.
 - 9 Singh H, Krishna G and Baske P K, Ethnobotanical observations on Mayurbhanj district of Odisha, India, in *Ethnobot Stud India*, edited by Sanjeev Kumar (Deep Publication New Delhi), 2014, 80-117.
 - 10 Singh H, Baske P K and Saravanan R, Ethnobotanical observations on Balangir district of Odisha, India, *J Econ Taxon Bot*, 2014, **38**(1), 40-73.
 - 11 Singh H, Dhole P A, Baske P K and Saravanan R, Ethnobotanical observations on Deogarh district of Odisha, India, *J Econ Taxon Bot*, 2015, **39**(2), 223-265.
 - 12 Singh H, Dhole P A, Baske P K and Saravanan R, Ethnomedicinal plants and their traditional conservation in Deogarh district, Odisha, in *Conservation of Medicinal plants: Conventional and Modern Approaches*, edited by HK Chourasia (Omega Publications, New Delhi), 2016, 28-66.
 - 13 Sahu A K and Goel A K, Ethnobotanical studies in Odisha (1942-2011): in pursuit of plant conservation, *Ethnobotany*, 2012, **24**, 29-42.
 - 14 Pani M, Nahak G and Sahu R K, Review on ethnomedicinal plants of Odisha for the treatment of malaria, *Int J Pharmacogn Phytochem Res*, 2014-15, **7**(1), 156-165.
 - 15 Sahu S S, Gunasekaran K, Raju H K, Vanamail P and Pradhan M M, Response of malaria vectors to conventional insecticides in the southern districts of Odisha State, India, *Indian J Med Res*, 2014, **139**, 294-300.
 - 16 Patil R R and Kumar R K, World bank EMCP malaria project in Orissa, India – A field reality, *Trop Parasitol*, 2011, **1**, 26-29.
 - 17 Haines H H, *The Botany of Bihar and Orissa*. Vol, 1-3 (Botanical Survey of India, Calcutta) 1921-1925 (Reprinted 1961).
 - 18 Mooney H F, Some addition to the botany of Bihar and Orissa, *Indian For Rec*, 1941, **3**(2), 63-119.
 - 19 Mooney H F, *Supplement to Botany of Bihar and Orissa* (Catholic Press, Ranchi, India), 1950.
 - 20 Saxena H O and Brahmam M, *The Flora of Orissa*. Vol 1-4 (Regional Research Laboratory and OFDC, Bhubaneswar), 1994-96.
 - 21 The Plant List, available from <http://www.theplantlist.org>. (Accessed on 11 July 2017).
 - 22 Pandey A K and Rout S D, Ethno botanical uses of plants of similipal biosphere reserve (Orissa), *Ethnobotany*, 2006, **18**, 102-106.
 - 23 Kandi B, Sahu S C, Dhal N K and Mohanty R C, Ethnomedicinal plant wealth of Sunabeda wildlife sanctuary, Nuapada, Odisha, *Ethnobotany*, 2012, **24**(1 & 2), 108-113.
 - 24 Mukherjee A and Namhata D, Medicinal plant lore of the tribals of Sundargarh district, Orissa, *Ethnobotany*, 1990, **2**, 57-60.
 - 25 Rout S D and Pandey A K, Ethnomedicobiology of Similipal biosphere reserve, Orissa, in *Advances in Ethnobotany*, edited by AP Das & AK Pandey (BSMPS, Dehra Dun), 2007, 247-252.
 - 26 Misra R C and Das P, Wild poisonous seeds: Some notable species from Gandhamardan Hill ranges of Orissa, *J Econ Taxon Bot*, 2003, **27**(3), 513-518.
 - 27 Misra R C, Therapeutic uses of some seeds among the tribals of Gandhamardan hill range, Orissa, *Indian J Tradit Knowl*, 2004, **3**(1), 105-115.
 - 28 Brahmam M and Saxena H O, Ethnobotany of Gandhamardan hills-some Noteworthy folk-medicinal uses, *Ethnobotany*, 1990, **2**, 71-79.
 - 29 Aminuddin and Girach R D, Native phytotherapy among the Paudi Bhuinya of Bonai hills, *Ethnobotany*, 1996, **8**, 66-70.
 - 30 Mishra K, Dash A P and Dey N, Andrographolide: A novel antimalarial diterpene lactone compound from *Andrographis paniculata* and its interaction with Curcumin and Artesunate, *J Trop Med*, 2011, **2011**, id 579518.
 - 31 Tuntiwachwuttikul P, Raynil K and Taylor W C, Chemical constituents from the flowers of *Nyctanthes arbor-tristis*, *Science Asia*, 2003, **29**, 21-30.