Journal of Applied Pharmaceutical Science Vol. 10(1), pp 046-054, January, 2020
Available online at http://www.japsonline.com
DOI: 10.7324/JAPS.2020.101006
ISSN 2231-3354

Survey and documentation of anthelmintic plants used in traditional medicine system of tribal communities of Udalguri district of Assam, India

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ARTICLE INFO

Received on: 07/08/2019
Accepted on: 10/11/2019
Available online: 03/01/2020

Key words:
Anthelmintic, ethnomedicine, traditional healer, Udalguri, Assam.

ABSTRACT

The present study was aimed to survey and document the anthelmintic medicinal plants traditionally used by the tribal communities of Udalguri district of Assam. The survey was conducted in different villages of the district following a face-to-face interview and a readymade questionnaire. The study found that a total of 75 plant species belonging to 67 genera and 44 plant families were used as deworming agents. The result showed that *Andrographis paniculata*, *Ananas comosus, Hydrocotyle sibthorpioides*, and *Centella asiatica* were the most popular plant species. Acanthaceae family was found to be most common among the traditional healers. The leaves were found to be commonly used plant parts for herbal preparation. Decoction, infusion, and raw preparations were found to be the most commonly used traditional formulation methodologies. The present study could be used to identify the potential anthelmintic plants and in designing new anthelmintic drug having better property and efficacy.

INTRODUCTION

Nature has always been an exemplary source of drugs since ancient times. Medicinal plants continued to be an important therapeutic aid for alleviating ailments of human kind. Ethnobotanical studies are often significant in revealing locally important plant species, especially for the discovery of crude drugs (Muthee *et al*., 2015). Ethnomedicinal survey of medicinal plants used by traditional medicinal practitioners can form a rich source of data for knowledge about medicinal plants and the ailments for which they are used. Scientists have often found that the herbs themselves, which possess unique combinations of chemical components, are more effective than the chemical derivatives (Shikov *et al*., 2014). Many developing countries like India rely on plants-based products for treating various diseases, including helminth infection. Medicinal plants are a viable source of parasiticides (Wangchuk *et al*., 2016). India is a country based on agriculture, and livestock play a significant role for the farmers. The infection with helminthes is still a big problem mainly due to warm temperatures, in association with poor management practices and inadequate control measures (Akhtar *et al*., 2000). The main goal of present study was the documentation of anthelmintic plants used in traditional medicine system of tribal communities of Udalguri district of Assam, India.

METHODS AND MATERIALS

Study area and its description

The present study was carried out in different villages under Udalguri district of Assam. Geographically, it covers an area of 1,852.16 sq. km. According to the 2011 Census report of India, Udalguri district has 802 villages (791 human inhabited and 11 uninhabited) and population size of 832,769, more than 95% living in the rural areas.

Data collection and identification of plant samples

The survey was done during the months of May to November, 2018 and information regarding the anthelmintic plants traditionally used by tribal communities of Udalguri district was collected. The information was collected from different community development block (CDB) with the help

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of informants (village traditional healer or Kaviraja in local language and elderly village people) having ethnomedicinal knowledge. Within every CDB, approximately 20 adjacent villages were taken as a single cluster and one sample (informant) was collected from a cluster. The information was collected in a face-to-face interview manner with the help of readymade questionnaires. Based on the number of villages per CDB, sample size varied from one CDB to another. Out of 11 CDBs, we did not collect any data from two CDBs, namely, Pachim-Mangaldai and Dalgaon-Sialmari because of less numbers of village(s). The information collected from informants mainly included—informer's bio-data, plant(s) part(s) used, local name of plant(s), traditional formulations, and mode of administration. The plants were collected as per the information given by the informer. A total of 42 informants were interviewed from 39 different villages. One informant was interviewed from each of the 36 villages, while two informants were collected from Pakribari, Barnagaon, and No. 2 Kadabil. The various information collection sites under different CDB were represented in Figure 1. Based on the information provided by the informants, sample plants were collected and processed for identification. Herbarium sheet were prepared and submitted to the Department of Botany, Bodoland University for identification.

Data analysis

Following quantitative analysis was carried out to assess the importance of medicinal plants following Hussain *et al*. (2018).

Frequency of Citation (FC): It is the number of informants who mentioned a certain species.

Relative frequency of citation (RFC): It is obtained by dividing FC by total number of informants (*N*). The value of RFC indicates the citing percentage of each species of medicinal plants. RFC was calculated by using the following formula (Tardio *et al*., 2008):

$$RFC = FC / N$$

The value of RFC varies from zero (when nobody cites to a plant as important) to one (when all the informants consider a certain species important).

Family importance value (FIV): FIV indicates the local importance of the families of plant species and is calculated by counting the percentage of informants mentioning a specific family (Vitalini *et al*., 2013).

$$FIV = [FC (family) / N] \times 100$$

Statistical analysis

All the statistical calculations, graphs, etc. were carried out in Microsoft excel and Origin software.

RESULTS AND DISCUSSIONS

Demography of informants and collection sites

Traditional knowledge system of herbal medicines based on the plant product is a healthy practice among the tribal

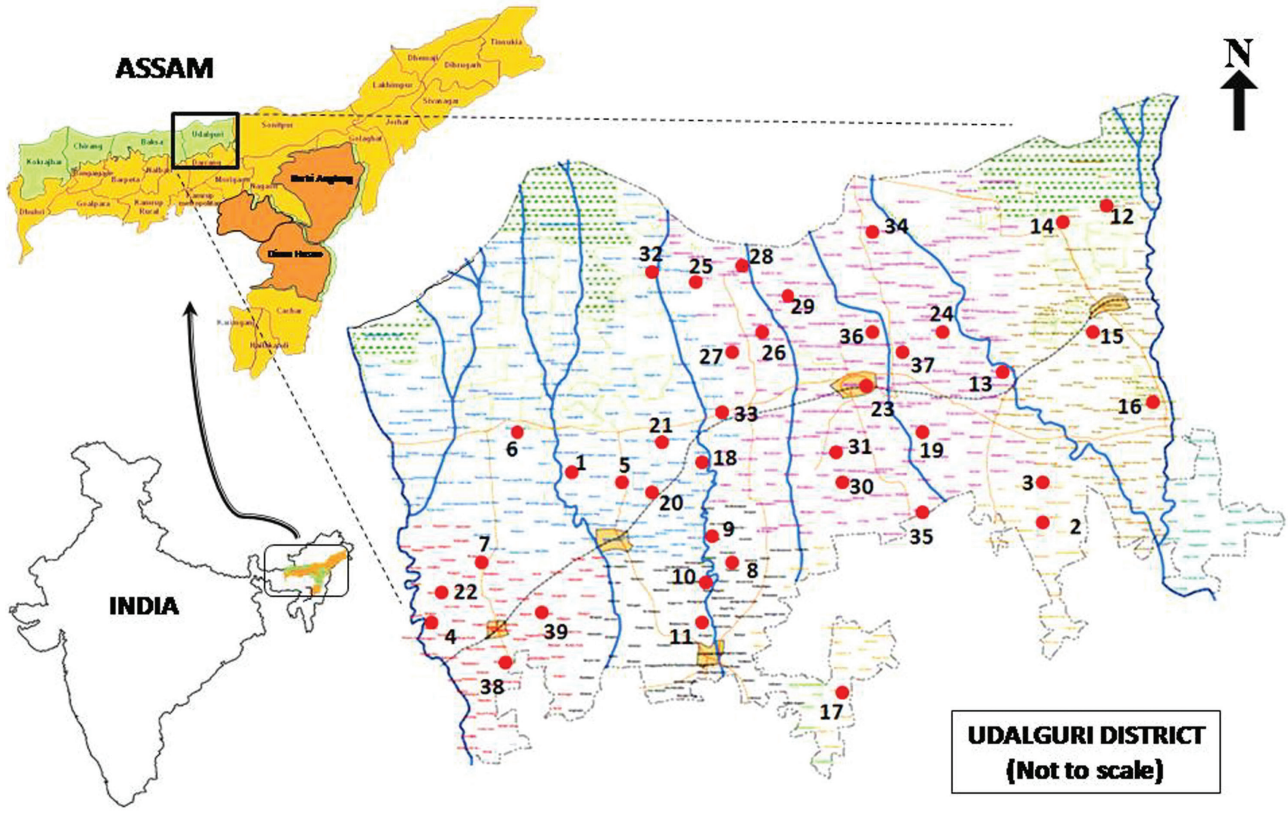

Figure 1. Map of Udalguri district of Assam and sample collection sites. Red dots represent the villages where data has been collected. [Numbers represents the serial no. of villages of Table 1].

communities of India. Living in the rural areas and far away from towns and cities, economically downtrodden tribal communities depends on plant-based medicines for common diseases. In our present study, we selected 39 sample villages from 9 CDBs and 42 numbers of traditional informants have been interviewed. The names of CDBs, villages, its geographical location, and demography of the selected informants were presented in Tables 1 and 2, respectively. Out of 9 CDBs, a highest of 12 villages was visited from Udalguri CDB and 14 numbers of informants were interviewed. However, only one informant was collected each from Borchola and Pub-Mangaldai CDBs.

A total of 39 villages were surveyed with the help of local people via the administration of semi-structured interviews and ready-made questionnaire (Table 1). A total of 42 informants were interviewed out of which 64% constitute the male informants (Table 2). Among the informants, 83% is traditional healer who possess the ethnomedicinal knowledge and practice regularly and earn little amount of money. Seventeen percent of the informants are the elderly people who do not practice but possess ethnomedicinal knowledge gathered from their forefathers. It is also seen that most of the traditional knowledge bearers are above 40-year old. Very few (about 12%) were found to be below 40 years of age. In terms of literacy rate, about 79% informants were having formal education, while 21% were illiterates. Among the literates, 19% were having college level education, while 60% have school level education. However, compared to females, the males were found to be more educated. Out of 27 numbers of male informants, 85% are found to be educated. Meanwhile, the female literacy was found to be about 60% of the 15 female informants. Among 42 informants, very few (18%) have government salaried job. In terms of plant citations, however, the literates and illiterates cited more or less similar number of plants, an average of 4.4 citations/informants and 4.2 citations/informants, respectively. The names of the plant species, its local name, habit, habitat, parts used, and traditional formulation of the herbal medicine is shown in the Table 3.

Use of medicinal plants for the treatment of diseases is a common practice to the rural, economically, and educationally backward tribal communities of India (Fayaz *et al*., 2019; Singh *et al*., 2017). Most of the times traditional medicine (TM) Systems do not have any form of written documents and are transferred orally from generation to generation. Like many other parts of the worlds, in Indian subcontinent also, TMs are practiced mainly by uneducated, poor, old, and aged people. It is also reported in many survey reports that male folks act as the major information bearer than females. Our study also revealed similar kind of traditional knowledge bearers where most of the informants are aged and male individualsx (Ritter *et al*., 2012; Teklehaymanot, 2017). However, unlike many other countries, such as Kenya, and Pakistan, where TMs are reported to be practiced mostly by illiterates, we found dissimilar result with most of the informants (79%) having formal education (Ahmad *et al*., 2015; Maphosa and Masika, 2010). Fayaz *et al*. (2019) also found that 71% of the informants from Jakholi Block of district Rudraprayag, Uttarakhand state were having formal education. It has also been seen that out of 42 informants 18% were having government salaried jobs, and none of them practice professional herbal treatment and they gathered their ethnomedicinal knowledge from their forefathers. Most of the traditional healers make some business out of their ethnomedicinal knowledge by making small packets and mixtures, which they sell to other villagers. During our survey, we have also come across many people who visited the traditional healer in their homes to purchase the herbal preparation.

Table 1. Name of the CDB, villages and geographical locations of survey sites.

Sl. no.	Name of the CDB	Villages	Geographical location
1.	Borchola	1. Dhupguri	26°39′49″N 91°45′00″E
2.	Bechimari	2. Koraibari	26°39′31″N 92°15′10″E*
		3. Aitharjhar	26°41′05″N 92°15′11″E*
3.	Bhergaon	4. Barigaon	26°35′35″N 91°46′12″E
		5. Ratanpur	26°42′29″N 91°55′06″E
		6. Dimakuchi	26°44′43″N 91°50′22″E
		7. Bhergaon	26°41′19″N 91°51′52″E
4.	Kalaigaon	8. Dumaruguri	26°39′56″N 91°59′54″E
		9. Kuiyabil	26°40′48″N 91°59′12″E
		10. Balipara	26°38′05″N 91°58′39″E
		11. Sagunbahi	26°36′30″N 91°58′55″E
5.	Mazbat	12. Adarsho	26°15′33″N 92°16′22″E
		13. Dhansri Gat	26°38′07″N 92°18′09″E
		14. No. 2 Kadabil	26°51′27″N 92°18′34″E**
		15. Gerubari	26°46′18″N 92°17′56″E
		16. Orang	26°42′25″N 92°19′37″E
6.	Pub-Mangaldai	17. Kacharipara	26°39′27″N 91°46′44″E
7.	Rowta	18. Kathalguri	26°42′57″N 91°58′46″E
		19. Goraibari	26°43′22″N 92°07′48″E
		20. Panipota	26°42′04″N 91°55′54″E
		21. No.1 Bhergaon	26°43′41″N 92°09′40″E
		22. Gopsachuba	26°38′06″ N 91°46′02″E
8.	Udalguri	23. Deolguri	26°44′13″N 92°00′21″E
		24. Ahomakha	26°47′30″N 92°10′36″E
		25. Kundarbil (No. 3), Amjuli	26°46′53″N 92°01′21″E
		26. Uttar Nalbari (Borigaon)	26°47′46″N 92°02′12″E
		27. Panimudijhar	26°47′47″N 92°00′34″E
		28. Kundarbil-No. 1	26°50′22″N 91°59′12″E
		29. Pakribari	26°46′51″N 92°02′57″E**
		30. Khatorbari	26°42′14″N 92°04′46″E
		31. Barnagaon	26°42′22″N 92°54′00″E**
		32. Majuli Basti	26°51′44″N 91°55′28″E
		33. Sonai bathabari	26°48′01″N 92°06′43″E
		34. Jamuguri	26°43′17″N 92°16′54″E
		35. Medhipara	26°40′29″N 92°10′08″E
		36. Sonai Alisinga	26°79′86″N 92°12′16″E*
		37. Niz sonai	26°79′40″N 92°12′40″E*
9.	Khoirabari	38. Batabari	26°35′25″N 91°49′01″E
		39. Moholiapara	26°37′29″N 91°51′45″E

Serial number indicates the information collection sites as shown in the map.
CDB = community development block.
*No report of anthelmintic plant use, **Villages from where two informants were collected.

Anthelmintic medicinal plants used by tribal communities

A total of 160 plant citations were recorded from 42 informants (Table 3). Out of total plant citations, 32 plants were found to be reported more than once by the local traditional healers.

Table 2. Demography of informants from different villages of Udalguri district of Assam.

Name of CDB	Traditionalhealer	Elderly person	Male	Female	Age (in years)		Literacy		
					40–50	>50	School level	College level	Illiterate
Udalguri	14	3	12	5	5	10	10	4	3
Khairabari	2	-	1	1	-	1	1	1	-
Rowta	5	-	4	1	4	1	4	-	1
Pub- Mangaldoi	1	-	-	1	1	-	1	-	-
Mazbat	5	1	4	2	1	5	-	3	3
Bechimari	-	2	1	1	-	-	2	-	-
Bhergaon	4	-	3	1	-	4	3	-	1
Kalaigaon	4	-	1	3	2	2	3	-	1
Borchala	-	1	1	-	1	-	1	-	-
Total	35	7	27	15	14	23	25	8	9

CDB = community development blocks.

Table 3. List of medicinal plants used in the traditional medicine system against helmintic infection by tribal communities of Udalguri district of Assam with their identification numbers.

Sl. No.	Scientific Name	Family	Local name	Habit	Habitat	Parts used	Formulation	FC	RFC
1.	*Persicaria strigosa* (R. Br.) Nakai [BUBH0000021]	Polygonaceae	Alari gwja	Herb climber	Wd	L	Raw	1	0.0238
2.	*Aloe vera* (L.) Burm.f. [BUBH0000022]	Xanthorrhoeaceae	Aloevera	Herb	Do	L, J	Raw	1	0.0238
3.	*Phyllanthus emblica* L. [BUBH0000023]	Euphorbiaceae	Amla	Tree	Do	F	Raw	2	0.047
4.	*Tinospora cordifolia* (Willd.) Miers [BUBH0000024]	Menispermaceae	Amor lata	Climber	Wd	St	Raw	4	0.095
5.	*Ananas comosus* (L.) Merr. [BUBH0000025]	Bromeliaceae	Anaras	Herb	Do	L	Raw	9	0.214
6.	*Morinda angustifolia* Roxb. [BUBH0000123]	Rubiaceae	Asho	Small tree	Do	R	Decoction	1	0.0238
7.	*Litsea glutinosa* Lour [BUBH0000087]	Lauraceae	Baghnala	Tree	Wd	B	Decoction	2	0.047
8.	*Terminalia bellirica* (Gaertn.) Roxb. [BUBH0000069]	Combretaceae	Bhaora	Tree	Wd	F	Raw	3	0.071
9.	*Aegle marmelos* (L.) Correa [BUBH0000068]	Rutaceae	Bell	Tree	Do	L	Decoction	3	0.071
10.	*Prunus persica* (L.) Stokes [BUBH0000088]	Rosaseae	Bon bwigri, Thaijou khohe	Tree	Do	L	Raw	1	0.0238
11.	*Scoparia dulcis* L. [BUBH0000089]	Plantagenaceae	Bongfang rakheb, Sini dongfang	Herb	Wd	L	Decoction	1	0.0238
12.	*Leucas aspera* (Willd.) Link. [BUBH0000010]	Lamiaceae	Brahmaputra, Kansinsa	Herb	Wd	L	Raw	1	0.0238
13.	*Zingiber zerumbet* (L.) Roscoe ex Sm. [BUBH0000090]	Zingiberaceae	Bura uth	Herb	Wd	T	Infusion	1	0.0238
14.	*Ziziphus mauritiana* Lam. [BUBH0000030]	Rhamnaceae	Bwigri	Shrub	Do	L	Raw	3	0.071
15.	*Lippia alba* (Mill.) N.E.Br. ex Britton & P.Wilson [BUBH0000056]	Verbenaceae	Bwrma dari, Onthai bajab	Shrub	Wd	L	Decoction	1	0.0238
16.	*Cocos nucifera* L. [BUBH0000091]	Arecaceae	Narengkol	Tree	Do	En	Decoction	1	0.0238
17.	*Punica granatum* L. [BUBH0000031]	Lythraceae	Dalim	Shrub	Do	B (R)	Raw	2	0.047
18.	*Cinnamomum verum* J.S. Presl [BUBH0000092]	Lauraceae	Dalsini	Tree	Do	B	Raw	1	0.0238
19.	*Clerodendrum indicum* (L.) Kuntze [BUBH0000093]	Lamiaceae	Ekhlabwr	Shrub	Wd	L, Fl	Raw	3	0.071
20.	*Premna herbacea* Roxb. [BUBH0000094]	Verbenaceae	Gadeb (keradapini)	Herb	Wd	L	Decoction	1	0.0238
21.	*Calotropis gigantea* (L.) Dryand. [BUBH0000072]	Apocynaceae	Gogondo, Ogango	Shrub	Wd	L	Raw	1	0.0238
22.	*Piper nigrum* L. [BUBH0000035]	Piperaceae	Golmoris	Shrub	Do	S	Raw	2	0.047
23.	*Cucumis callosus* (Roettler) Cogn. [BUBH0000095]	Cucurbitaceae	Gwmwri	Herb	Wd	L, F	Raw	2	0.047
24.	*Zingiber officinale* Roscoe. [BUBH0000096]	Zingiberaceae	Haijeng	Herb	Do	T	Raw	1	0.0238
25.	*Curcuma longa* L. [BUBH0000002]	Zingiberaceae	Haldi	Herb	Do	T	Raw	3	0.071
26.	*Centipeda minima* (L.) A. Br. & Asch. [BUBH0000097]	Asteraceae	Hatchew dongfang	Herb	Wd	WP	decoction	1	0.0238

(*Continued*)

Table 3. (Continued)

Sl. No.	Scientific Name	Family	Local name	Habit	Habitat	Parts used	Formulation	FC	RFC
27.	*Cissus quadrangularis* L. [BUBH0000098]	Vitaceae	Hatjora	Scandent shrub	Wd	WP	Infusion	1	0.0238
28.	*Ricinus communis* L. [BUBH0000003]	Euphorbiaceae	Indi dongfang	Shrub	Do	L	Raw	1	0.0238
29.	*Drymaria cordata* (L.) Willd. ex Schult [BUBH0000099]	Carryophyllaceae	Jabowsri	Herb	Wd	L	Raw	1	0.0238
30.	*Justicia gendarussa* Burm. f. [BUBH0000100]	Acanthaceae	Jaytrasi	Under shrub	Wd	L	Raw	1	0.0238
31.	*Nigella sativa* L. [BUBH0000101]	Ranunculaceae	Kaljeera	Herb	Do	S	Raw	1	0.0238
32.	*Andrographis paniculata* (Burm.f.) Nees [BUBH0000009]	Acanthaceae	Kalmech, Sirota	Herb	Do	L	Raw	12	0.286
33.	*Momordica charantica* Linn. [BUBH0000086]	Cucurbitaceae	Kerela gwkha, Udasi	Climber herb	Do	L	Raw	1	0.0238
34.	*Gymnopetalum chinense* (Lour.) Merr. [BUBH0000102]	Cucurbitaceae	Khaila	Herb	Wd	L, F	Raw	2	0.047
35.	*Meyna spinosa* Roxb. ex ink [BUBH0000103]	Rubiaceae	Khanthaokhra, Phanthao goglang	Tree	Wd	L	Decoction	2	0.047
36.	*Oroxylum indicum* (L.) Kurz [BUBH0000012]	Bignoniaceae	Kharong	Tree	Wd	R, T	Decoction	1	0.0238
37.	*Rauvolfia tetraphylla* L. [BUBH0000013]	Apocynaceae	Kharwkha	Shrub	Wd	R, B, L	Raw	2	0.047
38.	*Amaranthus spinosus* L. [BUBH0000104]	Amaranthaceae	Khuduna su, Khutra	Herb (spinous)	Wd	L	Decoction	1	0.0238
39.	*Morinda citrifolia* L. [BUBH00000016]	Rubiaceae	Khungkha gwkha	Tree	Wd	L	Decoction	2	0.047
40.	*Solanum torvum* Sw. [BUBH0000018]	Solanaceae	Khunthai nara	Shrub	Wd	F	Raw	2	0.047
41.	*Averrhoa carambola* L. [BUBH0000105]	Oxalidaceae	Khwrdwi, Kamrenga	Tree	Do	B	Decoction	1	0.0238
42.	*Paederia foetida* L. [BUBH0000015]	Rubiaceae	Kiphi bendwng	Climber	Wd	L	Raw	1	0.0238
43.	*Anthocephalus cadamba* (Roxb.) Miq. [BUBH0000106]	Rubiaceae	Kwdwm	Tree	Do	F	Raw	1	0.0238
44.	*Citrus limon* (L.) Osbeck [BUBH0000107]	Rutaceae	Lemon	Tree	Do	S	Decoction	1	0.0238
45.	*Dimocarpus longan* Lour. [BUBH0000108]	Sapindaceae	Lethekho, Hagrani lisu	Tree	Do	R	Decoction	1	0.0238
46.	*Syzygium aromaticum* (L.) Merr. & L.M.Perry [BUBH0000079]	Myrtaceae	Long	Tree	Do	S	Decoction	1	0.0238
47.	*Hydrocotyle sibthorpioides* Lam. [BUBH0000019]	Araliaceae	Manimuni fisa	Herb	Wd	L, WP	Raw	8	0.1905
48.	*Centella asiatica* L. [BUBH0000020]	Apiaceae	Manimuni gidir	Herb	Wd	L, WP	Raw	8	0.1905
49.	*Carica papaya* L. [BUBH0000109]	Caricaceae	Mwiduful	Tree	Do	R	Decoction	2	0.047
50.	*Clerodendrum infortunatum* L. [BUBH0000047]	Lamiaceae	Mwkhwna	Shrub	Wd	L	Decoction	4	0.095
51.	*Lindernia crustacea* (L.) F. Muell. [BUBH0000048]	Linderniaceae	Na bikhi	Herb	Wd	L	Decoction	1	0.0238
52.	*Citrus grandis* (L.) Osbeck. [BUBH0000064]	Rutaceae	Nareng jumbra	Tree	Do	F	Maceration	2	0.047
53.	*Azadirachta indica* A. Juss. [BUBH0000051]	Meliaceae	Neem	Tree	Do	L	Raw, decoction	3	0.071
54.	*Asparagus racemosus* Willd. [BUBH0000063]	Asparagaceae	Nilikhor	Climber	Wd	R	Raw	2	0.047
55.	*Cajanus cajan* (L.) Millsp. [BUBH0000110]	Leguminosae	Ohor, Khokling	Shrub	Do	L, S	Raw	3	0.071
56.	*Bryophyllum pinnatum* (Lam.) Oken [BUBH0000057]	Crassulaceae	Paat gaja	Herb	Do	L	Decoction	1	0.0238
57.	*Ficus riligiosa* Linn. [BUBH0000082]	Moraceae	Phakhri dongfang	Tree	Wd	B	Raw	1	0.0238
58.	*Ocimum basilicum* L. [BUBH0000111]	Lamiaceae	Ramtulusi	Herb	Do	L	Raw	1	0.0238
59.	*Allium sativum* L. [BUBH0000112]	Amaryllidaceae	Sambram gufur	Herb	Do	T	Raw	1	0.0238
60.	*Achyranthes aspera* L. [BUBH0000046]	Amaranthaceae	Samper ultha, Ultasur	Herb	Wd	L	Decoction	2	0.047
61.	*Terminalia chebula* Retz. [BUBH0000062]	Combretaceae	Silikha	Tree	Do	F	Raw	5	0.119
62.	*Piper longum* L. [BUBH0000085]	Piperaceae	Simfri fithai	Herb	Do	F	Raw	1	0.0238
63.	*Bixa orellana* L. [BUBH0000113]	Bixaceae	Sindoor dongfang	Tree	Wd	B	Infusion	1	0.0238
64.	*Oxalis corniculata* L. [BUBH0000114]	Oxalidaceae	Singri mwkhi fisa	Herb	Wd	L	Decoction	3	0.071
65.	*Alstonia scholaris* (L.) R. Br. [BUBH0000040]	Apocynaceae	Sithona	Tree	Wd	B	Infusion	4	0.095
66.	*Psidium guajava* L. [BUBH0000041]	Myrtaceae	Sofari	Tree	Do	L	Raw	8	0.1905

(*Continued*)

Table 3. (Continued)

Sl. No.	Scientific Name	Family	Local name	Habit	Habitat	Parts used	Formulation	FC	RFC
67.	*Kaempferia galangal* L. [BUBH0000115]	Zingiberaceae	Sompera	Herb	Do	T	Raw	1	0.0238
68.	*Cassia fistula* L. [BUBH0000043]	Leguminosae	Sonalu	Tree	Wd	L	Raw	1	0.0238
69.	*Streblus asper* Lour. [BUBH0000116]	Moraceae	Soura	Tree	Wd	St	Raw	1	0.0238
70.	*Mangifera indica* L. [BUBH0000117]	Anacardiaceae	Thaijow	Tree	Do	S	Raw	1	0.0238
71.	*Spondias pinnata* (L.f.) Kurz [BUBH0000118]	Anacardiaceae	Thaisuri	Tree	Do	B	Raw	1	0.0238
72.	*Musa balbisiana* Colla. [BUBH2018067]	Musaceae	Athia thalir	Tree	Do	C	Raw	3	0.071
73.	*Ocimum sanctum* L. [BUBH2018045]	Lamiaceae	Tulungsi	Undershrub	Do	L	Raw	1	0.0238
74.	*Ocimum gratissimum* L. [BUBH0000119]	Lamiaceae	Tulungsi gidir	Shrub	Do	L	Raw	1	0.0238
75.	*Acmella paniculata* (Wall. ex DC.) R.K.Jansen [BUBH2018007]	Asteraceae	Usumwi, jhari	Herb	Wd	L	Raw	1	0.0238

FC = frequency of citation, RFC = relative frequency of citation, Do = domesticated, Wd = wild, L = Leaves, J = jelly, F = Fruits, Fl = flower, C = corm, B = bark, S = seed, T = tuber, St = stem, R = roots, WP = whole plant, En = endosperm.

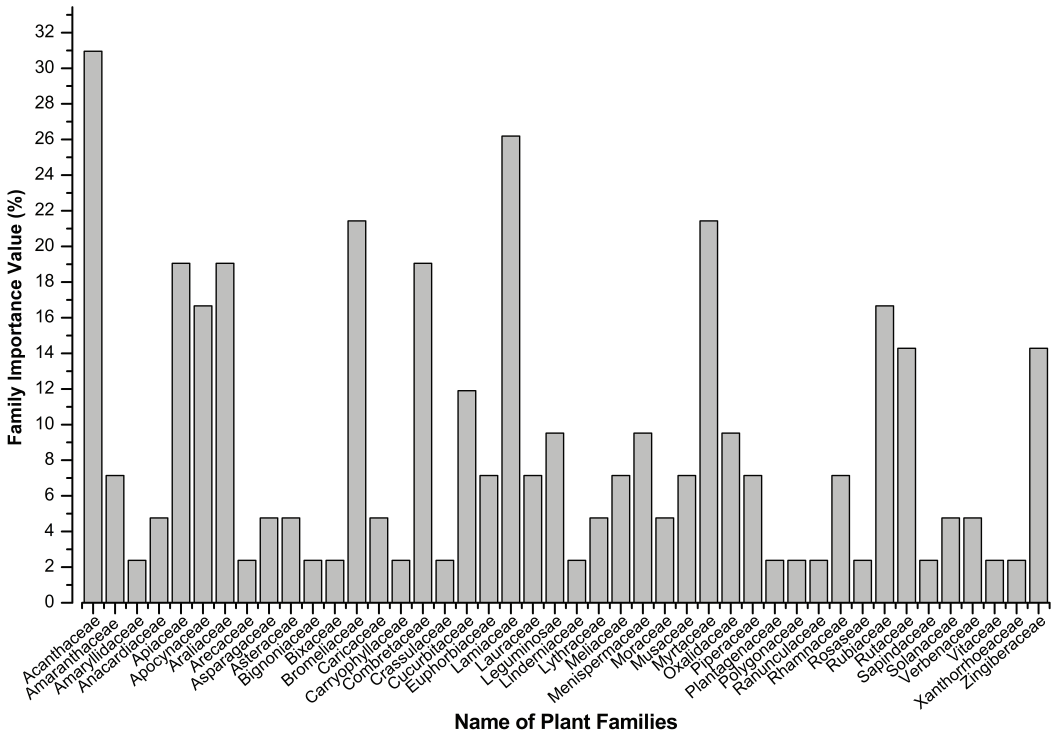

Figure 2. Graph showing the popularity of different Families of plants in Udalguri district of Assam having anthelmintic property.

However, 27% (43 citations) of the plants do not have any repetitions among the informants. A total of 75 plants species, belonging to 67 genera and 44 families were recorded from Udalguri district that are consumed as deworming medicines. The plants belonging to 16 families are found to be more common and have more than one citation. *Andrographis paniculata* was found to be the most popular plant species (FC = 12, RFC = 0.286) followed by *Ananas comosus* (FC = 9, RFC = 0.214), *Hydrocotyle sibthorpioides* (FC = 8, RFC = 0.190), *Centella asiatica* (FC = 8, RFC = 0.190), and *Psidium guajava* (FC = 8, RFC = 0.190). Similarly, out of 45 plant families, Acanthaceae was seen to be the most popular family with FIV value 32% followed by Bromeliaceae, Myrtaceae, Apiaceae, Araliaceae, and Lamiaceae with more than 15% FIV value (Fig. 2). Thirteen plant families do not seem to have any popularity among the traditional healers in terms of FIV value. However, in terms of plants species used under a single family, Rubiaceae was seen to be important with eight number of plant species, followed by Lamiaceae (six species), Zingiberaceae (four speciess), Cucurbitaceae and Apocynaceae (three species each), and Verbenaceae, Piperaceae, Oxalidaceae, Myrtaceae, Leguminosae, Lauraceae, Euphorbiaceae, Acanthaceae, Amaranthaceae, Anacardiaceae, and Asteraceae (two species each). However, from 29 families only one plant citation was reported. It has been found that most of the plants (53%) cited are wild in habitat, while others are domesticated. Our study also revealed that majority of the plants belongs to trees (39%). In our study, we also found that 37% of the plant species are herbs, 20% are shrubs, and 4% are climbers. Figure 3 shows the citation of the plants by different informants.

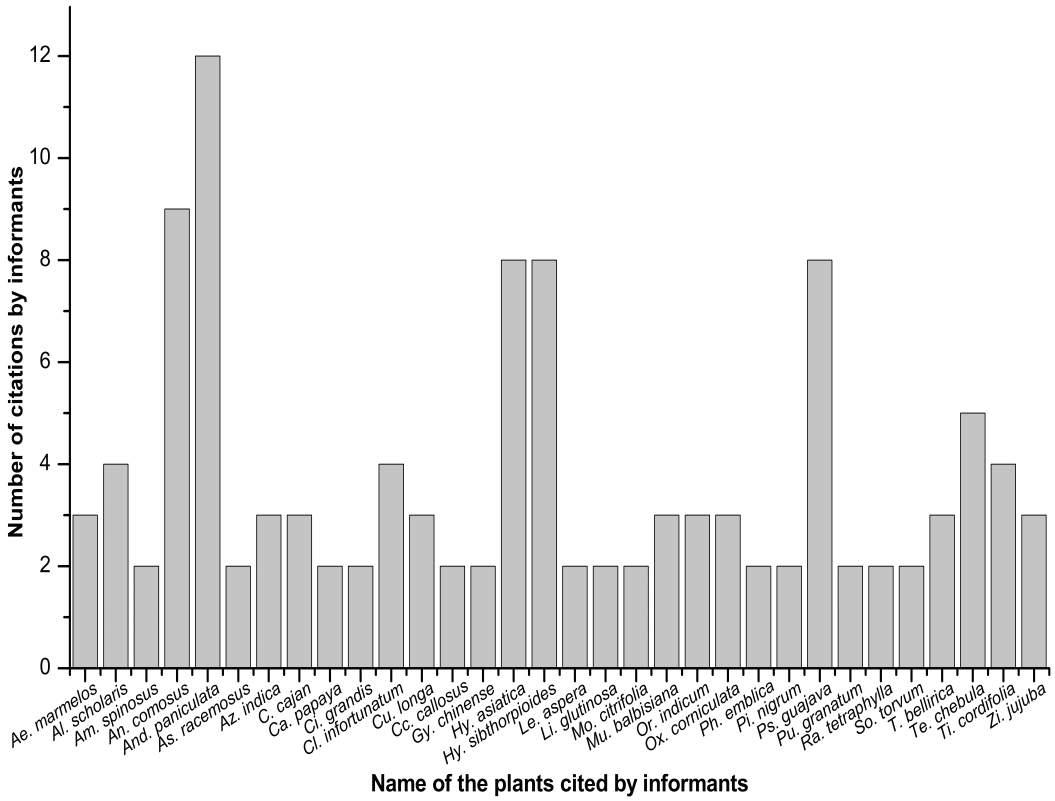

Figure 3. List of plants citations by different informants of Udalguri district of Assam.

Our survey reported a total of 75 species of plants used in TM system as deworming medicines. *Ananas comosus*, *A. paniculata*, *C. asiatica*, *H. sibthorpioides*, and *Psidium guajava* were found to be the most popular plants used as an anthelmintic agent among the tribal communities of Udalguri district. The traditional popularity has also been confirmed experimentally by many investigators (Molla and Bandyopadhyay, 2014; Pina-Vázquez *et al*., 2017). Similarly, plants having two or more citations, such as *Aegle marmelos* (Singh *et al*., 2012), *Alstonia scholaris* (Panda *et al*., 2017), and *Clerodendrum infortunatum* (Swargiary *et al*., 2016) also possess experimental evidence about anthelmintic activity. Out of 75 plant species reported by informants, 65% are having scientific and experimental evidence of anthelmintic property. The presence of such experimental evidence about the medicinal plants traditionally practiced by traditional healers suggests the efficiency and popularity of ethnomedicine. In a similar kind of research, several species of plants were reported from Cachar district of Assam having anthelmintic property (Das *et al*., 2008). Similarly, Sharma and Sharma (2010) reported many anthelmintic plants from Sonapur area of Kamrup district of Assam. Many plants from northeast India were investigated by Lyndem *et al*. (2008) showing effective anthelmintic agents. It can therefore be believed that although traditional healers do not perform any laboratory experiment, they have some kind of customary procedure by which they formulate their herbal doses.

Different plant parts are generally used in the preparation of herbal remedies. Among the plant parts used, leaves were found to be the most commonly used for the preparation of deworming

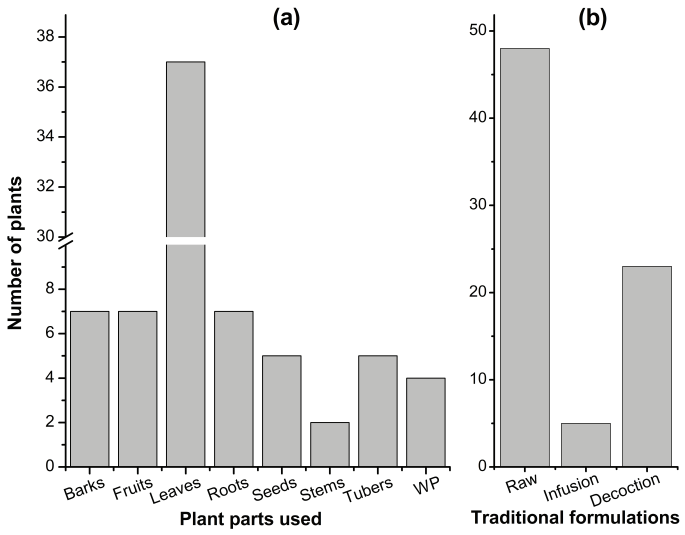

Figure 4. (a) Plant parts used in the traditional herbal formulation and (b) types of traditional formulations practiced. WP- whole plant.

herbal medicines (Fig. 4a). Unlike others, for three plants, namely, *Musa balbisiana, Cocos nucifera*, and *Clerodendrum indicum*, the corm, endosperm, and flower were found to be used for herbal formulations. Our survey also found that *Rauvolfia tetraphylla* is the most common plant in terms of parts used where all the leaves, barks, and roots were found to be used. Our survey also found that four plants, viz., *Cen. minima, Cissus quadrangularis*,

H. sibthorpioides, and *C. asiatica*, the whole plant parts was used for the herbal formulations. Regarding the herbal formulations, it has been seen that tribal communities of Udalguri district follows three methods of herbal formulations—decoction, infusion, and raw. Most of the time, traditional healers use raw plants for the preparation of herbal medicines (Fig. 4b). Trees are the most commonly used plants used by the herbal healers to cure helminthiasis followed by herbs, shrubs, and climbers. Because of its easy accessibility and availability, leaves tend to be the most commonly used plant parts. Many such studies have reported similar use of traditionally used medicinal plants (Choudhury *et al*., 2015; Raj *et al*., 2018). Although there are variations in the nature of herbal formulations among the traditional healers, three main traditional formulations are practiced by tribal communities of Udalguri district—raw, infusion, and decoction. Similar to our findings, decoction, extract, infusion, powder, and juice were found to be the main traditional formulations practiced by Neelum Valley, Pakistan (Ahmad *et al*., 2017).

CONCLUSION

Our study revealed that the ethnomedicinal knowledge for the treatment of helminth infection is prominent among the tribal communities of Udalguri district of Assam. A variety of medicinal plants are found to be used in traditional medicine system to treat helminthiasis. This study provides the documentation of the medicinal plants used for traditional healthcare. The literature survey has shown that most of the medicinal plants reported in the present study have scientific validation about their anthelmintic activity. Our survey also revealed that there is no precise method for formulating herbal remedies, but doses are altered according to their age and severity of the illness. The documented medicinal plants can serve as a database for future work or scientific validation. Furthermore, this study opens the door to scientific approach, which could lead to the discovery of new drugs, with lesser side effects.

ACKNOWLEDGMENT

AS would like to thank DST-SERB, Govt. of India for providing financial assistance (EEQ/2017/000071). The authors would also like to thank the traditional healer and elderly people for providing ethnomedicinal information. The authors also acknowledge to Dr. Sanjib Baruah Asstt. Prof., Department of Botany and Mr. Sanswrang Basumatary, Research Scholar, Department of Botany for helping scientific validation of the sample plants. The authors also acknowledge the infrastructural facilities provided by Department of Zoology, Bodoland University.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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How to cite this article:
Swargiary A, Daimari M, Roy MK. Survey and documentation of anthelmintic plants used in traditional medicine system of tribal communities of Udalguri district of Assam, India. J Appl Pharm Sci, 2020; 10(1):046–054.