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Original Article

Documentation of Mosquito Repellant Plants from Fringe Villages of Manas National Park, Assam, India

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ABSTRACT

Background: Mosquito-borne diseases are among the common problems in developing countries. For centuries, herbal formulations have been used by tribal communities as medicines. A survey was carried out to document the insecticidal plants from fringe villages of Manas National Park. **Materials and Methods:** The survey was carried out from April to July 2020. The survey was conducted in a face-to-face manner with a ready-made questionnaire. **Results:** A total of 25 fringe villages were surveyed, and 57 informants were interviewed. Most of the informants were male (87%) and aged (>50 years old). A total of 24 plant species belonging to 18 families were recorded in the present study. Among the plant families, Solanaceae and Lamiaceae were the most famous families. *Brassica rapa* was the most popular plant with five citations, followed by *Cinnamomum tamala* and *Nicotiana tabacum*. Leaves were the most commonly used plant parts, followed by stems. The survey also reported that smokes, produced by burning plant parts, are the most commonly practised mode of use, followed by the rubbing of raw juices of plant parts to repel mosquitoes by fringe villagers of Manas National Park. **Conclusion:** With a solid ethnobotanical knowledge system supported by scientific evidence, the present study may be used by researchers to explore further the insecticidal and mosquitocidal activities of the plants.

Keywords: Fringe village, Larvicidal, Medicinal plants, Manas National Park, Mosquitocidal.

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INTRODUCTION

Mosquito-borne diseases such as malaria, dengue, etc., are important diseases of the world, affecting millions of people every year.[1] There are about 3500 mosquito species, and most are native to the tropic and sub-tropic regions of the world.[2,3] The use of commercial insecticides is the primary control strategy for mosquito-borne diseases. Despite several insecticides, mosquito-borne diseases still pose major threats to humans. Over the few decades, more than 125 mosquito species have developed drug resistance to one or more commercial insecticides.[4,5] Studies have revealed that mosquitoes develop resistance capacity within 2-10 years against organic insecticides that are repeatedly applied for mosquito control.[6] A conclusive study on insect resistance was first reported in 1947 when dichlorodiphenyltrichloroethane was exposed to Culex mosquitoes in Italy. Researchers from Greece also reported the insecticide resistance of Anopheles mosquitoes in 1950s.[7,8] Insecticide pyrethroid resistance was first reported on Ivory Coast in 1993.[9] Subsequently, many resistant reports have been seen in more than 500 insects, of which 50 were malaria parasite vectors.[10,11]

Plants provide one of the major sources of food and medicine to humanity. There are about 3.5 lakh species of higher plants worldwide.[12] Despite the successes in medical facilities, traditionally used herbal medicines have played a major role in rural healthcare. It is estimated that about 80% population of Asia and Africa still rely on ethnomedicine.[13,14] Plants have been used as medicines against many common diseases, including mosquito-borne diseases. Plant-derived chemicals are gaining attention because of their easy availability and safe uses with lesser side effects.[15] However, because of the lack of proper documentation of the traditional medicine system, many valuable ethnomedicinal knowledge is being lost in time, and the trend continues.[16,17] Ethnomedicinal studies are important to preserve and document the locally important medicinal plants and discover naturally occurring drugs for healthcare.[18,19] Manas National Park (MNP) of Assam is one of the UNESCO World Heritage sites of India. Located between 26°45′ to 26°50′ North latitude and 90°30′ to 91°15′East longitudes, MNP is spread across two districts of Assam – Baksa and Chirang. The National Park is bordered on the north by Bhutan hills. The annual temperature varies from 6°C to 37°C. In the vicinity of the park, there are several tribal villages inhabited by Bodo, Rabha, Santhal, and Assamese communities.[20] The use of ethnobotanicals for

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ailments is a common practice there. Though the villagers are very much rich in ethnobotanical knowledge, no attempts have ever been made to document the ethnobotanicals from the adjacent villages of the Manas National Park. Therefore, in the present study, we have surveyed the fringe villages of Manas National Park to collect mosquito-repellant plants traditionally used by villagers.

MATERIALS AND METHODS

Data collection and identification of plants

A field survey was conducted between April to July 2020. A total of 25 villages were surveyed for the present study. The information was collected in a face-to-face interview manner with the help of ready-made questionnaires. During the survey period, informer's bio-data, plant(s) part(s) used, traditional formulation processes, and mode of use was recorded. The data was collected as per the information provided by the informants. Sample plants were collected with the help of traditional healers and older people. Herbarium sheets were prepared for the plants and submitted to the Department of Botany, Bodoland University, for taxonomic identification.

RESULTS

To obtain local information about ethnomedicine related to controlling mosquitoes in the study area, a field survey was conducted for about four months, from April to July 2020. The geographical area of the collection sites range from longitude N-26°37.50.6" to N-26°45.25.4" and latitude of E-090°58.19.4" to E-091°30.7.1". The names and geographical locations of all 25 villages are attached as supplementary file SF-T1. A total of 57 informants were interviewed during the survey period. Table 1 shows the demography of the informants interviewed during the survey period. The informants were mainly traditional healers (28%) and older people (72%) having ethnobotanical knowledge. Among the 57 informants, only seven participants were female, while 50 were male. Aged people over 50 years (>77% of total) possessed more ethnomedicinal knowledge than younger people. The survey also observed that most informants have school-level education, while a few have college-level education. Among the informants, about 32% were found to be illiterate.

Table 2 shows the list of plants traditionally used to repel mosquitoes by the fringe villagers of Manas National Park. A total of 24 plant species belonging to 18 families were recorded in the present study. Among the plant families, Solanaceae and Lamiaceae were the most popular, with three species each, followed by Lauraceae (2 species) and Amaranthaceae (2 species). Of the 24 plants, 14 were cited by more than one informant, while ten have only one citation. *Cinnamomum tamala, Brassica rapa, Nicotiana tabacum, Azadirachta indica*, and *Ocimum sanctum* were the best-cited plants by the informants (Figure 1). Among all the plants being referred to, mainly two plant parts – leaves

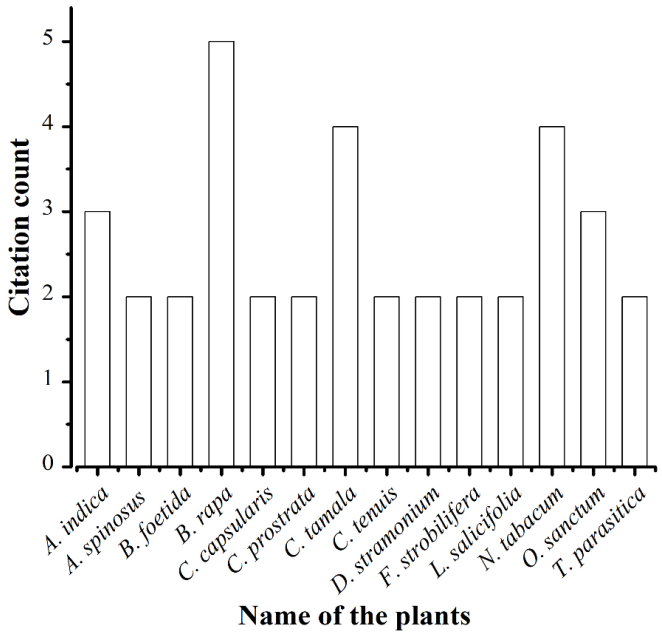

Figure 1: Name of the plants and their citation report by the informants.

and stems were found to be used in the traditional formulation practices. Leaves were found to be the most commonly used plant part, with 54.17% of all species reported, followed by stems in 12.5% of species. In some practices, the leaves and stems were used together, comprising 20% of species. The rhizome of *C. longa* and seed cake of *B. rapa* were also found to be used to repel mosquitoes. The whole plant part of *Leucas lavandulifolia* is also reported to be used as a mosquito repellent. Formulation or mode of use was straight of two kinds, wherein 83.22% were via smoke or fumigation, and 16.78% were in a raw manner. Villagers prepare raw extracts by grinding and squeezing the plant parts and apply on the skin as well as cloth to repel insects. Herbs were seen to be used abundantly with a percentage value of 45.84%, shrubs 29.17%, trees 20.84%, and climbers 4.15%. Of the 24 plant species, half of the plants were wild in habitat.

DISCUSSION

The study attempted to learn about the mosquito-repellent plants used by the fringe villagers of MNP. The information of traditional knowledge of many naturally found plants has contributed to many essential drug formulations.[21] However, due to the lack of proper documentation, several essential ethnobotanicals knowledge has been lost over the years. Therefore, the survey was carried out in Manas National Park to document the plant-based mosquito repellent locally used by fringe villagers.[22,23]

The old traditional medicine system as an alternative medicine source to tribal communities of India is still being practised since they are financially low, belong to the rural area, and are also lowly educated.[24] During our survey, it was observed that most knowledge bearers were traditional healers and older people. Many studies have also reported the transfer of knowledge

Table 1: Demography of informants from fringe villages of Manas National Park, Assam.

Sl. No.	Name of village	Traditional healer	Elderly persons	Male	Female	Age (yr.)		Education level		
						40–50	>50	School	College	Illiterate
1.	Bamunkhal	2	0	2	0	1	1	2	0	0
2.	Bhuyanpara	1	2	3	0	1	2	2	1	0
3.	Koroibari	1	1	2	0	1	1	1	0	1
4.	Kustratari	1	1	2	0	1	1	1	0	1
5.	Borgaon	2	1	3	0	1	2	2	1	0
6.	Lonthibari	0	2	1	1	0	2	2	0	0
7.	Betbari	1	2	3	0	1	2	3	0	0
8.	Dihira	1	2	3	0	1	2	2	1	0
9.	Garumara	0	2	2	0	0	2	1	0	1
10.	Thuribari	0	2	1	1	0	2	1	0	1
11.	Bispani	0	2	2	0	0	2	1	0	1
12.	Elengamari	1	1	2	0	1	1	0	0	2
13.	Kuthrijhar	0	2	2	0	0	2	2	0	0
14.	Khagrabari	0	2	2	0	0	2	1	0	1
15.	Narayanguri	1	2	2	1	1	2	1	0	2
16.	Gyatigaon	1	2	2	1	1	2	2	0	1
17.	Raghabeel	0	2	2	0	0	2	1	0	1
18.	Barengabari	1	2	2	1	0	3	1	0	2
19.	Mayangpara	0	2	2	0	0	2	1	0	1
20.	Madrijhora	1	1	2	0	1	1	1	0	1
21.	Kahibari	0	2	1	1	0	2	2	0	0
22.	Palsiguri	1	1	1	1	1	1	1	0	1
23.	Kamalabari	0	2	2	0	0	2	2	0	0
24.	Rajabeel	0	2	2	0	0	2	2	0	0
25.	Katajhar	1	1	2	0	1	1	1	0	1
	Total	16	41	50	7	13	44	36	3	18

systems from their fore-parents and have been practised for a long time.[25,26] However, unlike others, the survey showed a higher percentage of literacy (>65%) among the informants.[27] Our survey reported 24 plant species, of which four families were more popular among the informants, namely Solanaceae,[28] Amaranthaceae,[29] Lamiaceae[30] and Lauraceae,[31] and they all had scientific evidence of being effective as mosquitocidal agents. The present study found *B. rapa, C. tamala, N. tabacum, A. indica*, and *O. sanctum* as the most popular mosquito repellent plants. Several studies have also reported the mosquitocidal activities of these plants.[32-36] The highest usage of plant parts was leaves and stems in our study. As reported by many other kinds of literature, most traditional formulations use leave as the major ingredient.[37-39] Similarly to other studies, we also documented herbs as the highest used mosquito repellant plants by the fringe villagers of MNP.[40,41] The mode of use to repel away the mosquitoes were mostly smoking. The plant materials were directly burned out to generate smoke from which mosquitoes would repel away. The other method was directly squeezing out the plant leaves juice and applying the extract on the body directly or being applied a cloth so that the smell of the plant ingredient keeps circulating and the disease-injecting mosquitoes would repel away.[42] A literature survey found that almost all the plants (92%) have scientific evidence about larvicidal properties that are previously reported by other researchers. Like many other studies, the present study also observed that rural people are still practicing traditional medicines to cure ailments and mosquito control.[43]

Table 2: **Name of the plants, parts used, mode of use, and identification number of plants used by the fringe villagers of Manas National Park, Assam.**

Sl. No	Plant botanical name	Vernacular name (Assamese)	Family	Parts used	Mode of use	Habit	Habitat	References
1.	*Amaranthus spinosus* L. [BUBH0000851]	Katakhutura	Amaranthaceae	Leaves	Smoke	Shrub	Wild	Yes.[44]
2.	*Azadirachta indica* A. Juss [BUBH0000051]	Neem	Maliaceae	Leaf	Smoke	Tree	Domesticated	Yes.[45,46]
3.	*Benstonea foetida* (Roxb.) Callm and Buerki. [BUBH0000850]	Koya	Pandanaceae	Leaf	Smoke	Tree	Wild	No
4.	*Brassica rapa* (L.) Delarbre [BUBH0000849]	Besor	Brassicaceae	Oilseed cake	Raw	Herb	Domesticated	Yes.[33]
5.	*Calamus tenuis* Roxb. [BUBH0000059]	Bet	Arecaceae	Leaf	Raw, smoke	Climber	Wild	No
6.	*Catharanthus roseus* (L.) G.Don [BUBH0000854]	Nayantora	Apocynaceae	Leaf	Raw	Shrub	Domesticated	Yes.[47]
7.	*Cinnamomum tamala* (Buch-Ham) T.Nees and C.H. Ebern [BUBH0000860]	Tejjpat	Lauraceae	Leaf	Smoke, raw	Tree	Domesticated	Yes.[32]
8.	*Corchorus capsularis* L. [BUBH0000855]	Morapat	Malvaceae	Leaf	Smoke	Shrub	Domesticated	Yes.[48]
9.	*Cosmos sulphurous* Cav. [BUBH0000863	Gandhemaloti	Asteraceae	Leaves	Raw	Herb	Domesticated	Yes.[49]
10.	*Curcuma longa* L. [BUBH0000852]	Halodhi	Zingiberaceae	Leaves	Smoke, raw	Herb	Domesticated	Yes.[50]
11.	*Cyathula prostrata* (L.) Blume. [BUBH0000864]	Uvotisoth	Amaranthaceae	Leaf, stem	Raw, smoke	Herb	Wild	Yes.[51]
12.	*Cynadon dactylon* (L.) Pers [BUBH2018032]	Dubori-bon	Poaceae	Leaf	Smoke	Herb	Wild	Yes.[52]
13.	*Datura stramonium* L. [BUBH0000859]	Datura	Solanaceae	Leaves	Smoke	Shrub	Domesticated	Yes.[53]
14.	*Flemingia strobilifera* (L.) W.T.Aiton [BUBH0000866]	Makhioti	Fabaceae	Leaves	Raw, smoke	Shrub	Wild	Yes.[54]

Sl. No	Plant botanical name	Vernacular name (Assamese)	Family	Parts used	Mode of use	Habit	Habitat	References
15.	*Houttuynia cordata* Thunb. [BUBH0000862]	Mesendari	Saururaceae	Leaves	Smoke	Herb	Domesticated	Yes.[55]
16.	*Leucas lavandulifolia* Sm. [BUBH0000856]	Doron	Lamiaceae	Whole	Raw, smoke	Herb	Wild	Yes.[56]
17.	*Litsea salicifolia* (Roxb. ex Nees) Hook.f. [BUBH0000867]	Dighloti	Lauraceae	Stem, leaves	Smoke	Tree	Wild	Yes.[57]
18.	*Murraya koeningii* (L.) Spreng [BUBH0000055]	Norsingha	Rutaceae	Leaf	Smoke	Tree	Domesticated	Yes.[58]
19.	*Nicotiana tabacum* L. [BUBH0000859]	Sadha	Solanaceae	Leaf, stem	Smoke	Shrub	Domesticated	Yes.[59]
20.	*Ocimum sanctum* L. [BUBH2018045]	Kala tulsi	Lamiaceae	Leaf	Smoke	Herb	Domesticated	Yes.[36]
21.	*Persicaria hydropiper* (L.) Delarbre [BUBH0000029]	Behu	Polygonaceae	Leaf	Smoke	Herb	Wild	Yes.[60]
22.	*Solanum viarum* Dunal [BUBH0000857]	Katahi bengna	Solanaceae	Leaf, stem	Smoke	Shrub	Wild	Yes.[61]
23.	*Thelypteris parasitica* (L.) Tardieu. [BUBH0000865]	Bih-dekhia	Aspleniaceae	Stem, leaves	Smoke	Herb	Wild	Yes.[62]
24.	*Vitex trifolia* L. [BUBH0000858]	posotia	Lamiaceae	Leaf	Smoke	Shrub	Wild	Yes.[63]

CONCLUSION

The present study was carried out to document the insect-repellant plants used by the fringe villagers of Manas National Park of Assam, India. The study observed a diversity of plants used as insect repellants. Though the villagers do not have any standardized formulation practice, they have some understanding of formulating plant-based insecticides. The present study also approves the scientific merit of the ethnobotanicals traditionally used by fringe villagers of MNP. With a strong ethnobotanical knowledge system, the present study may be used by the researchers to explore further the insecticidal and mosquitocidal activities of the plants.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

MNP: Manas National Park; **UNESCO:** United Nations Educational Scientific and Cultural Organization.

SUMMARY

Plants are rich sources of bioactive components and exhibit many bioactive properties. In the present study, we have documented medicinal plants traditionally used by fringe villagers of Manas National Park of Assam. After interviewing 57 informants from 25 fringe villages, a total of 24 plant species have been documented in the present study. The most popular mosquito repellant plant was found to be *Brassica rapa* and *Cinnamomum tamala*. The present study highlighted the richness of ethnobotanicals used by the fringe villagers of Manas National Park which requires further investigation and scientific analysis to explore the larvicidal properties of the plants.

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