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Ethnomedicinal plants of the sacred groves and their uses by Karbi tribe in Karbi Anglong district of Assam, Northeast India

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The present study was conducted to record the ethnomedicinal plants and their uses by the Karbi tribe in Bichikri and Harlong sacred groves of West Karbi Anglong district of Assam. A prestructured questionnaire survey and quantitative analysis was carried out to record the medicinal plants and to determine the ailments categories. A total of 38 ethnomedicinal plants (36 genera and 27 families) were recorded from the study sites. Leaves were found as the dominant plant parts used for the treatment of various health ailments. The highest F_{ic} value was recorded for cold, dermatological, skeletal muscle pain and inflammation, general health, and infectious disease and genital-urinary disorder categories. The informant agreement ratio (IAR) was found higher for 18 species. The fidelity level (FL) of 11 species secured the highest FL value (100%) and the used value (UV) was in the range of 0.05 to 0.93. The present study has revealed that the Karbi tribe living around the sacred groves depends on the plant species for their health care. However, proper management is required for the conservation of sacred groves through sustainable utilization of medicinal plants occurred in the groves.

Keywords: Assam, Conservation, Ethnomedicine, Karbi Anglong, Karbi tribe, Sacred grove

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Plants are the essential source of therapeutic drugs which play an important role in the preparation of traditional medicines. The majority of rural people in Asian countries use plant-based traditional medicines for health problems[1]. In China, traditional herbal preparation account for 30–50% of the total medicinal consumption[2]. In India, 70% of the rural population depends on traditional medicines to meet their medical care[3]. The dependence of the rural community on plant-based herbal medication is common because of cheaper, easy availability, the simplicity of their applications. Moreover, they do not have side effects and has built up resistance to protect human health[4]. Forests are home to a diverse population of medicinal plants and indigenous people rely on the forest resources for their traditional medicines. There are also patches of forest that are known as sacred groves, where the indigenous community protect plants because of their associated socio-cultural and traditional beliefs. These sacred groves also provide medicinal plants to the local people.

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The Northeastern part of India is the wealthiest reservoir of various plant species where altogether more than 200 tribes[5] along with other communities protect the forest and sacred groves. The majority of the tribal communities are inhabited in the hilly terrain in different states. Assam, one of the states in Northeast India, comprises different tribal and non-tribal communities, which use numbers of plant species both identified and unidentified ones for the treatment of health disorder[6]. The ethnomedicinal study of plants in different parts of Assam was carried out several times by different workers[7,8,9,10,11]. Some specific ethnobotanical studies in relation to medicinal plants used for gynecological disorder[12] and plants used as herbal dyes by the Karbi tribe have also been studied[13]. A few studies[14,15,16] have also been made on the ethnomedicinal plants used by the Karbi tribe in the state. In Karbi Anglong a total of 7 sacred groves were reported[17]. However, the ethnobotanical studies considering the sacred groves are limited or not available which may signify the valuable plants preserved in the sacred groves. Hence, the present study is aimed to highlight the ethnomedicinal plants

and their uses by the Karbi tribe in two sacred groves of West Karbi Anglong district of Assam.

Methodology

Study area

The study was conducted in West Karbi Anglong district of Assam, Northeast India (Fig. 1). The district is inhabited by different indigenous communities, like Moran, Kuch, Kalita, Dimasa, Garo, Bodo and Tiwa with Karbi being one of the dominant populations. The Karbi tribe traditionally protects the sacred groves due to their associated religious beliefs and taboos. Two sacred groves namely Bichikri and Harlong sacred groves were selected for study (Fig. 1). Bichikri (25°58'08.46"N to 92°30'24.39" E) and Harlong (25°58'46.29" N to 92°29'49.08" E) sacred groves (Fig. 2) are located 15 km and 10 km, respectively away from Boithalangsu town in West Karbi Anglong district. Both the sacred groves are situated in remote hilly terrain. The accessibility to road transportation and modern medical facilities are limited in the adjacent habitation. Bichikri sacred grove cover an area of 16 hectares while Harlong sacred grove are comparatively small in size covering an area of 1.4 hectares and located at an elevation of 435 m and 160 m amsl, respectively. As there is no definite boundary around the sacred grove, the given area is an approximate estimation acquired with the confidence of the village head. Bichikri and Harlong sacred groves are protected by a small population of 89 individuals and 125 individuals of Karbi tribe, respectively inhabiting adjacent to the sacred forest. The economic condition of the people inhabited in this area is poor, and their primary occupation is agriculture which includes shifting cultivation. Betel nut and rubber plantation are found to be the main commercial crops. According to Champion and Seth[18] classification of the forest the region falls under semi-evergreen forest (2B/C1). The district exhibit different climatic conditions due to variation in the topography. However, both the sacred groves fall under more or

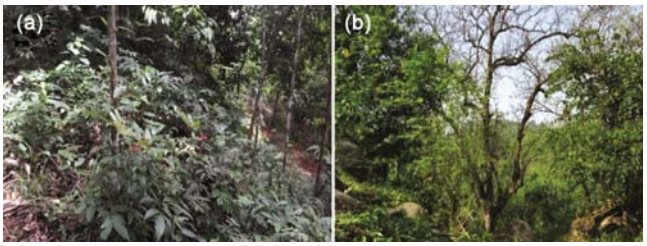

Fig. 2 — Outlook of (a) Bichikri and (b) Harlong sacred groves

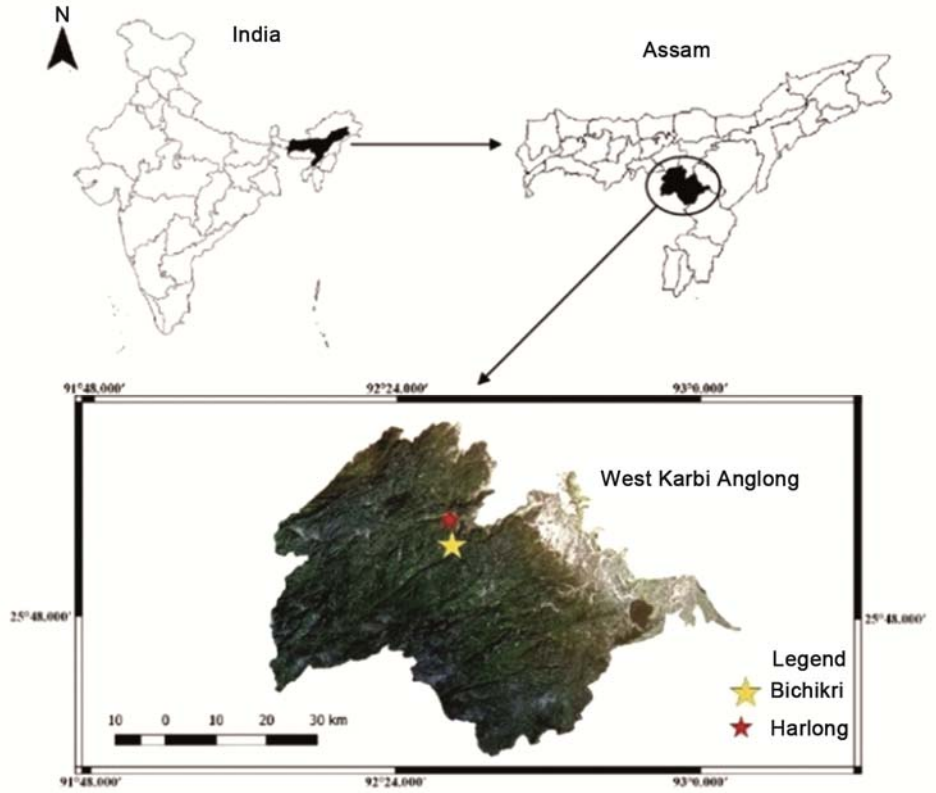

Fig. 1 — Map of West Karbi Anglong district, Assam indicating the location of the studied sacred groves

less similar microclimate zone. The temperature in summer ranges from 21^{0}C to 32^{0}C and in winter, it differs from 6^{0}C to 12^{0}C, while the rainfall varies from 4 mm in winter to 186 mm in monsoon.

Data collection

The study was carried out in 2017 using standard ethnobotanical approach[19] through field survey using prestructured questionnaire. Traditional healers who practice herbal treatments for human ailments over an extended period were considered as a source of data for this study. A total of 15 and 20 informants from Bichikri and 20 from Harlong sacred groves respectively were interviewed. Information collected from the informants includes the vernacular name of ethnomedicinal plants, parts used, mode of crude drug preparation and administration and treatment of ailments. The plants were identified referring to Flora of Assam[20] and other relevant taxonomic literature. The correct nomenclature of each species was checked with The Plant list[21]. For voucher sample, herbarium specimens for each species were prepared[22] and housed in the Tezpur University Herbarium, Department of Environmental Science.

Quantitative analysis

The information recorded in the field was converted into used reports (UR); where one UR represent an informant (i) mention the use of a species (s) for the treatment of a particular ailment (u)[23]. Similarly, if an informant (i) used a species (s) for the treatment of two different ailment categories, then it was considered as two UR. The use of a species (s) for treating an illness category by at least two informants (i) was also measured as two UR. The health ailments were classified into different ailment categories[24,25]. The quantitative analysis of ailments category and plant species recorded in the field was measured with 4 indices. These indices are the factor of informant consensus (F_{ic}), FL, IAR and UV.

The factor of informant consensus (F_{ic})

F_{ic} was calculated to know the uniformity of ethnomedicinal plants shared by all the informants in particular ailment category[26]. The factor was calculated as.

F_{ic}=(Nur–Nt)/ (Nur-1),

where,

Nur number of URs of an informant for a particular ailment category

Nt total number of species used for a specific ailment category by all informants.

The value of F_{ic} ranges from 0 to 1, where the value close to 0 means that there is disagreement among informants on the plants used for the treatment of a particular ailment. The value close to 1 means that that the plants that are used for the treatment of a specific ailment are highly shared among the informants.

Informant agreement ratio (IAR)

The IAR was enumerated to measure the consensus of each recorded species[26]. The IAR is calculated as

IAR=(Nr- Na)/(Nr-1)

where,

Nr total number of UR registered for a particular plant species

Na number of ailment categories that are treated with this species.

The values vary from 0 to 1, where the value 0 means that the number of UR is equal to the number of ailment category. Whereas, one signifies that the greater respondent agreed to the use of the species for a particular ailment category[26]. For the present study, the same species used for two different ailments was not considered for the calculation of IAR.

Fidelity level (FL)

The FL was calculated to identify a species which is most frequently used for the treatment of a particular ailment category[27]. The FL is calculated as

FL=N_p/(N×100)

where,

N_p number of UR for each species in a particular ailment category

N total number of UR for that specific species.

Use value (UV)

The UV is established to know the importance of locally used species[28]. UV is calculated as

UV=U/N

where,

U is the number of UR mentioned by each informant for a particular species

N total number of informant interviewed.

Results and discussion

Diversity of medicinal plants

The study in both the sacred groves recorded a total of 38 plant species belonging to 36 genera and 27 families (Table 1). Out of 38 plant species, 19 species (19 genera and 14 families) are common in both sites. The study recorded a total of 24 species under 21 genera and 17 families in Bichikri sacred grove while in Harlong sacred grove it was 32 species under 30 genera and 22 families. The species used for the treatment of ailments is comparatively low in Bichikri than Harlong. The higher ethnomedicinal use of plant species has attributed due to the presence of varieties of medicinal plant species in Harlong. Similarly, the study observed, Lamiaceae, Compositae (3 species each) in Bichikri and Leguminosae (5 species)

Table 1 — Ethnomedicinal plants recorded in Bichikri (B) and Harlong (H) sacred groves

Scientific name & Voucher number	Verna-cular name	Family	Habitat	B	H	Human ailments	Plant parts used	Route of administration	Crude drug type
Ageratum conyzoides L. [517]	Bongjnai (Karbi)	Compositae	Herb	✓	✓	Wound	Leaves	Cutaneous	Paste
Albizia lebbeck (L.) Benth. [521]	Siris (Assamese)	Leguminosae	Tree	-	✓	Dental problems Eye disorders Piles	Leaves, seeds and bark	Sublingual Ocular Oral	Paste Extract Decoction
Albizia procera (Roxb.) Benth. [522]	Boga siris (Assamese)	Leguminosae	Tree	-	✓	Stomach pain	Bark	Oral	Decoction
Amaranthus spinosus L. [508]	Dido (Karbi)	Amaranthaceae	Herb	-	✓	Poisonous bites Mensuration cramps	Root	Oral	Juice
Bauhinia purpusea L. Lam.[518]	Ingku (Karbi)	Leguminosae	Tree	✓	✓	Poisonous bites	Leaves	Oral	Decoction
Bryophyllum pinnatum (Lam.) Oken [520]	Dupor tenga (Assamese)	Crassulaceae	Herb	-	✓	Kidney stone Hypertension	Leaves	Oral Oral	Decoction Juice
Chukrasia tabularis A. Juss. [519]	Boga poma (Assamese)	Meliaceae	Tree	✓	-	Astringent	Young leaves	Cutaneous	Paste
Clerodendrum infortunatum L. [504]	Phelik (Karbi)	Lamiaceae	Shrub	✓	✓	Cold Poisonous bites	Apical part	Oral	Paste
Colocasia esculenta (L.) Schott [523]	Henrukik (Karbi)	Araceae	Herb	✓	✓	Blood coagulation	Tuber	Cutaneous	Juice
Cynodon dactylon (L.) Pers. [512]	Dubori bon (Assamese)	Poaceae	Herb	-	✓	Intestinal infection Skin diseases	Leaves	Oral Cutaneous	Decoction Paste
Dillenia indica L. [524]	Plum plum (Karbi)	Dilleniaceae	Tree	✓	✓	Dysentery	Whole plant	Oral	Decoction
Dioscorea alata L. [531]	Ruichin (Karbi)	Dioscoreaceae	Herb	✓	-	Blood pressure	Leaves and bark	Oral	Decoction
Euphorbia hirta L. [536]	Babchulang (Karbi)	Euphorbiaceae	Herb	-	✓	Dysentery	Whole plant	Oral	Extract
Ficus hispida L. f. [525]	Ingtham (Karbi)	Moraceae	Tree	-	✓	Ringworm	Leaves, bark and fruits	Cutaneous	Powder
Gmelina arborea Roxb. [526]	Phang kurbau (Karbi)	Lamiaceae	Tree	✓	✓	Fever	Flowers and leaves	Oral	Juice
Hibiscus rosa-sinensis L. [507]	Hanserong (Karbi)	Malvaceae	Shrub	-	✓	Dysentery	Shoots	Oral	Paste
Homalomena aromatica (Spreng.) Schott [532]	Okhiate-hang (Karbi)	Araceae	Herb	✓	✓	Blood purifier	Leaves, rhizome and bulb	Oral	Decoction
Houttuynia cordata Thunb. [533]	Hankumphi (Karbi)	Saururaceae	Herb	✓	-	Skin infections Dysentery	Leaves	Cutaneous Oral	Paste Juice
Lantana camara L. [509]	Guphul (Assamese)	Verbenaceae	Shrub	✓	-	Blood clotting Constipation	Leaves	Cutaneous Oral	Paste Juice

(*Contd*.)

Table 1 — Ethnomedicinal plants recorded in Bichikri (B) and Harlong (H) sacred groves (*Contd.*)

Scientific name & Voucher number	Verna-cular name	Family	Habitat	B	H	Human ailments	Plant parts used	Route of administration	Crude drug type
Leucas aspera (Willd.) Link [537]	Chanrong aan (Karbi)	Lamiaceae	Herb	✓	✓	Sinus problem	Flowers and leaves	Inhalation	Paste
Mallotus philippensis (Lam.) Müll.Arg. [527]	Henduri (Assamese)	Euphorbiaceae	Tree	✓	-	Skin infections	Seeds	Cutaneous	Powder
Mangifera indica L. [529]	Therve (Karbi)	Anacardiaceae	Tree	✓	✓	Constipation	Fruits	Oral	Paste
Mikania micrantha Kunth [503]	Japanilota (Assamese)	Compositae	Vine	✓	✓	Skin infections	Leaves	Cutaneous	Paste
Mimosa pudica L. [513]	Bab therak (Karbi)	Leguminosae	Herb	✓	✓	Jaundice	Root	Oral	Juice
Oroxylum indicum (L.) Kurz [528]	Napak ban (Karbi)	Bignoniaceae	Tree	✓	✓	Gastric problem	Bark	Oral	Decoction
Oxalis corniculata L. [502]	Vathung-mekbob (Karbi)	Oxalidaceae	Herb	-	✓	Dysentery	Whole plant	Oral	Juice
Paederia foetida L. [534]	Rikangi kimi (Karbi)	Rubiaceae	Herb	✓	✓	Joint pain and muscle stiffness	Root and leaves	Cutaneous	Powder and paste
Persicaria chinensis (L.) H. Gross [535]	Kelnap (Karbi)	Polygonaceae	Herb	-	✓	Stomach pain	Shoots	Oral	Juice
Phlogacanthus curviflorus (Wall.) Nees [545]	Tita bahak (Assamese)	Acanthaceae	Shrub	✓	-	Stomach ulcer Uterus contraction	Root and leaves	Oral Oral	Juice Decoction
Phyllanthus emblica L. [530]	Thelu kame (Karbi)	Phyllanthaceae	Tree	✓	✓	Jaundice	Fruits	Oral	Juice
Phyllanthus amarus Schumach. & Thonn. [510]	Longle thelu (Karbi)	Phyllanthaceae	Herb	✓	✓	Jaundice	Fruits	Oral	Juice
Piper longum L. [539]	Ahombrik (Karbi)	Piperaceae	Vine	-	✓	Cough	Fruits and root	Oral	Juice
Rubus alceifolius Poir. [540]	Jetulipoka (Assamese)	Rosaceae	Shrub	-	✓	Menstrual cramps	Roots, shoots and fruits	Oral	Juice
Senna tora (L.) Roxb. [541]	Medeluwa (Karbi)	Leguminosae	Shrub	-	✓	Tonsil	Bark	Oral	Decoction
Solanum indicum L. [514]	Hepi sokran (Karbi)	Solanaceae	Shrub	✓	✓	Cough Asthma Teeth disorders	Fruits	Oral Oral Buccal	Decoction Decoction Powder
Spilanthes acmella (L.) L. [511]	Pirazha (Assamese)	Compositae	Herb	✓	✓	Anesthesia Toothache	Flowers and leaves	Cutaneous Oral	Paste and juice
Tinospora sinensis (Lour.) Merr. [515]	Honguni lota (Assamese)	Menispermaceae	Herb	✓	✓	Diabetes	Stems	Oral	Juice
Zingiber officinale Roscoe [538]	Hanso (Karbi)	Zingiberaceae	Herb	✓	✓	Blood coagulation	Leaves and roots	Cutaneous	Paste

in Harlong as dominant plant families for ethnomedicinal plants (Fig. 3). Leguminosae (Fabaceae) is one of the largest families of ethnomedicinal importance being used by the local traditional communities as herbal medicines for the treatment of various diseases[29]. Similar observation was made in tribal communities (Kurumas, Kurichiyas and Paniyas) of Kerala where Leguminosae was found to be a dominant family of medicinal plant species[30]. However, the present study exhibited higher utilization of plant species of Asteraceae and Lamiaceae families in traditional medicine. The contribution of plant

species was observed to be highest in herbs (50%, 50%) followed by trees (33%, 28%), shrubs (13%, 16%) and vine (4%, 6%) in Bichikri and Harlong, respectively. The highest percentage contribution of herbs was due to presence of relatively active ingredients and easy management as compared to trees, shrubs and vines[31]. Similarly, herb species contributed highest among the medicinal plants in sacred groves of Manipur[32].

Plant parts used

In the present study, a total of 13 plant parts (apical part, bark, bulb, fruits, flowers, leaves, roots, seeds, shoots, stems, tuber, whole plant and rhizome) recorded for the preparation of traditional medicines (Fig. 4). The study also observed that the use of plant parts for the treatment of different health ailments varies according to the species availability. Among the plant parts used, leaves (43%) recorded as the dominant plant part used in Bichikri followed by root and fruits (12% each), flowers (9%), bark (6%), apical part, seeds, bulb, whole plant, tuber and rhizome (3% each). Also, in Harlong leaves (29%) recorded as the highest followed by fruits (16%), bark and root (11% each), whole plant, shoot, flowers (7% each), rhizome, tuber, apical part and bulb (2% each). Leaves are used for the synthesis of many active constituents and pharmacologically more active

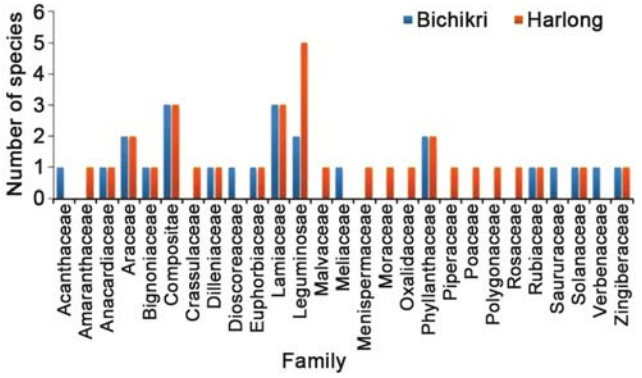

Fig. 3 — Recorded families and their respective species in Bichikri and Harlong sacred groves

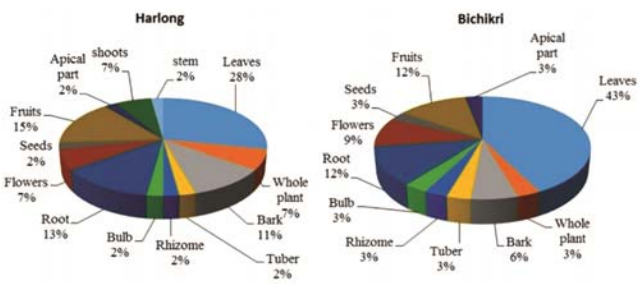

Fig. 4 — Proportion of plant parts used for preparation of medicines

against certain diseases as compared to other plant parts. Also, the sustainability of leaves has provided its usability hence, the use of leaves for medicinal purposes is a more practiced than other plant parts. The utilization of leaves in ethnomedicine for the treatment of various ailments has also reported in studies conducted in Assam[33,34] and elsewhere[35].

Routes of administration and crude drug type

In the study, herbal healers prescribed medicine commonly through the oral route of administration (66%) followed by cutaneous (25%), buccal, inhalation, ocular and sublingual (2% each). Based on crude drug type, juice and paste recorded the highest (32.64% and 28.57%) followed by decoction (26.5%), powder (8.16%) and extract (4.08%). Despite the fact that there are different crude types and modes of administration, juice reported to be the common crude type used while oral represents the maximum route of administration for the treatment of human ailments. Similar findings were reported in many studies where an oral route is the most commonly preferred route of administration[36,37,38,39].

Human ailments

A total of 30 health ailments treated by the healers were recorded during the study. Out of 30 health ailments, 20 ailments recorded in Bichikri and 26 in Harlong while, 16 were observed to be common in either of the studied sites. In Thrissur district of Kerala, *Chassalia curviflora* (Wall ex Kurz) Thw. was found to be a common plant species from the 4 sacred groves[40]. The present study recorded 9 health ailments that can be treated by more than one plant species, but the rest (21) have species-health ailments

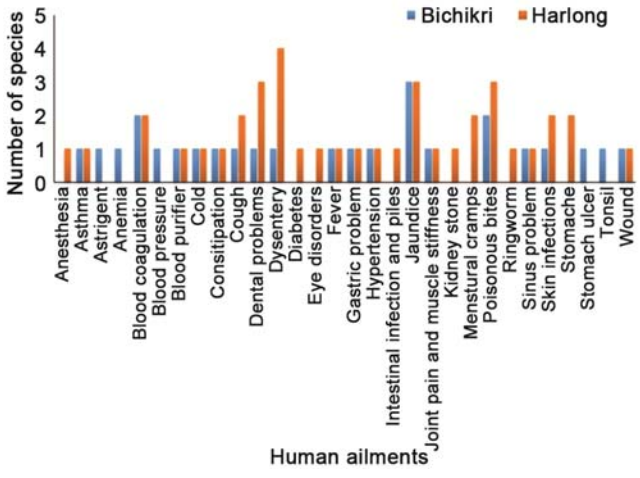

Fig. 5 — Number of plant species used in the treatment of human ailments

specificity (Fig. 5). Photographic representation of some medicinal plant species recorded from the sacred groves is shown in (Fig. 6). The health ailments which recorded the highest number of plant species for the treatment were Jaundice (3) and Dysentery (4) in Bichikri and Harlong respectively. The observed species used for the treatment of Jaundice in Bichikri are *Mimosa pudica* L., *Phyuanthus emblica* L., and *Phyllanthus amarus* Schumach. & Thonn. Whereas, *Dillenia indica* L., *Euphorbia hirta* L., *Hibiscus rosa-sinensis* L. and *Oxalis corniculata* L. are used for the treatment of Dysentery in Harlong. The use of different plant species for the treatment of Jaundice and Dysentery could be associated by the common occurring problems as a result of poor water supply and sewage management in the study sites.

Quantitative analysis

The recorded human ailments were classified into 15 ailment categories based on the UR (Table 2). In Bichikri, allergy and circulatory system are two

Fig. 6 — Photographic representation of some medicinal plant species recorded from the Bichikri and Harlong sacred groves

Table 2 — Ailment categories based on the information of UR

Ailment category	F_{ic}	
	Bichikri	Harlong
Allergy (skin and eyes)	0.8	0.5
Cardiovascular (high blood pressure)	0.8	0.8
Circulatory system (blood clotting, blood purifier and blood coagulation)	0.9	0.8
Cold	1	1
Dermatological (wounds and burns)	1	1
Ear, Nose and Throat (sinuses, tonsillitis, toothache and nasal bleeding)	0.5	0.6
Endocrine and liver disorder (diabetes and liver disorder)	0.7	0.4
Fever (malaria, typhoid and jaundice)	0.5	0.5
Gastrointestinal disorder (stomached, gastric, dysentery, ulcers, bloating and constipation)	0.6	0.6
General health (infection, fever and weakness)	1	0.6
Infectious disease and genital-urinary disorder (cholera, urinary infection and kidney problem)	-	1
Poisonous bites (snake bite)	0.8	0.5
Reproductive and birth disorder (uterine pains, placenta expulsion, promote fertility in women and sexual fluids in women)	-	0.6
Respiratory infections (whooping cough, lung infection and asthma)	0.3	0.6
Skeletal muscle pain and inflammation (headache, joint pains, bone fracture, and cancer/tumor)	1	1

ailment categories recorded with a large number of UR. Whereas, in Harlong the circulatory system and gastrointestinal disorder marked with the highest number of UR. The calculated F_{ic} values was found in the range of 0.3 to 1 and 0.4 to 1, with a mean value of 0.63 and 0.69 in Bichikri and Harlong, respectively (Table 2). Highest number of F_{ic} value (F_{ic}=1) for both the groves was recorded in cold, dermatological, skeletal muscle pain and inflammation, general health and infectious disease and genital-urinary disorder categories. Three ailment categories namely cold, dermatological and skeletal muscle pain and inflammation are common in both the groves. While, general health was recorded in Bichikri and infectious disease and genital-urinary disorder in Harlong sacred grove. The record of the highest number of F_{ic} value in different ailment categories have indicated that large informants used only a few or single species for a particular ailment category. The low F_{ic} value of 0.3 and 0.4 were recorded in respiratory infections and endocrine as well as liver disorder in Bichikri and Harlong, respectively. The lower recorded F_{ic} value portrayed that the informant has disagreed on the use of species in the treatment within the same health ailment category. A study conducted in Manipur[41] recorded the higher F_{ic} values in skeleton muscular system disorder, oral care and circulatory system disorder. (Table 3) shows the IAR values which ranged from 0 to 1 in either of the study sites. An average mean of 0.54 was recorded relatively high in Harlong as compared to 0.4 in Bichikri. The variation between the sites revealed that the species used for the treatment of particular ailment is shared more in Harlong than Bichikri. A total of 18 species found with the highest IAR value (1), where *A. conyzoides* L., *Dillenia indica* L., and *Paederia foetida* L. recorded as common species from both the sites. Other species with highest IAR in Bichikri sacred grove are *Chukrasia tabularis* A. Juss., *Lantana camara* L., *Leucas aspera* (Wild.) Link., *Mangifera indica* L., *Mikania micrantha* Kunth, *Oroxylum indicum* (L.) Kurz, *Solanum indicum* L. and *Spilanthus acmella* (L.) L. In Harlong sacred grove, *Albizia procera* (Roxb.) Benth., *Bryophyllum pinnatum* (Lam.) Oken, *Hibiscus rosa-sinensis* L., *M. pudica* L., *Persicaria chinensis* (L.) H Gross, *Rubus aleifolius* Poir. and *Tinospora sinensis* (Lour.) Merr. were found with highest IAR values.

Table 3 — Fidelity level (FL), used value (UV) and informant agreement ratio (IAR) of plant species

Plant species	Bichikri			Harlong		
	IAR	FL (%)	UV	IAR	FL (%)	UV
Ageratum conyzoides L.	1.0	100	0.93	1.0	85.7	0.9
Albizia lebbeck (L.) Benth.	-	-	-	0.8	50	0.1
Albizia procera (Roxb.) Benth.	-	-	-	1.0	100	0.1
Amaranthus spinosus L.	-	-	-	0.0	57.1	0.2
Bauhinia purpusea L.	0.3	75	0.20	0.9	100	0.1
Bryophyllum pinnatum (Lam.) Oken	-	-	-	1.0	100	0.25
Chukrasia tabularis A. Juss.	1.0	100	0.13	-	-	-
Clerodendrum infortunatum L.	0.0	50	0.07	0.5	60	0.15
Colocasia esculenta (L.) Schott	0.9	100	0.40	1.0	100	0.3
Cynodon dactylon (L.) Pers.	-	-	-	0.0	60	0.15
Dillenia indica L.	1.0	80	0.27	1.0	75	0.15
Dioscorea alata L.	NC	100	0.27	-	-	-
Euphorbia hirta L.	-	-	-	0.0	60	0.15
Ficus hispida L.f.	-	-	-	0.9	50	0.05
Gmelina arborea Roxb.	0.0	66.7	0.13	0.9	50	0.05
Hibiscus rosa-sinensis L.	0.9	57.1	0.27	1.0	50	0.05
Homalomena aromatica (Spreng.) Schott	0.7	66.7	0.13	0.5	42.9	0.15
Houttuynia cordata Thunb.	NC	80	0.27	0.3	40	0.1
Lantana camara L.	1.0	100	0.13	-	-	-
Leucas aspera (Willd.) Link	1.0	75	0.20	0.9	88.9	0.4
Mallotus philippensis (Lam.) Mull.Arg.	0.0	100	0.13	-	-	-
Mangifera indica L.	1.0	50	0.13	0.5	60	0.15
Mikania micrantha Kunth	1.0	77.8	0.47	0.7	66.7	0.4

(*Contd*.)

Table 3 — Fidelity level (FL), used value (UV) and informant agreement ratio (IAR) of plant species (*Contd.*)

Plant species	Bichikri			Harlong		
	IAR	FL (%)	UV	IAR	FL (%)	UV
Mimosa pudica L.	0.7	66.7	0.27	1.0	85.7	0.3
Oroxylumindicum (L.) Kurz	1.0	100	0.13	NC	100	0.3
Oxalis corniculata L.	-	-	-	0.9	66.7	0.1
Paederia foetida L.	1.0	40	0.13	1.0	60	0.15
Persicaria chinensis (L.) H. Gross	-	-	-	1.0	80	0.2
Phlogacanthus curviflorus (Wall.) Nees	-	-	-	0.5	77.8	0.35
Phyllanthus emblica L.	0.0	75	0.40	NC	72.7	0.4
Phyllanthus amarus Schumach. & Thonn.	0.8	100	0.20	0.0	100	0.45
Piper longum L.	-	-	-	0.0	81.8	0.45
Rubus alceifolius Poir.	-	-	-	1.0	33.3	0.1
Senna tora (L.) Roxb.	-	-	-	0.5	80	0.2
Solanum indicum L.	1.0	90	0.60	NC	86.7	0.65
Spilanthes acmella (L.) L.	1.0	84.6	0.73	0.5	77.3	0.85
Tinospora sinensis (Lour.) Merr.	-	-	-	1.0	67	0.1
Zingiber officinale Roscoe	0.7	80	0.27	0.5	100	0.15

Note: NC= Not Considered

The highest FL values (100%) were recorded in 11 species from both the sacred groves. In Bichikri sacred grove, the species namely *Ageratum conyzoides* L., *Chukrasia tabularis* A. Juss., *Colocasia esculanta* (L.) Schott, *Dioscorea alata* L., *Lantana camara* L., *Oroxylum indicum* (L.) Kurz. and *Phyllanthus amarus* Schumach. & Thonn. found with FL of 100 %. On the other hand, in Harlong sacred grove, *Albizia procera* (Roxb.) Benth., *Bauhinia Purpusea* L., *Bryophyllum pinnatum* (Lam.) Oken, *Oroxylum indicum* (L.) Kurz., *P. amarus* Schumach. & Thonn. and *Zingiber officinale* Roscoe found 100 % FL value. The lowest FL values were recorded for *Paderia foetida* L. (40%) in Bichikri sacred grove and *Rubus alceifolius* Poir. (33.3%) in Harlong sacred grove. However, the FL values in both the sacred groves showed variation among plant species used for the treatment of human ailments. The difference could be due to the availability of a particular plants species in their locality. Nevertheless, the plant species that are widely used by the local people have higher FL values than those which are less used[42], as well as they possess different phytochemicals responsible for their therapeutic actions[43].

The study recorded UV ranged from 0.07 to 0.93 and 0.05 to 0.9 in Bichikri and Harlong, respectively. The species *Ageratum conyzoides* L. was recorded as the most culturally essential species in Bichikri (0.93) and Harlong (0.9) sacred groves. *Clerodendrum infortunatum* L. recorded lowest UV with 0.07 in Bichikri while *Ficus hispida* L.f., *Gmelina arborea* Roxb. and *Hibiscus rosa-sinensis* L. with 0.05 each recorded lowest UV in Harlong sacred grove. High UV levels indicate high numbers of use reports by the informants for a particular plant[44]. *A. conyzoides* L. contains biologically active compounds, which are effective against certain ill-health[45]. That could be the reason that the local people of the study area consider *A. conyzoides* L. for the treatment of human ailments. The record of *A. conyzoides* L. was also recorded from the other sacred groves of India[46,47,48]. Regardless of the lower UV recorded by some plant species but they have an essential medicinal role for the treatment of different diseases[49]. As a result, presence of medicinal plants in both the sacred groves serves as a hub of rich ethnomedicinal treasure for the Karbi tribe.

Conclusion

Karbi community by and large utilized several medicinal plants for treatment of various health ailments. The study also revealed that relationship between the plants found in sacred groves and Karbi tribe is not limited to the taboos and beliefs but has become an essential part of their health security. People inhabited near the sacred groves collect and use different plant species for the treatment of their various health ailments as they have high pharmaceutical potential. Before collecting parts of the medicinal plants from the groves, they pray to deities and seek permission by offering betel leaf (*Piper betle* L.) and areca nut (*Areca catechu* L.). Different parts of the plant are used for preparation of herbal medicine among them leaves are the dominant

plant part used for preparation of herbal medicine, and oral application is common mode of administration of medicine.

Open boundaries without closed fencing indeed affect the protection of the groves. Conservation of sacred groves is essential as they are the remnants of forest, rich in plant diversity with medicinal and economic values, and culturally linked with ethnic communities. Hence, proper management of the sacred groves is required for the conservation of the medicinal plants occurred therein and also protection of socio-cultural and religious practices associated or intertwined with the indigenous knowledge of the ethnic community.

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