

Ethnobotany of medicinal trees from sacred groves of the Imphal valley, Manipur, India

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The expanding urban areas in the Imphal valley have put the fate of the sacred groves or “Umang Lai” managed by the Meitei ethnic group in an uncertain state. In the present field study, the indigenous oral knowledge of ethnomedicinal trees from 10 sacred groves in the valley was documented. In total, 35 ethnomedicinal trees from 29 genera and 20 families were reported. It was observed that the local healers have used the ethnomedicinal trees to treat 37 different ailments from 11 ailment categories. During the field visits, it was observed that most of the sacred groves required immediate intervention measures for restoration so that the biodiversity pockets are preserved and the socio-cultural linkages are safeguarded for future generations.

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Across the world, nature worship in several forms is practised by different indigenous groups¹. Among different modes, conservation of untouched forest devoted to a deity, also known as “sacred groves” is observed among different ethnic communities^{2,3}. With a total of 100,000 to 150,000, India has the maximum number of studied sacred groves^{4,5}.

In addition to the groves having strong connections with the culture and tradition, they serve as cornerstone of biodiversity conservation¹. Most of the sacred groves have abundant vegetation, hence upholding various life forms. In many cases, the groves have served as refuge habitats for different vulnerable, endangered and endemic species⁶. Today, numbers of sacred groves are a core house of diverse gene pool for many endemic and endangered species³.

Likewise, the ancestors of Meitei ethnic group in Manipur, northeast India have followed animism which focussed on the worship of forest botches called as “Umang Lai”⁷. Around 365 sacred groves are reported from the state, with 166 sites located in the Imphal valley⁸. The ethnic group worship “Umang Lai” by celebrating “Lai Haraoba”, the pleasing of the deity

residing in the groves. For ages, the sacred sites are an integral part of the Meitei culture and serve as centers for spirituality and heritage. Further, the groves protected by cultural association act as residence of diverse genetic pool and abode for rich biodiversity as the sacred sites are undisturbed. In addition, the sites harbour numerous ethnomedicinal plants and have supplied traditional medicine for generations⁹.

However, with the changing societal norms, urbanization and commercial pressures, most of the sacred groves do not enjoy their privilege of protection¹⁰⁻¹². The same phenomenon is observed in the constantly expanding urban parts of the Imphal valley. The urban portion of Imphal has seen an exponential rise of build up area (236.19%) between 1970 and 2015¹³. The population increased to 834,154 in 2011 from 67,717 in 1961¹⁴. Ultimately, the consequence of an expanding population and urban space is also observed in the form of disappearing sacred groves. Most of the sacred grove habitats in the region are on the brink of disappearing because of negligence from the communities managing the sacred sites⁹. At present, majority of the sacred groves are victims to human encroachment and are shrinking along with the disappearing biodiversity.

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Hence, preservation of the oral indigenous knowledge associated with the plant diversity found in the disappearing sacred groves has become a responsibility of the present generation. Therefore, a field study was designed to document the oral indigenous medicinal knowledge associated with the different trees found in 10 sacred groves of the Imphal valley. The documentation will help in the preservation of the oral tradition which used the trees to heal numerous ailments in the Meitei community. In addition, the study aimed to highlight the role of the sacred groves as refuge centres for the significant trees in the urban region.

Materials and Methods

Study area

Manipur is located in the northeast region of India (23°51' to 23°41' N latitude and 93°20' to 94°47' E longitude)¹⁵. The state is divided into two distinct geographical regions, the oval shaped central Imphal or Manipur valley and the surrounding hill ranges (Fig. 1). The valley covering an area of 2238 km² has an average elevation of 790 m above MSL. The region is influenced by sub tropical monsoon climate. The temperature ranges between 2° to 21° C in winter and 23° to 36°C in summer, respectively. The valley is home to Meitei and Meitei-Pangals sharing the majority of the population followed by Naga and Kuki-Chin groups. For the Meitei community, each and every khul or distinct locality is protected or guarded by an “Umang Lai” deity. Altogether, Khumbongmayum *et al.* reported 166 “Umang Lai”

sacred sites in the valley districts of the Imphal valley⁸. The Umang Lai habitats are sacred sites for the localities where biodiversity remains untouched and undisturbed.

Informants: the Meitei ethnic group

The Mongoloid ethnic group can be subdivided into seven clans or yek salai *viz.*, Khuman, Luwang, Ningthoujas, Khaba-Nganba, Chenglei, Angom, and Moirang and speak Manipuri or Meiteilon. Hinduism is the dominant religion of Meitei with 14% practicing Sanamahism (the native religion)¹⁵. Agriculture and various allied activities are the backbone of the state's economy with a major share of population being agriculturist or horticulturist. Today, majority of the population have migrated towards service and other private sector jobs owing to the change in the societal forms and development.

Plant collection and identification

Field survey was conducted in 10 sacred groves from the Imphal valley during 2021-23 (Table 1). For the field visits, approval was taken from the caretakers of the groves. The medicinal trees were photographed and representative specimens were collected during field visits. Later, the plants were identified by a local expert and using floras of North-East Indian states^{16,17}. The scientific names, families and authors were corrected following the online website, Plant List (<https://wfo.plantlist.org/>) of the Royal Botanic Garden, Kew and Missouri Botanical Garden¹⁸.



Fig. 1 — Map of (a) India, (b) Manipur, (c) Imphal valley and (d) the sacred groves from the valley, (Sources: Map of India and Manipur from d-maps.com; Imphal valley images from Google Earth Pro)

Table 1 — Sacred groves surveyed from the Imphal valley

Locality	Latitude	Longitude
Keishampat	24°47'59.65"N	93°56'5.01"E
Nagamapal	24°48'30.82"N	93°55'58.92"E
Thangmeiband	24°49'37.40"N	93°56'9.38"E
Khurai	24°49'28.23"N	93°57'40.91"E
Nongmeibung	24°48'13.53"N	93°57'19.66"E
Wangkhei	24°47'20.54"N	93°57'25.55"E
Konhoujam	24°46'1.85"N	93°51'11.03"E
Heingang	24°52'35.18"N	93°56'58.56"E
Andro	24°44'49.53"N	94° 2'38.93"E
Nambol	24°43'27.58"N	93°50'15.22"E

Ethnomedicinal data collection

The oral ethnomedicinal knowledge associated with the trees from the sacred groves was collected using semi-structured interviews with locals having in-depth knowledge of traditional healing practices *i.e.*, “maiba” or “maibi”. Since the authors belong to the same ethnic group, the interviews were carried out in Meiteilon. Altogether, 10 maiba / maibi were interviewed. One maiba / maibi each were selected from the localities where the sacred groves were located. The majority of the healers interacted during the study that practiced the traditional methods of treatments were males, with few exceptions of females with profound knowledge of the field. During the interview, information of the ethnomedicinal trees such as local name, diseases treated, plant parts used for treatment, preparation modes and administration routes were collected. Moreover, additional information associated with the medicinal trees *viz.* edible, fuel, fodder, witchcrafts and cultural relevance were also recorded.

Ailment categories

Based on data collected from the traditional healers during the survey, the ethnomedicinal trees were categorized following ICPC-2 (International Classification of Primary Care, version 2)¹⁹. As per ICPC-2, the reported ailments were grouped into 11 categories: General and unspecified (GEN-A), Digestive (DIG-D), Cardiovascular (CAR-K), Musculoskeletal (MUS-L), Neurological (NEU-N), Respiratory (RES-R), Skin (SKN-S), Endocrine/metabolic and nutritional (MET-T), Urological (URO-U), Pregnancy, Childbearing and family planning (WOM-W) and Female genital (FGE-X), respectively.

Data analysis

The results obtained during questionnaire survey were analyzed using the quantitative indices *viz.*,

Relative Frequency of Citation (RFC), Informant Consensus Factor (ICF) and Fidelity Level (FL).

Relative frequency of citation

It highlights the significance of the trees to the locals. It is calculated as described^{20,21}:

$$RFC = FC / N \quad \dots(1)$$

where, FC = total citation that is recorded without considering the use categories, and N = total number of maiba/maibi.

Informant consensus factor

It is generally used to confirm the homogeneity of the oral information collected from the healers on the use of the medicinal trees and the overall degree of agreement among them for the treatment of specific ailments category. It is represented as

$$ICF = N_{ur} - N_t / N_{ur} - 1 \quad \dots(2)$$

where, N_{ur} = number of the use reports for each category, and N_t = number of tree species used²².

The values range from 0 to 1. The higher ICF value (near to 1) showed a strong agreement among the healers for the utilization of a tree to treat a particular ailment category.

Fidelity level

It is an assessment of the preferability of a tree species for the treatment of an ailment category, and calculated as per the following formula^{23,24}:

$$FL (\%) = N_p / N \times 100 \quad \dots(3)$$

where, N_p = number of use reports for a given tree species to treat a particular ailment category and N = number of use reports for any given tree species. The higher values showed the broad recognition among the healers for the treatment of a particular ailment category.

Microsoft Excel 2010 was used for preparation of graphs, tabulation and map editing works. The pharmacological properties of the medicinal trees was collected from the online scientific databases such as Web of Science, Science Direct, Scopus, Google Scholar, Elsevier, Springer, Taylor and Francis, and Wiley etc. Further, Google Earth Pro was used for the preparation of the Imphal valley images.

Results and Discussion

Socio - demographic characteristics of the informants

During the study, most of the locals involved in the traditional healing practices were males. Thus, a great

disparity between male and female counterparts was observed in the inheritance of the traditional oral knowledge within the community. From the 10 locals participated in the questionnaire survey, 90% were men and 10% were female (Table 2). In the past, the healers were involved in agriculture. However, there is an occupational change observed in the society with the healers moving towards other forms of job sectors such as service sector, commercial, industrial or private ventures. Today, the importance of healers in society and their demand has reduced to the level that the profession is disappearing. The healers participated during the survey no longer practice traditional treatments practices as their main profession anymore, which is endangering the passage of knowledge and tradition. Further, the transfer of healing knowledge is also restrictive and information sharing is limited to nearby kins or relatives, which exacerbates the problem. Such phenomenon is quite common among other ethnic communities of the region^{25,26}.

Diversity of ethnomedicinal trees

In total, 35 ethnomedicinal trees from 29 genera and 20 families were reported from the 10 sacred groves (Table 3 & Fig. 2). Rutaceae, Moraceae, Anacardiaceae and Meliaceae were among the top ethno-medicinally significant tree families in the sacred groves. From the genera, the maximum number of species belongs to *Ficus* (4 species), and *Garcinia*, *Citrus* and *Zanthoxylum* (each with 2 species), respectively.

Table 2 — Demographic profile of local informants, N = 10

Characteristics	Number
Gender	
Male	9
Female	1
Religion	
Sanamahism	6
Hinduism	4
Ethnicity	
Meitei	10
Education level	
None	01
Primary Education	06
Secondary Education	03
Graduate Education	01
Age level	
40-50	02
50-60	01
60-70	02
> 70	05

Tree parts used

During the preparation of crude drugs, nine different tree parts were used (Fig. 3a). Fruits represent the most frequently used part (17 species), as it was easier in collection and their availability is more during their fruiting seasons. Further, fruit collection is a harmless method of harvest for the ethnomedicinal trees and is significant from conservation perspective²⁷.

Modes of preparation and administration

From the different modes of preparation, the majority of the crude drugs were prepared in the form of boiled juice (Fig. 3b). The healers recommend the intake of fresh fruit juice of *Rhus semialata*, *Spondias pinnata*, *Punica granatum*, *Psidium guajava* and *Phyllanthus emblica* etc. In total, nine ethnomedicinal trees showed two or more different preparation methods, which also reveal the versatile nature of the trees that were utilized by the healers to treat different ailments. For example, *Azadirachta indica* leaves are boiled and the juice is used for the treatment of skin irritation problems; and leaf paste is applied to treat boils etc. During the survey, oral intake was the most favored way of crude drug administration (44%) (Fig. 3c). During topical application, paste or boiled extracts of trees parts were pasted or applied on the surfaces for the treatment of ailments such as muscular sprain, skin problems, body ache, boils, ringworm and toothache etc. For example, *Garcinia pedunculata* fruits paste on the joints and left to heal. In addition, using the boiled juices of medicinal trees parts to take bath is also a common treatment practice. For example, *A. indica* leaves are boiled with water, which is used to take bath for the treatment of skin problems. Such incidences are quite common among different indigenous communities of Manipur^{25,28}. During the interviews, it was observed that the healers were confident of their preparation methods and the routes which have been utilized for administration of crude drugs for maximum efficacy. Such confidence in the trade comes from years of experience in the field. Similar observations are reported by different studies from different ethnicities of the region^{29,30}.

Traditional medicinal knowledge

For the 35 medicinal trees, 61 recommended uses and 175 use reports were documented (Table 3). In total, the trees were used for the treatment of 37 different ailments which are grouped into 11 categories. Among the trees, *Carica papaya*, *P.*

Table 3 — Ethnomedicinal association of trees from 10 sacred groves of the Imphal valley with Meitei ethnic group.

Scientific name, Family	Vernacular name (Meiteilon)	Use reports (UR)	Relative Frequency of Citation (RFC)	Parts used	Ethnomedicinal application		
					Ailment treated or other uses	Preparation / Formulation	Administration routes
ANACARDIACEAE							
<i>Mangifera indica</i> L.	Heinou	10	1.00	Fr	Constipation	Fresh	Oral
				Br	Dysentery	Fried	
<i>Rhus semialata</i> Murray	Heimang	14	1.40	Fr	Diarrhea, urinary complaints, stomach ulcer	Fresh juice	Oral
					Nourishing hair	Boiled juice	Topical, Massage
<i>Spondias pinnata</i> (L. f.) Kurz	Heining	4	0.40	Br, Lf	Dysentery	Fresh juice	Oral
					Muscular sprain	Paste	Topical, Massage
APOCYANACEAE							
<i>Nerium oleander</i> L.	Kabirei	1	0.10	Rt	Vaginal discharge	Boiled juice	Oral
BIXACEAE							
<i>Bixa orellana</i> L.	Ureiom	4	0.40	Fr	Skin diseases	Paste	Topical
BIGNIONACEAE							
<i>Oroxylum indicum</i> (L.) Kurz	Shamba	6	0.60	Fr	Throat problem and piles	Decoction	Oral
				Lf, Br	Epilepsy	Boiled juice	
					Muscular sprain	Paste	Topical
CANNABACEAE							
<i>Celtis australis</i> L.	Heikreng	4	0.40	Lf	Kidney stones, jaundice and dysentery	Boiled Juice	Oral
CARICACEAE							
<i>Carica papaya</i> L.	Awathabi	9	0.90	Lf	Dog bite	Paste	Topical
				Rt	Urinary problems	Boiled juice	Oral
CLUSIACEAE							
<i>Garcinia xanthochymus</i> Hook.f. ex T. Anderson.	Heiranggoi	1	0.10	Fr	Body ache	Paste	Topical
<i>Garcinia pedunculata</i> Roxb. ex Buch.-Ham.	Heibung	10	1.00	Fr	Muscular joints problem	Paste	Topical
COMBRETACEAE							
<i>Terminalia citrina</i> (Gaertn.) Roxb.	Manahei	2	0.20	Br, Fr	Skin ulcers	Paste	Topical
FABACEAE							
<i>Erythrina variegata</i> L.	Kurao angouba	7	0.70	St	Ward off evil	Dried	Tied
<i>Parkia speciosa</i> Hassk.	Yongchak	3	0.30	Fr, Br	Piles, diarrhoea, dysentery	Boiled juice	Oral
LAURACEAE							
<i>Cinnamomum tamala</i> (Buch.-Ham.) T. Nees & C.H. Eberm.	Tejbata	1	0.10	Lf	Scanty urination	Boiled juice	Oral
LYTHRACEAE							
<i>Punica granatum</i> L.	Kamphoi	9	0.90	Lf	Dysentery	Fried	Oral
				Fr	Urinary tract infection	Fresh juice	
MALVACEAE							
<i>Bombax ceiba</i> L.	Tera	2	0.20	Lf	Skin diseases	Paste	Topical

(Contd.)

Table 3 — Ethnomedicinal association of trees from 10 sacred groves of the Imphal valley with Meitei ethnic group. (*Contd.*)

Scientific name, Family	Vernacular name (Meiteilon)	Use reports (UR)	Relative Frequency of Citation (RFC)	Parts used	Ethnomedicinal application		
					Ailment treated or other uses	Preparation / Formulation	Administration routes
MELIACEAE							
<i>Azadirachta indica</i> A. Juss.	Neem	10	1.00	Lf, Br	Skin irritation	Boiled juice	Bath
				Lf	Boils	Paste	Topical
<i>Toona ciliata</i> M. Roem	Tairen	5	0.50	Br	Piles	Boiled juice	Bath
<i>Melia azedarach</i> L.	Sejrak	9	0.90	Lf, Fw, Sd, Br	Headache, and rheumatism	Boiled juice	Oral
				Lf	Skin diseases	Boiled juice	Topical
MORACEAE							
<i>Ficus benghalensis</i> L.	Khongnang bot	1	0.10	Br	Piles	Fresh juice	Oral
<i>Ficus racemosa</i> L.	Heibong	2	0.20	Rt, Fr, Lx	Dysentery, and skin irritation	Fresh juice	Oral
<i>Ficus hispida</i> L.f.	Asi heibong	1	0.10	Fr, Lf, Sd, Br	Ringworm	Paste	Topical
<i>Ficus religiosa</i> L.	Sana khongnang	1	0.10	Br	Boils	Fresh juice	Oral
MYRTACEAE							
<i>Psidium guajava</i> L.	Pungdon	10	1.00	T.Lf	Dysentery	Fresh juice	Oral
<i>Syzygium cumini</i> (L.) Skeels	Jam	1	0.10	Fr	Diabetes	Boiled juice	Oral
PHYLLANTHACEAE							
<i>Phyllanthus emblica</i> L.	Heikru	16	1.60	Fr	Jaundice Tonic Nourishing hair	Fresh Juice Fresh juice Boiled juice	Oral Oral Massage, Topical, Bath
PINACEAE							
<i>Pinus kesiya</i> Royle ex. Gordon	Uchan	2	0.20	St, Br	Blood purifier and during postpartum	Boiled juice	Oral
RUBIACEAE							
<i>Meyna spinosa</i> Roxb. ex Link	Heibi	1	0.10	Sd	Intestinal worm for children	Paste	Oral
RUTACEAE							
<i>Aegle marmelos</i> (L.) Correa.	Heiri Khagok	3	0.30	Fr	Boil	Paste	Topical
<i>Citrus maxima</i> (Burm.) Merr.	Nobab	10	1.00	Lf	Nourishing hair	Boiled juice	Massage, Topical, Bath
<i>Citrus latipes</i> Hook.f. & Thomson	Heiribob	1	0.10	Fr	Cold and Cough	Fresh juice	Oral
<i>Zanthoxylum acanthopodium</i> DC.	Mukthruhi	3	0.30	Lf, Fr	Mouth ulcer	Boiled juice	Gargling
				Fr	Toothache, bad breath	Fresh	Oral
<i>Zanthoxylum rhetsa</i> (Roxb.) DC	Ngang	1	0.10	Sd, Br	Toothache	Paste	Topical
SALICACEAE							
<i>Flacourtia jangomas</i> (Lour.) Raeusch.	Heitroi	2	0.20	Fr	Toothache and bleeding gum	Paste	Topical
<i>Xylosma longifolia</i> Clos	Nongleishang	10	1.00	Lf	Skin diseases	Boiled juice	Bath

Notes: T.Lf – Tender leaf; Lf - Leaves; St - Stem; Lx – Latex; Br - Bark; Fw – Flower; Fr - Fruits; Sd – Seeds; Rt - Roots.



Fig. 2 — Examples of ethnomedicinal trees viz., (a) *Phyllanthus emblica*, (b) *Ficus* sp., (c) *Garcinia pedunculata*, (d) *Spondias pinnata*, (e) *Citrus latipes*, (f) *Zanthoxylum acanthopodium*, and (g) *Meyna spinosa* from the sacred groves

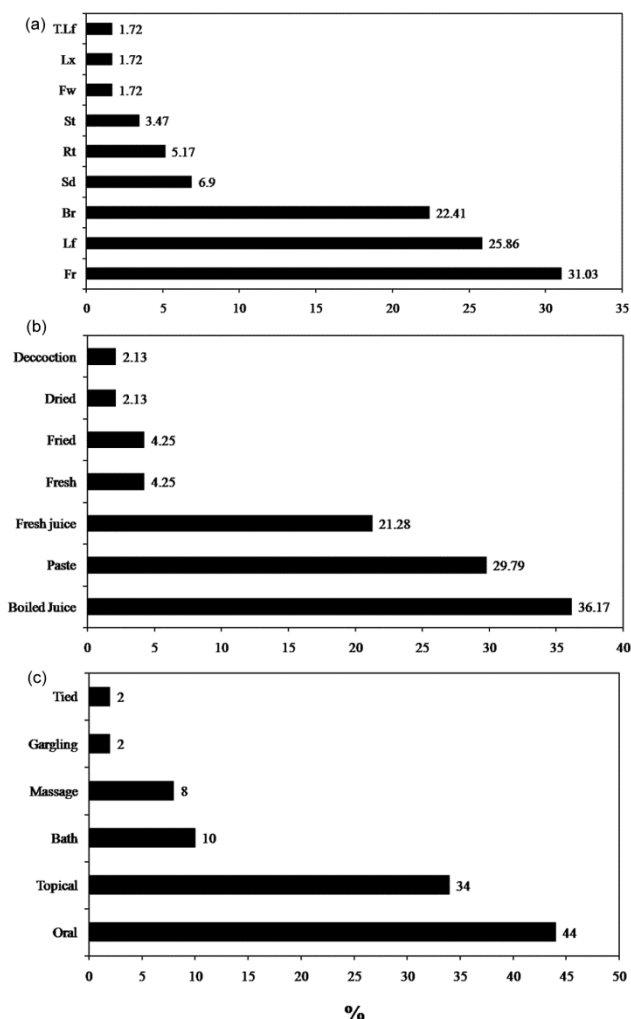


Fig. 3 — Percentage distribution of (a) plant parts used; (b) mode of preparation; and (c) route of administration

granatum, *G. pedunculata*, *Melia azedarach*, *P. emblica*, *A. indica*, *Citrus maxima*, *Erythrina variegata*, *R. semialata*, *Mangifera indica*, *P. guajava*, and *Xylosma longifolia* were commonly mentioned. In total, 21 tree species were used to treat various digestive problems. Moreover, the prevalence of dermatological infections in the community is also supported by the healers mentioning 12 tree species commonly utilized to treat various skin diseases. A total of 16 medicinal trees were found to have versatile healing properties which can treat more than one ailment. For example, *R. semialata* for diarrhea, urinary complaints, stomach ulcer and as hair nourisher; *O. indicum* for throat problem, piles, epilepsy and muscular sprain; *Zanthoxylum acanthopodium* for mouth ulcer, toothache and bad breath etc. Moreover, fruits of *R. semialata* and *P. emblica*, and leaves of *C. maxima* were commonly harvested from sacred groves and utilised for preparation of the traditional shampoo called “Chenghi”. In addition, healers will recommend the use of *E. variegata* dried barks or piece of branch to be kept inside “jantra” and tied on the body. Similar mentions of healers using plants to treat ailment through witchcrafts is mentioned in different ethnic groups of the region, viz., Zeliangrong²⁹, Thangal Naga²⁵, and Zeliang²⁶ etc. However, the disease categories such as Respiratory; Endocrine, Metabolic and Nutritional; Pregnancy, Childbirth and Family Planning; and Female genital system and breast, represents the least mentioned with only one tree species each reported.

Relative Frequency of Citation

Phyllanthus emblica (1.60), *R. semialata* (1.40), *A. indica* (1.00), *C. maxima* (1.00), *G. pedunculata* (1.00), *M. indica* (1.00), *P. guajava* (1.00), and *X. longifolia* (1.00) showed the highest RFC values (Table 3). It showed that the trees are the most frequently used medicinal species. On the other hand, species such as *Zanthoxylum rhetsa*, *C. latipes*, *Meyna spinosa*, *Syzygium cumini*, *Ficus religiosa*, *Ficus hispida*, *Ficus benghalensis*, *Cinnamomum tamala*, *Garcinia xanthochymus* and *Nerium oleander* are least cited, with rare usage by healers. The observed results showed lack of information sharing within healers with respect to the use of the specific tree species during the treatment of ailments. The healers maintain a rule of strict secrecy, and hence information passage is restricted and limited. At the end, most of the oral medicinal knowledge never reaches the common population³¹.

Informant consensus factor

The values ranged from 0.00 to 0.88 (Table 4). It was found that the ICF values for six categories were less than 0.50, which indicate a low level of consensus on information sharing. In addition to their secretive nature, the healers participated in the survey belong to different localities and hence, their interactions is unlikely. The highest ICF (0.88) was observed for General and Unspecified ailment category with 42 use reports for 6 tree species. The

high value is attributed to use of various fruits from the medicinal trees as ingredient for “chenghi”, which is known to all. Skin, musculoskeletal, circulatory and digestive ailment categories have ICF values of 0.76, 0.73, 0.67 and 0.58, respectively. The prevalence of common cases of skin problems, skin ulcer, skin irritation, boils and ring worm etc in the society corresponds with the high use reports of 47 for skin ailment category. Moreover, the involvement of locals in various physical and labour jobs is accompanied with the problems such as muscular sprain, body ache, muscular joints problem and rheumatism. Further, lifestyle choices, unhygienic water and food, pollution and bad hygiene also lead to a number of digestive ailments. Some notable medicinal trees with high use reports include boiled leaf juice of *X. longifolia* for skin diseases; boiled leaf juice of *C. maxima* for nourishing hair; fruit paste of *G. pedunculata* for muscular joints problem etc.

Fidelity level

Table 5 showed the FL of commonly used medicinal trees with the ailments. *Bixa orellana*, *G. pedunculata*, *E. variegata*, *Toona ciliata*, *P. guajava*, *C. maxima* and *X. longifolia* etc showed the maximum value of 100%. The high value showed that healers have preferred the same species for treatment of same ailment, which shows the high healing potential, as for example, *B. orellana* for skin diseases; *G. pedunculata* for muscular joints problems; *T. ciliata*

Table 4 — Number of trees in treatment of 11 category of ailments and its ICF values

Sl. No	ICPC categories*	Recorded Ailments / Diseases	No. of species (N _t)	No. of use reports (N _{ur})	ICF values
1.	General and Unspecified	Tonic, blood purifier, ward off evil, nourishing hair	6	42	0.88
2.	Digestive	Constipation, dysentery, diarrhea, stomach ulcer, throat problem, jaundice, intestinal worm, mouth ulcer, toothache, bad breath, bleeding gum	21	49	0.58
3.	Circulatory	Piles	3	7	0.67
4.	Musculoskeletal	Muscular sprain, body ache, muscular joints problem, rheumatism	5	16	0.73
5.	Neurological	Epilepsy, headache	2	2	0.00
6.	Respiratory	Cough, cold	1	1	0.00
7.	Skin	Skin problems, skin ulcer, skin irritation, dog bite, boils, ring worm	12	47	0.76
8.	Endocrine, Metabolic and Nutritional	Diabetes	1	1	0.00
9.	Urology	Urinary problems, kidney stones, scanty urination, urinary tract infection	5	8	0.43
10.	Pregnancy, Childbirth and Family Planning	Post partum complications	1	1	0.00
11.	Female genital system and breast	Vaginal discharge	1	1	0.00

* Following Staub *et al.*³².

for piles and *X. longifolia* for skin diseases etc. Hence, the findings help identify generally favoured tree species by healers, which can be used for further investigation and analysis for the discovery of allelopathic drugs.

Comparison between traditional knowledge and pharmacological properties of the medicinal trees

A cross-checks of 10 medicinal tree species from the sacred groves showed that the indigenous medicinal knowledge aligns with recognized pharmacological properties (Table 6). For example, Devi and Singh³³ in their review reported antibacterial, antiviral, antidiarrheal, antioxidant, anticaries, anticholesterol and antidabetic activities of *R. semialata*. It correlates with the traditional

application of the tree used to treat diarrhea and stomach ulcer. Dinda et al.³⁴ mentioned the antimicrobial, anti-inflammatory, anti-arthritic, anticancer, anti-ulcer, hepatoprotective, antidiabetic, antidiarrheal and antioxidant activities of *Oroxylum indicum*. In the present study, the medicinal tree is used for the treatment of throat problem, piles, epilepsy and muscular sprain. Similarly, Alzohairy³⁵ reported the antimicrobial, anti-inflammatory and wound healing effects of *A. indica*, which gives the properties for the treatment of skin irritation and boils. The presence of azadirachtin, quercetin and polyphenolic flavonoids gives the antibacterial and antifungal characters. The antihyperglycemic, hypolipemiant, anti-inflammatory, cardioprotective, and antioxidant properties of *S. cumini* was mentioned by Chagas et al.³⁶, which correlates with the usage of fruit extracts for the treatment of diabetes. The extract rich in various kinds of flavonoids helps in lowering the blood glucose levels. Hence, it is safe to conclude that most of the pharmacological findings favour the traditional indigenous knowledge of local healers. Moreover, use of the tree species such as *C. papaya* for dog bite; *G. pedunculata* for muscular joints problems; *P. granatum* for dysentery; *A. indica* for skin irritation; *P. guajava* for dysentery; *X. longifolia* for skin problems are extensively carried out by locals without the references of healers. It shows the common usage of the knowledge repetitively by locals for treating diseases and their experience over

Table 5 — Fidelity level of some important trees used for treating ailments

Scientific name	Ailments treated	Np	N	FL (%)
<i>Bixa orellana</i>	Skin diseases	4	4	100
<i>Garcinia pedunculata</i>	Muscular joints	10	10	100
<i>Erythrina variegata</i>	Ward off evil	7	7	100
<i>Toona ciliata</i>	Piles	5	5	100
<i>Psidium guajava</i>	Dysentery	10	10	100
<i>Citrus maxima</i>	Nourishing hair	10	10	100
<i>Xylosma longifolia</i>	Skin diseases	10	10	100
<i>Punica granatum</i>	Dysentery	8	9	88.89
<i>Azadirachta indica</i>	Skin irritation	8	10	80.00
<i>Melia azedarach</i>	Skin diseases	7	9	77.78
<i>Rhus semialata</i>	Nourishing hair	10	14	71.43

Table 6 — Pharmacological properties of the medicinal trees reported by various scientific studies

Species	Ethnobotanical knowledge	Pharmacological properties	Local knowledge in sync with the pharmacological properties	Reference
<i>Rhus semialata</i>	Diarrhea, urinary complaints, stomach ulcer, nourishing hair	Antibacterial, antiviral, antidiarrheal, antioxidant	Yes	[33]
<i>Oroxylum indicum</i>	Throat problem and piles, epilepsy, muscular sprain	Anti-Inflammatory and analgesic, antimicrobial, gastroprotective effect, antioxidant, anti-arthritic, antiulcer	Yes	[34]
<i>Azadirachta indica</i>	Skin irritation, boils	Wound Healing Effect, Antimicrobial, Anti-Inflammatory	Yes	[35]
<i>Syzygium cumini</i>	Diabetes	Antihyperglycemic, hypolipemiant, anti-inflammatory, cardioprotective, and antioxidant	Yes	[36]
<i>Spondias pinnata</i>	Dysentery, muscular sprain	Antimicrobial, antiarthritic activity	Yes	[37]
<i>Garcinia xanthochymus</i>	Body ache	Antidiabetic, antioxidant, nerve growth factor (NGF) potentiating activity, anti-inflammatory	Yes	[38]
<i>Garcinia pedunculata</i>	Muscular joints problem	Antioxidant, anti-inflammatory	Yes	[39]
<i>Toona ciliata</i>	Piles	Antioxidant, Anti-inflammatory	Yes	[40]
<i>Ficus religiosa</i>	Boils	Antibacterial, antioxidant, wound healing effect	Yes	[41]
<i>Xylosma longifolia</i>	Skin diseases	Antifungal and Anti-dermatophytic, Antioxidant, antibacterial	Yes	[42]

generations. Further, it highlights the efficacy of the medicinal tree species in the treatment of mentioned ailments within the local community.

Conservation of sacred groves: an issue

A pattern of cultural shift is already observed in Meitei society of the Imphal valley. Today, the ethnomedicinal knowledge used for treatment of various ailments is considered as an outdated idea amongst younger generation. Therefore, the practices are disappearing and the information wealth got restricted to few individuals within the ethnic group. During the interview, the healers clearly mentioned that sacred groves used to have centuries old trees which usually take 3 or 4 fully grown humans stretching their arms in circle to cover the entire girth of these spirited trees. Nowadays, it is becoming hard to find such aged trees that have lasted 100s of years in the urban region of Imphal. Today, the sacred groves which harbour rich biodiversity for centuries are no longer immune from human degradation, with most of the sites in the Imphal valley being partly threatened (58%) or threatened (31%)⁸. Hence, the concept of sacred groves or “Umang Lai” preservation as biodiversity conservation centres is a diluted concept. Along with the sacred groves, the associated tree species are disappearing from the Imphal valley, one tree at a time. Even though, most of the trees in the groves belong to the “Least Concern” category of the IUCN Red List, their protection is necessary to maintain the spirit of sacred groves as abodes of the deities and to safeguard the habitats of the different life forms that depend on the forest patches in this urbanized part of the Imphal valley. Therefore, community driven conservation initiatives, effective implementation of available legal mechanisms and introduction of local policies, capability building of locals and different approaches to sensitize the common mass on the topic must be taken up by the concerned authorities.

Conclusion

Even though, the sacred groves have provided safe refuge to the ethnomedicinal trees in the culturally protected spaces and guarantees their survival for generations, at the moment the groves are disappearing. Hence, the oral traditional ethnomedicinal knowledge associated with the trees and the habitats of the trees are in danger. Therefore, it is timely that the oral knowledge is documented and preserved; the lost vigour of the sacred groves as habitats of biodiversity are restored and the spirit of conservation is revived in the Imphal valley of Manipur, India.

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Conflict of Interest

All authors have read the manuscript and there is no conflict of interest.

Author Contribution

KRD and YBD performed the field survey (equal contribution); MDM designed and supervised the work; MDM, KRD and YBD analysed the data and drafted the manuscript; MDM, KRD, YBD, HK, LN, NDD and SGD were involved in editing and revising the manuscript. All authors have read the manuscript.

Ethic Statement

Prior approval was taken from the caretakers of the groves to conduct the ethnobotanical survey.

Prior Informed Consent

The informants were informed about the nature and purpose of the work. All the informants involved in the study have agreed to be a part of the research and their consent for participation was obtained. Further, they have agreed to the results published as research findings.

Data Availability

All data generated or analysed during this study are included in this published article.

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