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Medicinal plants used in traditional bone setting by the Khasi tribe of Meghalaya, India

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Abstract

Meghalaya is one of the 8 states of Northeastern India; it is known for its scenic beauty, unique culture, vibrant traditions and rich bio-diversity. Traditional bone setting is a field of study that focuses on ancient methods of treating bone fractures and joint dislocations, often practiced by traditional healers. This ancient art of healing fractures and musculoskeletal injuries has been passed down through generations, blending indigenous knowledge with practical experience. Conservation initiatives should also encourage the local communities to ensure sustainable practices that benefit both nature and people. The purpose of this study was to identify, document and preserve knowledge about the medicinal plants used in traditional bone settings by the Khasi tribe of Meghalaya. The data for the ethnobotanical study were collected by interviewing the traditional bone setters through a pre-structured questionnaire. Through extensive field surveys and interviews with 115 traditional bone setters, a total of 85 medicinal plant species (belonging to 44 families) were recorded. The Zingiberaceae family contributed the most species with 11 species, followed by Asteraceae with 7 plant species and Urticaceae with 6 species, Acanthaceae, Fabaceae, Rubiaceae, Amaranthaceae and Plantiginaceae with 3 species each, while other species were represented by 2 and 1 species. More scientific investigation is required to validate the folk claims/medicine and further research and validation of these practices could lead to the development of alternative or complementary therapies for bone-related ailments.

Keywords

ethnobotany; Khasi tribe; medicinal plants; traditional bone setting

Introduction

The traditional healing system in India is one of the oldest in the country; traditional bone setters are one of the largest groups practicing traditional medicine (1). Traditional bone setting (TBS) holds immense significance not just as a medical practice but also as a cultural heritage and a symbol of community resilience. In some rural places where modern healthcare facilities may not always be ready and accessible, it plays a vital role in providing immediate and effective care to those in need. Practitioners of this art believe in blending the body and mind and their treatments reflect this holistic understanding. The knowledge and skills associated with bone setting are often passed down within families or through apprenticeships, strengthening familial and communal bonds (2, 3). It is said to be more affordable than modern medical treatments, making it accessible to the wider population,

particularly those from lower-income backgrounds, and the other reasons why people still opt to visit TBS are because of fear of plaster cast or bandages, extended immobilization and the possibility of amputation (4, 5). Closely tied to the effectiveness of traditional bone setting is the use of natural remedies and techniques. Many traditional healers rely on herbal medicines, poultices, massages, and manipulations to facilitate healing (6). The traditional healing practices of indigenous communities often hold profound insights into the intricate relationship between humans and nature. Among these communities, the Khasi tribe in Meghalaya, India, stands out for its rich tradition of using medicinal plants in bone-setting techniques.

The Khasi tribe, indigenous to the Northeastern region of India, has long relied on their traditional medicine system to address various health concerns, particularly bone-related ailments and injuries. Their approach to healing is deeply rooted in the surrounding natural environment, where a diverse array of medicinal plants serves as the backbone of their traditional healthcare (7). Sacred forests located in Mawphlang also play a significant role in sourcing these medicinal plants, emphasizing the holistic approach of Khasi traditional medicine that considers not just physical ailments but also spiritual and emotional well -being(8). Beyond their healing efficacy, the conservation implications of using medicinal plants in traditional practices are also noteworthy. The sustainable harvesting and preservation of these plants are intertwined with the cultural heritage and biodiversity conservation efforts in Meghalaya, as highlighted by studies (9, 10). In light of these aspects, it is also to provide a comprehensive understanding of the TBS techniques of the Khasi tribe and the pivotal role played by medicinal plants in sustaining their indigenous healthcare system intertwined with the cultural heritage and biodiversity conservation efforts in Meghalaya (11, 12). Ethnobotanical studies conducted in Meghalaya have documented the extensive use of medicinal plants by the Khasi tribe. These studies reveal the profound knowledge and expertise of Khasi healers in identifying, preparing, and administering medicinal remedies derived from local flora. Moreover, the utilization of medicinal plants in traditional healing practices is not merely a matter of convenience but a reflection of the deep cultural and spiritual connections that the Khasi people have with their environment and healthcare systems (13–16).

This article aims to document the traditional bone-setting practices along with the diversity of medicinal plants that are used in the practices by the Khasi traditional healers. This study will also help to integrate valuable insight from traditional medicine into modern healthcare practices, potentially leading to the development of new treatments or therapies derived from natural sources. This will also highlight the diversity of medicinal plants commonly used by the healer. This information may serve as a baseline source for further study in the field of ethnobotany and pharmacognosy.

Materials and Methods

Study area

Meghalaya is one of the 8 states of Northeast India, situated between 25°47'–26°10' N latitude and 89°45'–92°47' E longitude, covering an area of 22720 km^2 (17). The surveyed district, surveyed village and area, along with the geographical coordinates are mentioned in (Table 1) and (Fig. 1).

Examination and selection of the study site

The verbal and written informed consents were obtained from all the informants who were participating during the study periods in both English and the local language, i.e., Khasi. One of the researchers is from Meghalaya. Therefore, the interview was conducted smoothly. The study area for the field survey was selected based on the information priorly gathered from the community leaders and the number of TBS present in the area.

Table 1. Shows the surveyed district area along with villages and geo-coordinate

Sl . No.	Surveyed district	Surveyed village/area	Geographical coordinates
1	West Khasi Hills	Siejlieh	25°32'09"N 91°14'53"E
		Riangdo	25°40'33"N 91°03'58"E
		Rambrai	25°38'55"N 91°19'25"E
		Maweit	25°26'17"N 91°04'30"E
		Seinduli	25°39'20"N 91°08'56"E
		Pyndengrei	25°31'41"N 91°15'44"E
		Nongstoin	25°31'05"N 91°15'54"E
		Mawphansyiar	25°36'19"N 91°16'00"E
2	South-West Khasi Hills	Mawkyrwat	25°22'05"N 91°27'43"E
		Ngunraw	25°17'51"N 91°19'20"E
		Keniong	25°17'43"N 91°22'00"E
		Ranikor	25°13'20"N 91°14'26"E
		Jakrem	25°23'23"N 91°30'30"E
3	Eastern-West Khasi Hills	Mairang	25°33'43"N 91°37'57"E
		Kynrud	25°42'21"N 91°30'29"E
		Nongkhlaw	25°41'13"N 91°38'13"E
		Nongsohma	25°41'58"N 91°30'01"E
		Kynshi	25°31'27"N 91°32'24"E
4	East Khasi Hills	Mawlai-Maiong	25°37'37"N 91°53'15"E
		Mawsynram	25°17'44"N 91°34'52"E
		Mawlyngbna	25°13'45"N 91°33'45"E
		Thynroit	25°29'31"N 91°58'12"E
		Mawmluh	25°15'28"N 91°42'21"E
		Sohra	25°16'17"N 91°43'47"E
5	Ri-Bhoi	Pahamsyiem	25°54'07"N 91°52'33"E
		Umsning	25°43'44"N 91°53'14"E
		Bhoirymbong	25°42'31"N 92°01'13"E
		Umlimg	25°57'57"N 91°51'26"E
		Umroi	25°43'04"N 91°58'51"E
		Sumer	25°41'38"N 91°54'20"E

Selection of the informant

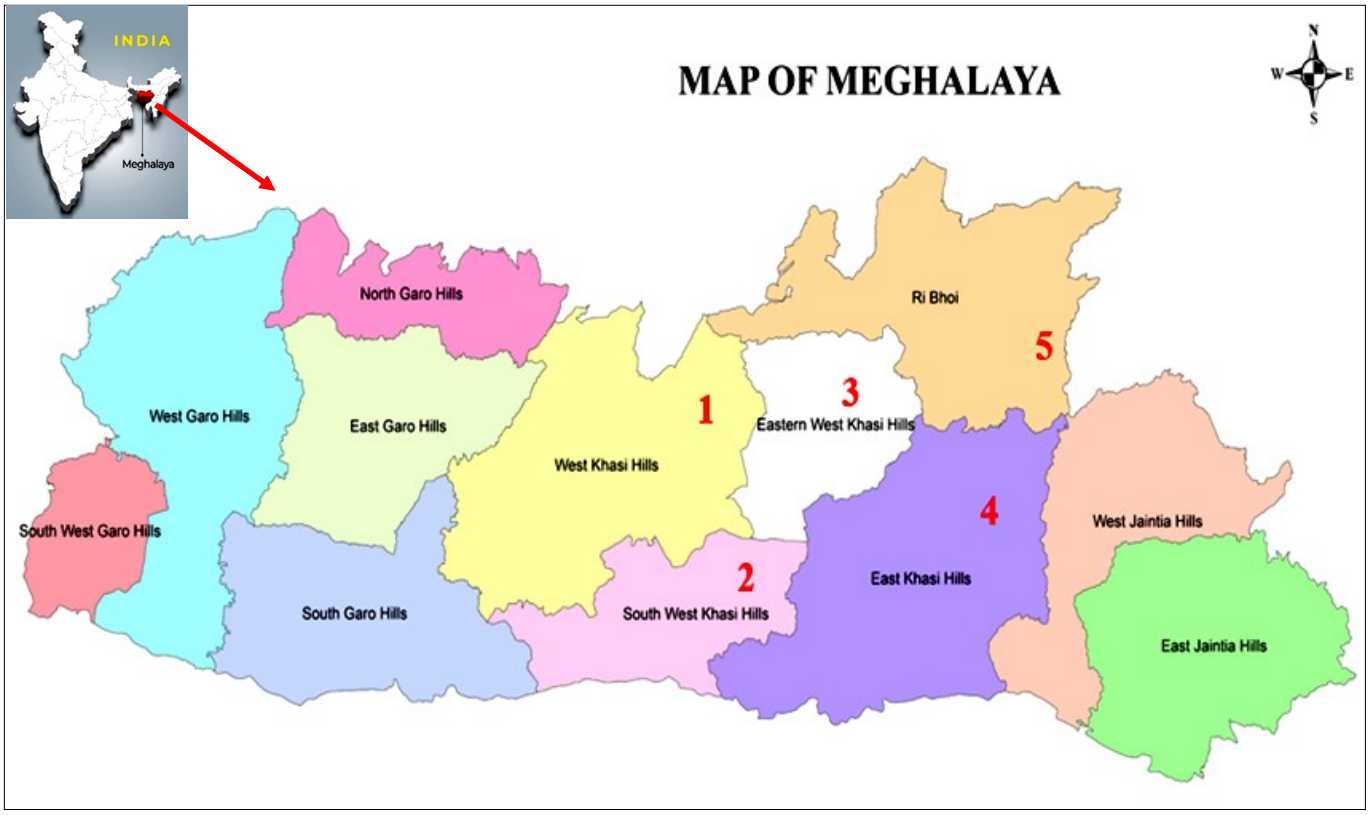

Fig. 1. Map of Meghalaya showing the study area

The informants were identified with the help of village headmen and the leaders of Khasi traditional healers. One hundred and fifteen TBS (83 males and 32 females) were selected as the key informants to determine the status of medicinal plant use in the bone setting technique by the Khasi tribe.

Data collection

The data was gathered through an extensive field survey from March 2023–March 2024 in different villages from 5 districts of Meghalaya, as mentioned in Table 1. The information regarding the utility of medicinal plants in traditional bone settings was collected through discussions and interviews with the traditional healers of the Khasi tribe using an ICF and questionnaire prepared beforehand in both English and local language (Khasi). The answer was recorded in written forms and pictures. The pre-structured questionnaire contains the names of traditional healers, local names of plants, plant parts used, methods of preparation, dose, mode of administration, source of collection, dietary restriction, number of patients treated per year and source of knowledge asked of the informants (18).

Taxonomic identification of plant specimens

The collected specimens were identified by consulting relevant literature (19–22), and the names have been updated using World Flora Online (23). Herbarium specimens were prepared following standard methods of plant taxonomy (24) and stored in the Raw Drug and Herbarium (NEIAFMRH) of North Eastern Institute of Ayurveda & Folk Medicine Research (NEIAFMR), located in the Pasighat, Arunachal Pradesh.

Data analysis

The collected data was reviewed and organized using MS Excel sheet. The relative frequency citations (RFCs) and fidelity level (FL) were also investigated in the plant species that were recorded for bone setting (25, 26).

Relative frequency of citation (RFC)

The relative frequency of citation (RFC) is a quantitative ethnobotanical index that is used to determine the importance of a particular plant species based on how frequently informants mentioned it. It is calculated by using the following formula (25):

$$RFC = FCs/ N \quad \text{.....(Eqn. 1)}$$

Where, FC is the number of informants who mentioned a particular plant species. N is the total number of informants interviewed. The value of RFC ranges from 0–1.

Fidelity level percentage (FL%)

The fidelity level percentage (FL%) is a measure used in ethnobotanical research work to determine the relative importance of a certain plant species used by informants to treat a particular ailment. FL% is calculated by using the following formula (26):

$$FL\ (\%) = (Np\ /N) \times 100 \quad \text{.....(Eqn. 2)}$$

Where Np= number of informants who claimed the use of a certain particular plant species for a particular ailment and N= total number of informants who mentioned the plant species for other ailments.

Results and Discussion

Demographic details of the informants

In the present study, a total of 115 traditional bone setters were identified, out of which 95 of them obtained their healing skills through familial inheritance and 20 of them learned the healing skills through self-interest. The majority of traditional bone setters come from rural areas and they have very good knowledge about the use of medicinal herbs to cure bone-related problems like fractures, dislocation, etc. Among the 115 traditional bone setters, 72.17% are male and 27.83% are female. The age group of 51–60 years has the highest number of traditional bone setters with a percentage of 29.56%, followed by the age group of 41–50 years with 26.08%, 61–70 years with 17.39%, 31–40 years with 12.17%, age below 30 years 8.69% and age above 70 years with the percentage of 6.08%. By profession, out of the total 115 traditional bone setters, 65 of them (56.52%) are full-time traditional bone setters, 36 of them (31.30%) are farmers, 8 are daily wagers or laborers (6.95%), 5 of them are part-time traditional healer (4.34%) and one among them is a student (0.86%). When it comes to the source of knowledge, 95 (82.60%) of the traditional bone setters got this knowledge passed down to them from generations like grandfather, grandmother, uncle, etc. and 20 (17.40%) have the knowledge of bone setting through self-interest and practices (Table 2).

Diversity of medicinal plants

In this present study, a total of 85 medicinal plants belonging to 44 families were recorded as being used in the management of traditional bone-setting practices (Supplementary Table 1). The Zingiberaceae family is the dominant family, which contributed 11 species, followed by Asteraceae with 7 species, Urticaceae with 6 species, Acanthaceae, Fabaceae, Rubiaceae, Amaranthaceae and Plantiginaceae with 3 species each, while other families were represented by 2 and 1 species. This study is similar to other findings, where they also reported Zingiberaceae as the dominant family commonly used in TBS practices (27). This study significantly enhances our understanding of traditional bone-setting practices and the use of medicinal plants by the Khasi tribe in Meghalaya. By identifying 85 medicinal plants across 44 families, it serves as a valuable resource for ethnobotanical research, showcasing the region's rich biodiversity and traditional knowledge. Moreover, emphasizing the use of locally sourced medicinal plants can foster sustainable practices in the cultivation and preparation of herbal medicine. This research may inspire local communities to adopt sustainable harvesting methods, ultimately aiding in the conservation of plant species and their natural habitats.

Table 2. Demographic data of traditional healers

Sl. No.	Variable	Categories	No. of persons	Percentage
1	Gender	Male	83	72.17%
		Female	32	27.83%
2	Age group	Below 30 years	10	8.69%
		31-40 years	14	12.17%
		41-50 years	30	26.08%
		51-60 years	34	29.56%
		61-70 years	20	17.39%
		Above 70 years	7	6.08%
3	Profession	Traditional healer	65	56.52%
		Farmer	36	31.30%
		Labour	8	6.95%
		Part time traditional healer	5	4.34%
		Student	1	0.86%
4	Source of knowledge	Family inheritance	95	82.60%
		Self interest	20	17.40%

Habit and plant parts used in traditional bone setting

After examining the diversity of the habits of the medicinal plants used in traditional bone settings, it is found that the herbs (52) had the highest usage, at 61.17%, followed by trees (13) at 15.29%, shrubs (17) at 20% and ferns (3) at 3.52%. This report is also similar to other findings of another study (28) (Fig. 2).

Most of the plant's parts used are its leaves (36), followed by the whole plant (17), rhizomes/tubers/bulbs (16), roots (9), barks (7), stems (6), seeds and fruits (4) (Fig. 3).

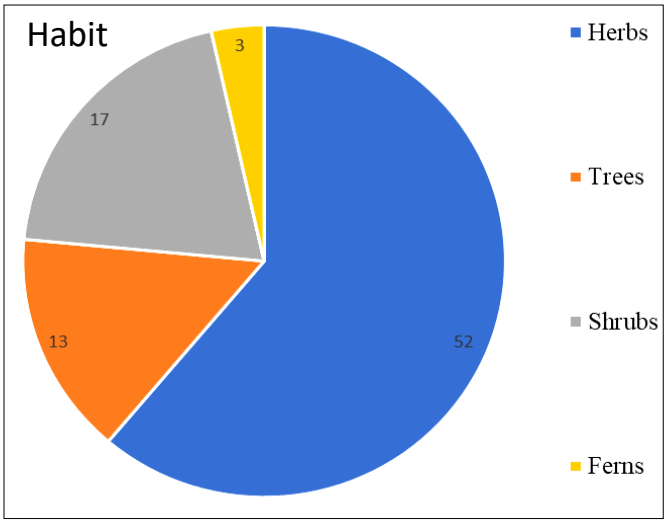

Fig. 2. Showing the habit of the plant used in bone setting

Others finding

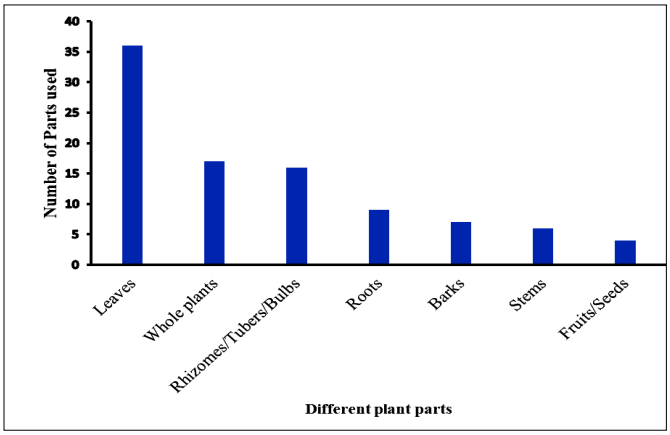

Fig. 3. A bar graph showing the parts of the plant used in bone setting practices

During the field survey, it was reported that mostly the traditional healers give external applications rather than internal medication, except in some cases like internal bleeding and unbearable pain. The paste used in external applications is mostly prepared by multiple combinations of plant species. Some leaves, like *Musa accuminata, Piper betle* and *Phrynium pubinerve* are used not only for medicinal purposes but also in the form of bandages. Sheaths of *Bambusa arundinacea, Areca catechu* and *M. accuminata* are used for splint purposes by the TBS practitioners. It was noted that the dosage for patients receiving internal medication is determined by taking into account their age and symptoms. Additionally, food restrictions like sour food, spicy food, fermented food, etc. and food recommendations like milk, meat, soup and green leafy vegetables like cabbage, broccoli, etc. are given to the patients during their course of treatment. The finding is also similar to the findings of another study, where they reported similar types of food recommendations (29) (Fig. 4 & 5).

Quantitative analysis

The relative frequency citation (RFC) ranging from 0.03 to 0.98 was calculated and reported (Supplementary Table 1). Among the plant species, *Bambusa bambos* (L.) Voss had the highest RFC value (0.98), followed by *Musa acuminata* Colla (0.97), *Allium sativum* L. (0.89), *Allium cepa* L (0.88), *Curcuma longa* L. (0.88), *Ageratina adenophora* (Spreng.) R.M.King & H.Rob. (0.87) and *Zingiber officinale* Roscoe (0.84). In Meghalaya, *B. bambos*, being the most prevalent plant, is widely used for its application in the treatment of traditional bone setting practices. Plant species with high RFC values can be further investigated to explore their potential in the treatment of bone setting.

Fidelity level (FL) is an index that indicates the importance of a plant species in traditional utilization. The fidelity level of all the reported species was calculated and presented (Supplementary Table 1). Among the plant species, *B. bambos*, *C. longa*, *M. acuminata*, *Phrynium pubinerve* Blume, *Piper nigrum* L. *Z. officinale* and *Zingiber zerumbet* (L.) Sm. represent the plant species with a 100% fidelity level, followed by *Drimia indica* (Roxb.) Jessop and *Piper betle* L. (98.26%), *A. cepa* and *Rubia cordifolia* L. (97.39%), *A. sativum* (96.52%), *Ageratum conyzoides* L., *Hibiscus rosa-sinensis* L. (95.65%), *Ricinus communis* L. (95.56%) and other plant species showed the least fidelity level.

Limitations

Although this study identified 115 traditional bone setters, this sample may not comprehensively represent all practitioners throughout Meghalaya. Variations in practices and knowledge likely exist across different regions and communities, which could affect the findings. Moreover, the

Fig. 4. A & **B)** Medicinal paste used in bone setting practices. **C**) Storage of medicines **D**) During interaction with traditional bone setter

Fig. 5. Different types of splints and bandaging

preparation methods, dosages and applications of the medicinal plants used by traditional healers can differ significantly, leading to potential inconsistencies in treatment effectiveness. Additionally, the therapeutic claims related to the identified medicinal plants have not been scientifically validated within the scope of this research. To address these limitations, further investigations are necessary to systematically assess the pharmacological properties and efficacy of the medicinal plants employed in traditional bone setting practices.

Conclusion

Traditional bone setting practices and folk medicine serve as an alternative system of medicine that efficiently manages the burden in the state of Meghalaya. It contributes to the local economy by providing employment and opportunities for traditional healers as well as supporting those who use herbal medicine cultivation and preparation. This economic aspect is particularly significant in rural areas where alternative sources of income are limited. In the current study, researchers discovered that the Khasi tribe continues to rely significantly on ethnomedicine for treating bone settings and 85 herbal species belonging to 44 families were identified based on their practical experience. According to previous research, plant species such as *Bambusa bambos* (L.) Voss, *Curcuma longa* L., *Zingiber officinale* Roscoe and *Ricinus communis* L. have pharmacological properties such as anti-inflammatory, analgesic, anti-arthritic, anti-bacterial and anti-rheumatism. These pharmacological effects have proven to be useful in treating bone-related diseases. The availability of allopathic drugs and industrialization have contributed to a progressive decline in the popularity of traditional healing methods and knowledge, particularly among younger people. Detailed studies on the aspect of TBS practices have yet to be carried out. Present work will provide baseline information for future work and more scientific research is needed to validate traditional claims/medicine used by the Khasi tribe for the treatment of bone settings.

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Authors' contributions

LH and RA drafted the manuscript and carried out the fieldwork. DT, IR, AB and RT participated in its design and coordination. IM supervised and reviewed the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The author declares no conflicts of interest.

Ethical issues: None

Supplementary data

Supplementary Table 1. Enumeration of medicinal plants used in Traditional Bone Setting

Questionnaire "On Documentation and Validation of Traditional Bone Setters (TBS) Practitioners of Khasi Tribe of Meghalaya."

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