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SHORT REVIEW

# Traditional Healing of Bone Fracture Complications Through Wild Plants in Hamirpur, India

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## Abstract

Wild plants have a medicinal sense that can be applied to treat different ailments of the human body worldwide. They have been assessed for pharmacological, pharmaceutical, nutritional and ecological significance. In the present work, an effort has been made to conduct an ethnobotanical survey in the Hamirpur district, Himachal Pradesh from 2012 to 2019. Key informants were identified in the preliminary study and information was collected by conducting semi-structured and open interviews. The focus was primarily on the wild plant the residents used to treat bones and related complications for ages. The local people employed 23 main ethnomedicinal plant species belonging to 15 families for the same purpose. The Citation Frequency (CF) and Medicinal Importance Value (MIV) of wild plants were evaluated. It varied from 0.68 to 10.63 and 1.16 to 42.2, respectively. The highest CF was observed for *Cissus quadrangularis* (10.63) and lowest for *Peristrophe bicalyculata* (0.68), whereas the highest (42.12) MIV was calculated for *Cissus quadrangularis* and lowest (1.16) for *Cleome viscosa*. The present study found that *Cissus quadrangularis*, *Tinospora cordifolia*, *Celastrus paniculata*, *Litsea glutinosa*, *Cuscuta reflexa*, *Soymida febrifuga* and *Osyris arborea* are traditionally important ethno-medicinal plants for the treatment of bone problems, such as hematoma formation, inflammation and repair.

**Keywords:** Bone Fracture, Citations, Ethnomedicine, Informants, Survey

## 1. Introduction

Despite the marvellous progress in the modern medical system, most of the population relies upon traditional herbal medicine to meet primary health care needs in tribal or remote areas of developing as well as developed countries of the world. It is not false that people's attention has dropped continuously in the past years towards the Ayurvedic system in urban and rural areas globally. However, the work of scientists has increased again due to increased side effects of modern medicine and increasing infectious diseases around the world, i.e., COVID-19[1,2,3]. Herbal medicines are reasonably preferred due to their effectiveness, low cost and fewer side effects. These alternative therapies can effectively reduce swelling, pain, soreness of fracture and speedy recovery.

The use of medicinal plants to treat bone fracture complications has a long history in traditional medicine systems across various cultures. While modern medical practices often rely on surgical intervention and pharmaceuticals, many herbal remedies continue to be explored for their potential to aid in fracture

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healing and alleviate associated symptoms. Medicinal plants used for bone fractures have been an old-age practice in India[4]. Plants associated with the healing of bone fracture are mentioned in the Sushruta Samhita (500BC) which described traction, manipulation and immobilisation by splitting and using a particular type of clay and also in the time of Hippocrates (400-300C)[5]. The healing properties of certain herbs in Rigveda seem to be the oldest original record of using plants in medicine and surgery. The present study is confined to bone fractures, traditional herbal practitioners and local informants offering treatment for bone fractures and related complications in the study sites. Bone fracture healing is a complex process of cell and tissue proliferation and differentiation, i.e., hematoma formation, inflammation, repair and remodelling.

Traditional use of natural products can be developed as a potential therapy by phytochemical constituents reducing the healing period of bone fracture[6]. It was observed during the survey that a layman (an old informant) is also aware of the remote area to tackle the bone fracture cases and the application of plants found nearby. Only a handful of references are available which have attempted to study and understand the use of plants to treat bone fractures. Various medicinal plants are often incorporated into Ayurvedic formulations, such as oils, powders, decoctions, and tablets, which are prescribed by qualified Ayurvedic practitioners based on individual constitutions and the specific nature of the fracture.

The utilisation of traditional herbal medicine for primary healthcare, income generation, and enhancing livelihoods is widespread across both developing and developed nations. Various factors fuel this popularity, including perceived effectiveness, affordability, and fewer associated side effects than conventional pharmaceuticals. Through systematic documentation of these traditional practices, this study contributes to preserving valuable knowledge that might be lost over time. It is estimated that approximately 70-80% of the population relies on these practices for primary healthcare generating income and improving livelihoods through medicinal plants[7,8,9]. The annual sales of herbal medicine amounted to $110.2 billion in 2020 with projections indicating a growth to $178.4 billion by 2026. The market for ayurvedic medicines is experiencing an annual increase of around 20%[10]. Hence, the main aim of this study was to investigate the utilisation of medicinal plants for treating bone fractures and other related complications within local communities. It sought to explore the traditional knowledge held by these communities regarding the use of medicinal plants including their application methods and the specific plant parts employed. The study aimed to assess the MIV, plant CF and other relevant parameters to better understand the significance of these plants in traditional bone healthcare practices. In essence, the research aimed to comprehensively document and analyse the traditional knowledge surrounding the medicinal use of plants for bone-related ailments, providing insights into their efficacy and usage patterns within the local context.

## 2. Materials and Methods

### 2.1 Data Collection

An ethnobotanical survey was conducted in different localities of Hamirpur district in Himachal Pradesh. The plant specimens were collected mainly in the flowering and fruiting stage. The plant specimens collected were preserved in the form of herbarium. Intensive ethnobotanical exploration was undertaken in selected places in Hamirpur district to find various medicinal plants used for bone fracture problems and other complications. The effectiveness of wild plants depends upon the plant part used for curing specific diseases and phenological events of plants. A questionnaire approach was utilised to document ethnobotanical knowledge with around 430 informants (25% of those approached) selected randomly and contributing insights on bone fracture treatments. Key informants were identified initially and information was gathered through semi-structured and open interviews. Informants were chosen irrespective of gender, education, or occupation, based on their availability and willingness to share knowledge with a focus on knowledgeable elders and traditional healers in the tehsils. Plant identities were confirmed through repeated informant consultations and group discussions. Uncommon or unidentified plants were brought to the herbaria of Punjab University Chandigarh for identification, and plants related to bone complications were authenticated using standard

floras and voucher specimens from the university's herbarium. Photographs of plants were taken for future reference. Each plant species was documented with information including botanical name, local name, part used, preparation method, administration mode, number of informant citations, CF and MIV. The informants were asked for the plant parts used in the herbal formulation which constitute stem bark, leaves, roots, Whole Plants (WP) and Whole Aeriel Plant (WAP).

These details were tabulated (Table 1), highlighting plants directly employed in treating bone fractures, strengthening bones, relieving pain, reducing inflammation and aiding in speedy recovery.

## 2.2 Citation Frequency (CF)

FC represents the use of reports or citations made by the informant for a specific species which also indicates the importance and common availability of the plant. It was calculated as follows:

$$FC(\%) = NCs/TNc \times 100 \quad \text{Eqn 1}$$

Here, NCs are the number of use reports cited for a given species for a particular ailment and the total number of use reports cited for any given species. If

**Table 1.** Medicinal uses of wild and cultivated plants for the treatment of bone fracture and related complications: Use Reports (UR), Citations Frequency (CF), and Medicinal Importance Value (MIV).

| Name of Plant Species | Common Name | Family | Part Used | UR | CF | MIV |
|---|---|---|---|---|---|---|
| *Celastrus paniculata* Willd. | *Sankhiru* | Celestraceae | Leaf, Seed, Bark | 117 | 9.95 | 36.17 |
| *Cassia fistula* L. | *Amaltas/Ali* | Fabaceae | WP | 38 | 3.23 | 5.87 |
| *Celtis australis* Linn. | *Khidak* | Ulmaceae | Bark, Leaf | 29 | 2.47 | 8.96 |
| *Cissus quadrangularis* Linn. | *Hadjor* | Vitaceae | WP | 125 | 9.27 | 42.12 |
| *Cleome viscosa* Linn. | *Hulhul* | Capparaceae | WP | 15 | 1.28 | 1.16 |
| *Cuscuta reflexa* Roxb. | *Amarbel/ Akashbel* | Cuscutaceae | WAP | 105 | 8.93 | 16.23 |
| *Dalberia sissoo* Roxb. | *Shisham/Tahli* | Fabaceae | Leaf, Bark | 23 | 1.96 | 5.33 |
| *Dioscorea bulbifera* Linn. | *Jangli Aloo* | Dioscoraceae | Tuber | 13 | 1.11 | 2.01 |
| *Dodonea viscosa* Linn Jacq. | *Mendru* | Sapindaceae | Leaf, Bark | 71 | 6.04 | 16.46 |
| *Ficus religosa* Linn. | *Pipal* | Moraceae | Leaf, Bark, Root | 40 | 3.40 | 6.18 |
| *Ficus semicordata* Buch-Ham. Ex Sm. | *Khain* | Moraceae | Fruit | 27 | 2.30 | 8.35 |
| *Flacourtia indica* (Burm. F.) Merr. | *Kangu* | Flacourtiaceae | Bark, Fruit | 67 | 5.70 | 15.53 |
| *Leea macrophylla* Roxb. ex Hornem. | *Hastikand* | Leeaceae | Root | 13 | 1.11 | 2.01 |
| *Litsea glutinosa* (Lour.) C.B. Rob. | *Rihaan* | Lauraceae | Bark | 121 | 10.29 | 28.05 |
| *Osyris arborea* Wall. Ex A. Dc. | *Kaila* | | Bark, Leaf | 71 | 6.04 | 27.43 |
| *Peristrophe bicalyculata* (Retz.) Nees | | Acanthaceae | WP | 8 | 0.68 | 1.24 |
| *Ricinus communis* Linn. | *Arandi* | Euphorbiaceae | Seed | 65 | 5.53 | 10.05 |
| *Soymida febrifuga* (Roxb.) A. Juss. | *Rohan* | Meliaceae | Bark | 75 | 6.38 | 23.18 |
| *Stellaria media* (L.) Vill. | *Makhni* | Caryophyllaceae | WAP | 16 | 1.36 | 2.47 |
| *Terminalia arjuna* (Roxb.ex Dc.) Wight and Arn. | *Arjun* | Combretaceae | Bark | 26 | 2.21 | 8.04 |
| *Tinospora cordifolia* (Wild.) Hook.f.and Thomson. | *Giloy/Gulanj* | Menispermaceae | Stem Leaf | 118 | 10.03 | 27.36 |
| *Vanda roxburghii* Br. | *Vanda* | Orchidaceae | leaf | 37 | 3.15 | 8.58 |
| *Vitex negundo* | *Bana* | Verbenaceae | Leaf, Root, Bark Fruit, Flower | 90 | 7.65 | 27.82 |

the CF value is higher for a plant, it means that all use reports refer to a significant way of using it. However, if the values are low, then that plant might be uncommon for ailments[11].

### 2.3 Medicinal Importance Value (MIV)

MIV was used to calculate the relative importance of the species locally as follows:

$$MIVis = ((MUVis \times NCis))/((TNC)) \times 100 \quad \text{Eqn 2}$$

Where MUV is the number of uses of ith species, NC is the total number of citations of the species and TNC is the total number of citations of all species. The medicinal importance of each species depends upon the uses of the plants cited by the informants and the total citations quoted by all informants of the same species. If the MIV is higher, it means that people commonly or frequently use the plant to treat ailments[7].

## 3. Results and Discussions

Out of 1720 informants surveyed across 274 villages, comprising 1069 males and 651 females, approximately 25% provided information on plants for treating bone fractures. Notably, fewer female informants were observed than male informants and similar observations were reported by another study[12]. The average age of informants ranged from 20 to 90 years with most being elderly individuals possessing extensive knowledge of plant usage for food and medicine. Knowledge transfer occurs through generations within families and communities, often in herbal traditions or to interested individuals as disciples. As per the informants, learning practice for treating bone fractures usually begins at 15-18 years old.

In the present study, the average citations of medicinal plants per informant were more than five, which indicates good knowledge about medicinal plants. Further, it was observed that the informant used bamboo sticks to support and fix fractured bone after applying herbal preparations. However, modern practices involving X-ray reports are emerging, particularly among younger generations who show less interest in traditional practices which might cause the diminishing of such knowledge[11,13].

The study identified 23 plant species belonging to 21 families (as listed in Table 1). The Fabaceae and Moraceae families had the highest representation, each with two species. Trees contributed to 44% of herbal drugs followed by herbs (22%), shrubs (17%) and climbers (17%) indicating a rich diversity of wild plants in the area. Stem bark (30%) was the most commonly used plant part for medicine preparations followed by leaves (24%), roots (11%), whole plants (11%), WAP) (5%), fruits (8%) and seeds (3%) (Figure 1). Multiple plant parts were sometimes used to prepare medicines, particularly in pastes and decoctions to reduce inflammation and pain.

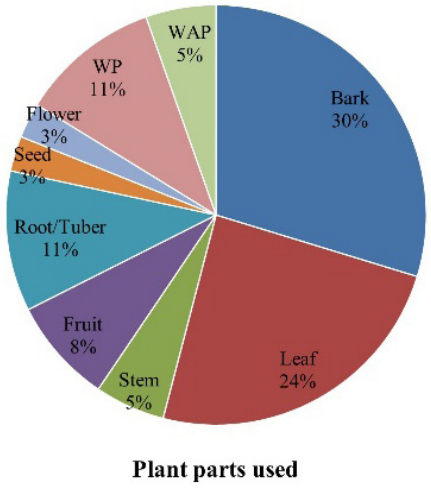


**Figure 1.** Contribution of plant parts in the preparation of medicine.

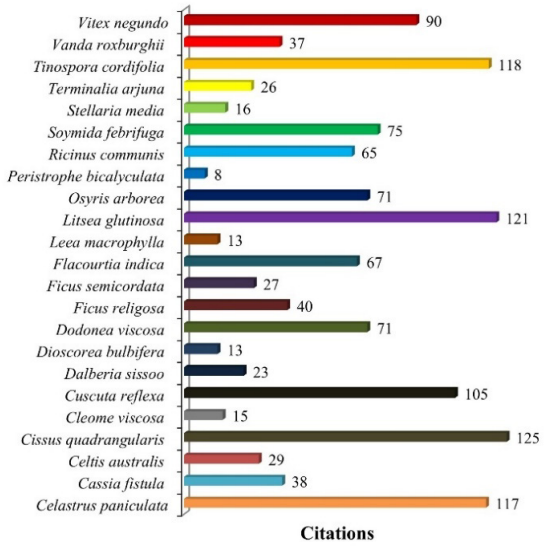


**Figure 2.** Use reports (citation) made by informants for bone fracture in the study.

### 3.1 Mode of Application and Administration

The administration methods included both oral ingestion and external application. All preparations were externally applied in pastes and poultices on the affected areas of the body. Before application, any broken or dislocated bones were carefully set back into their correct positions. Subsequently, a medicinal paste was applied to the affected area and secured with bamboo sticks tied using a rope. Reapplication of the paste was typically done every 12-15 days depending on the severity of the fracture. The duration of the bandage varied from 30 to 75 days. For dislocated bones or broken ligaments, a paste and decoction of one or more plants mixed with black salt and alum were applied daily, both in the morning and evening. This regimen aimed to provide support and aid in the healing process of the affected area.

### 3.2 Citation and Citation Frequency

In the present study, documented plant species used by the local community and practitioners to treat bone fractures have been mentioned (Table 1). Based on Citations and CF/ FC, *Cissus quadrangularis* (125, 10.63) has the highest value, followed by *Litsea glutinosa* (121, 10.23), *Tinospora cordifolia* (118, 10.03), *Celastrus paniculata* (117, 9.93), *Cuscuta reflexa* (105, 8.93 ), *Soymida febrifuga* (75,6.4), *Osyris arborea* (71, 6.04), *Dodonea viscose* (71, 5.0), *Flacourtia indica* (67, 5.7), *Ricinus communis* (60, 5.53), *Ficus religosa* (40, 3.4), *Vanda roxburghii* (38,3.2), *Cassia fistula* (38, 3.2) and least cited plants are *Leea microphylla* (13,1.11), *Dioscorea bulbifera* (13, 1.10) and *Peristrophe bicalyculata* (8, 0.68) (Figure 2 and 3). The plant species cited least by the informants does not mean it has less medicinal value. However, it may be due to other reasons, such as the unavailability of the plants in the area and the disappearance of knowledge. More species have been added to the list of plants used for the treatment of bone fracture during this study.

Some species are used to reduce pain and inflammation strengthen and speed up recovery. The external application was for pain relief and reducing inflammation whereas oral administration was preferred for strengthening and speedy recovery. Juice and decoction were prepared normally with water or oil and an oil cake of Sarson (Mustard) or Arandi (Castor bean) was made. Sometimes for making poultices gummy bark extract was used to keep it wet for longer.

### 3.3 Medicinal Importance Value

Several plant species were documented in the present study. *Cissus quadrangulari* has the highest MIV(42.12), which is in conformity with other studies[1,3,4] and is followed by *Celastrus paniculata* Willd (36.17), *Litsea glutinosa* (28. 05), *Vitex negundo* (27.82), *Osyris arborea* Wall. Ex A.Dc. (27.43), *Tinospora cordifolia* (27.36)[7], *Soymida febrifuga* (23.18), *Dodonea viscosa* (16.46), *Cuscuta reflexa* (16.23), *Flacourtia indica* (15.53)[11], *Ricinus communis* (10.05) and *Ficus religosa* (6.18) are used in bone fractures as an anti-inflammatory[6,14], *Vanda roxburghii* (8.58) for wound healing and

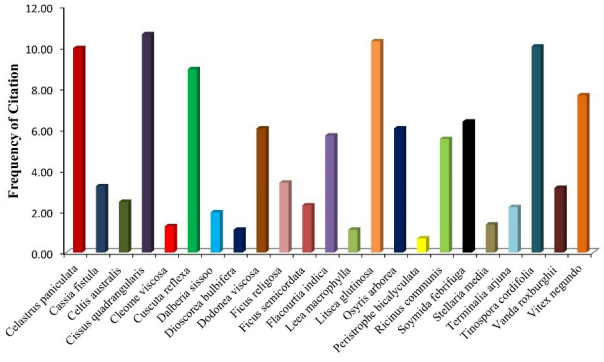


**Figure 3.** Species-wise citation frequency (CF) for the treatment of bone complications.

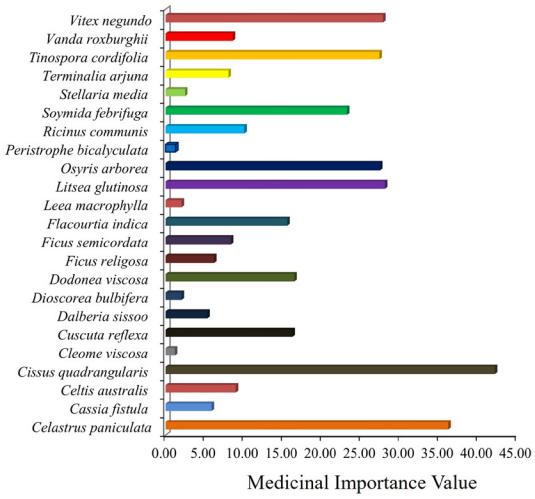


**Figure 4.** Medicinal importance value of various plant species for treating bone fractures and complications.

reducing inflammation[10], *Cassia fistula* (5.87)[15-17]. The MIV of various species has been mentioned in Figure 4.

## 4. Conclusions

Traditional knowledge regarding medicinal plants and their uses is often transferred through oral presentation and there is a risk of this knowledge diminishing as modern practices and lifestyles take precedence. The research seeks to foster mutual understanding and collaboration between traditional practitioners and the scientific community by disseminating its findings. Additionally, it aims to lay the groundwork for further exploration in the field by identifying avenues for in-depth pharmacological investigations, clinical trials and formulation development based on traditional wisdom. Overall, the research endeavours to document, analyse and validate traditional practices related to using medicinal plants in bone fracture treatment, ultimately contributing to developing novel therapies while preserving traditional knowledge. By scientifically investigating the conventional claims and practices surrounding using plants for bone fracture treatment, the study offers an opportunity to identify active compounds and potential therapeutic agents. These discoveries can serve as a basis for further drug development efforts, creating new treatment options for bone fractures. Corresponding knowledge regarding herbal medicine is often deeply rooted in specific cultures and communities. The research facilitates cross-cultural understanding and promotes collaboration between traditional healers, scientists, and healthcare professionals by sharing findings and insights from different regions. Further, the study underscores the medicinal significance of plants found in Hamirpur, such as *Cissus quadrangularis*, *Tinospora cordifolia*, *Celastrus paniculata*, *Litsea glutinosa*, *Cuscuta reflexa*, *Soymida febrifuga* and *Osyris arborea* in addressing bone-related issues, including hematoma formation, inflammation, repair and remodelling.

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