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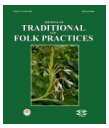

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The ethnopharmacological role of *Ulmus wallichiana* Planch., in osteogenesis: Insights from Indian traditional medicine

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Abstract

The Indian Himalayan region has exceptional floral diversity with profound therapeutic value. In this region, indigenous communities and local Vaidhyas still depend upon a natural, plant-based healing system deeply rooted in their cultural practices. This traditional approach includes preventive measures and treatments for various ailments and is achieved through intricate knowledge of medicinal plants. One of the treasures of medicinal heritage is *Ulmus wallichiana* Planch. which is locally known as *Chamarmou*. It is widely used as a medication for bone fractures in both humans and animals. The study aims to document and authenticate the traditional preparation methodology of the remedy *Chamarmou* and to emphasize the urgent need for preserving this knowledge as traditional healers decline in number across the region. It focuses on intergenerational transmission of traditional medicinal practices, dealing the formulation, ingredients, and methods of use to safeguard this unique cultural and medicinal heritage of the Indian Himalayan Region. *Chamarmou*, prepared from tree bark through six steps to form a paste, is widely used for treating bone fracture in humans and animals. This research contributes traditional healing knowledge and offers insights into indigenous healthcare practices that have long supported local communities.

Keywords: Bone fracture, Ethnobotany, Folk medicine, Kumaun Himalaya, Osteogenesis

1. Introduction

Bone fracture healing is a complex physiological process involving tissue regeneration, bone remodelling and restoration of mechanical strength. Since ancient times, traditional systems of medicine have developed diverse methods for managing fractures and dislocations. The classical text *Shushruta Samhita* provides one of the earliest detailed descriptions of orthopaedic treatment, including techniques such as traction, manipulation, and immobilization using splints (Shastri, 2002). These ancient approaches demonstrate a deep understanding of anatomical principles and mechanical stability essential for bone repair.

Ethnopharmacological studies have highlighted the role of various plants in strengthening bone health and *Ulmus wallichiana* Planch., is no exception (Ratnam and Raju, 2008; Upadhya *et al*., 2012; Singh, 2017). *U. wallichiana* is a traditionally important and vulnerable plant species in western Himalaya that is used for the treatment of fractured bones in animals and humans (Nazima *et al.,* 2014; Fragnière *et al*., 2021). *U. wallichiana* (Himalayan Elm) belongs to the Ulmaceae family and is found in Himalayan regions from Afghanistan to West Nepal. In India, it is found in the Kumaun and Garhwal hills of Uttarakhand (India), locally known as *Chamarmou* (Jain, 1991; Bora, 2016).

U. wallichiana is used as a traditional medicine for rapid fracture repair in India (Swarnkar *et al*., 2011, Aslam *et al*., 2024). Locally, bark paste of plants is used for treating bone fractures, whereas leaves are used as fodder for cattle. *U. wallichana* is found in temperate and lower temperate forest areas at altitudes ranging from 800 - 3000 m, and the tree grows to 30 m in height, with a broad crown having greyish brown bark at the trunk and longitudinally furrowed (Nazima *et al.,* 2014).

U. wallichiana has a variety of chemical compounds with different medicinal properties due to the presence of a novel flavanol [2S, 3S- Aromadendrin-6-C-ß-D-glucopyranoside (AG)] isolated from the extract of *U. wallichiana* which has potent osteogenic, anti-osteoclastogenic and antiadipogenic effects (Swarnkar *et al*., 2011). Chemical analysis of *U. wallichiana* stem bark resulted in isolation and identification of three new compounds (2S,3S)-(+)-3',4',5,7 tetrahydroxy dihydroflavonol-6-C-b-D glucopyranoside, (2S, 3S)-(+)-4',5, trihydroxyhydroflavonol-6-C-b-Dglucopyrano side and 3-C-7 β-D-glucopyranoside-2,4,6 trihydroxy ymethylbenzoate, together with five known flavonoid-6 -C glucosides which significantly increase osteoblast differentiation (Rawat *et al*., 2009) a bone anabolic function that is desirable for osteoporosis therapy (Khosla *et al*., 2008).

Awareness of the medicinal properties of the surrounding flora has played a crucial role in the development of numerous traditional therapies. However, owing to a lack of scientific investigation and general awareness, many traditional knowledge systems have gradually disappeared over time (Sharma *et al*., 2014). Even when the medicinal properties of a plant are known, information on its formulation and proper application for specific illnesses remains largely undocumented for many medicinal plants. Hence, in light of these concerns, the present study aims to first time document the traditional knowledge associated with the preparation of herbal remedy from *U. wallichiana* bark for bone fracture healing and to determine the awareness status of the medicinal properties of these plant species.

2. Materials and methods

The study was carried out in Simrar village, Ramgarh block, and Atal Utkrisht Government Inter College (AUGIC) Dhokaney, Nainital District in Uttarakhand (India) at N 29^0 30' 36.5" and E 79^0 34' 33.3" (Fig. 1).

The methodology adopted for this study focused on purely traditional knowledge, where our documentation was based on household interviews, informal discussions and observations. A questionnaire was prepared to collect the data; however, thorough group

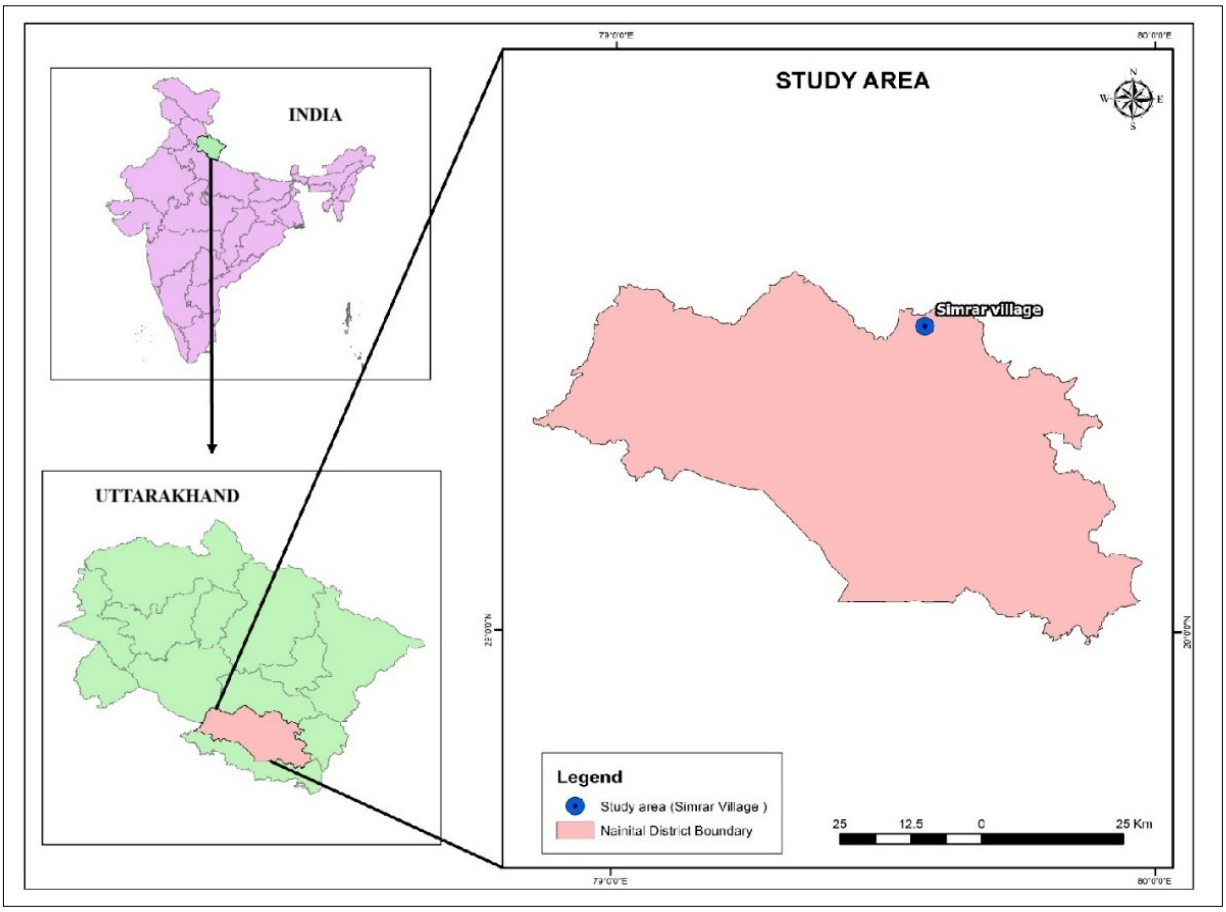

Fig. 1. Study area *(source- Survey of India)*

discussion and personal interviews among different age groups were also conducted to gather the information by surveying nearby schools and *toks* (small groups of houses that are under the Gram Sabha) in the study area. Field survey was conducted from August - October 2024. The questionnaire survey was conducted in two different groups of the study area which included the (1) Students of AUGIC, Dhokaney, Nainital and (2) villagers of different age groups from Simrar village of Ramgarh block, Nainital District. The AUGIC is situated 1000 m from Simrar village. The study area has an average elevation of 1,228 m (4,028 ft) above mean sea level. In the AUGIC 40 students were surveyed and out of 40 students, 13 respondents were girls, and 27 respondents were boys ranging from 16-17 years of age. In Simrar village, the total population is 74, of which 43 individuals are males and 31 are females. Among the 74 individuals, 43 (58.10%) were interviewed to gather information about the traditional uses of *U. wallichiana.* The age groups of the study area were as follows: 47 (0-20 years), 26 (21-40 years), 22 (41-60 years), 17 (61-80 years) and 2(<80 years).

3. Results and discussion

In AUGIC only 3 out of 40 students had minimal knowledge about the plant but excluded its use, implying lack of knowledge deficiency among the youth and a disinterest in acquiring knowledge of traditional medicinal practices, which was also observed in several earlier studies (Upadhya *et al*., 2012; Ndou *et al*., 2023).

Among all informants in Simrar village, males were considered the key informants; this knowledge inadequacy among women about traditional medicinal practices was also observed from various regions earlier (Upadhya *et al*., 2012; Bhat *et al*., 2019; Panghal *et al*., 2010), which contrasts with observations from other regions where both genders had equal knowledge (Kropi *et al*., 2024) and places where rural women had substantial information on traditional medicines (Uniyal and Shiva, 2005).

3.1. Recipe of the herbal remedy (Fig. 2)

Step one: Remove the bark of *U. wallichiana* carefully with a sharp knife.

Step two: After the removal of the bark (500 gm) from the tree, the bark is thrashed with the help of a hammer until it becomes sticky.

Step three: The thrashed bark is then transferred in an iron container, it is mixed with cow urine (2 litres, older cow urine is more effective) boiled at 100^0 C, and reduced to half.

Step four: Once the solution comes to a boil, ash (100 gm) is added to the solution, followed by the addition of green needles (100 gm) of Chir-pine (*Pinus roxburghii* Sarg).

Step five: After Ash and green needles of Chir-pine are added to the solution, it boils until it changes into a thread-like texture and the solution is now ready to be applied on a wound.

Step six: After the solution cools off, apply it directly to the affected area and tightly binded with cotton cloth. According to the local people of the village it exerts a great effect after 30-45 days.

Fig. 2. Stepwise recipe of the herbal remedy

3.2. Application of medicine (*Chamarmou*)

After the paste is formed, it is applied on the wound followed by wrapping a cotton cloth and supporting the fractured bone with a pencil sized flexible stick of *Debregeasia salicifolia* (D.Don) Rendle*,* locally known as *Tushiyari*, as its wood is flexible and not rigid compared to the other trees found in the study area. Its use varies depending upon the locality and availability.

Then it is kept as it is for 15-20 days, then the fractured bone is checked if it has healed or not, if it is not healed then the same process is repeated for another 15 -20 days until the fractured bone is healed.

In the case of inflammation, a cotton cloth is soaked in the *Chamarmou* paste solution and then applied to the affected part of the body, which is also called hot fomentation, where heat is used to relieve pain and promote healing. In some cases of inflammation, the *Chamarmou* paste is applied on the inflamed body part and then wrapped with a cloth, until the inflammation is healed the affected part is daily reapplied with the paste, after washing the area. The recipe of this formulation was also reported in 2011 by Arya *et al.* (2011) but it was with incomplete constituents and no mention of using the stick of *Debregeasia salicifolia* (D.Don) to support the fractured bone and to treat the inflammation caused (in some cases) after the treatment. The current formulation is much detailed and has no chances of making an error while preparation.

U. wallichiana is crucial for treating fractured bones and has potential osteogenic properties (Nazima *et al*., 2014). Its stem-bark enhances osteoblast activity while inhibiting osteoclast and adipocyte differentiation due to the presence of a (2S, 3S)-Aromadendrin -6-C-β-D-glucopyranoside (AG), a novel flavanol that helps in healing bones (Arya *et al.,* 2011) also 6-C-β-D- glucopyranosyl -(2S,3S)-(+)-5,7,3′,4′- tetrahydroxydihydroflavonol (GTDF) found in *U. wallichiana* protects against glucocorticoid induced bone loss by promoting osteoblast survival when administered in-vivo some in-vivo studies also conclude that Total Ethanolic Extract (TEE) and Butanolic Fraction (BF) in *U. wallichiana* effectively promote peak bone achievement making it safe to use for treating menstrual osteoporosis as it is devoid of any harmful uterine effects (Khan *et al.,* 2013; Sharan *et al.,* 2010) and the plant is used in some villages of the Almora and Bageshwar districts of Uttarakhand for treating bone fractures in humans and animals (Arya *et al.,* 2011). *U. wallicihiana* has been used by the people of this study area for more than 5 decades, as 2 of the informants were more than 80 years in age, and the available literature proves that owing to the presence of certain chemicals, this tree is indeed beneficial and that the generational knowledge of the individuals using this tree's bark is helpful and needs to be passed on to the upcoming generations as it was also found in the study that the school-going population has little to no knowledge about the tree's healing properties. The inadequacy of the knowledge among the young generation can be attributed to acculturation, a lack of financial acknowledgment to the people who have this knowledge which makes the youngsters disinterested in learning about healing practices (Namsa *et al.,* 2011; Ndou *et al.,* 2023)

Similar to *Ulmus*, *Cissus quadrangularis* L., also known as "bone setter" has the ability to join bones by stimulation of metabolism and increased uptake of minerals and calcium by the osteoblasts in fracture healing (Mishra *et al*., 2010). Similarly, ethanolic extract of *Dalbergia sissoo* Roxb. ex DC. significantly induce bone regeneration at the fracture site and may be considered beneficial in fracture healing of animals (Khedgikar *et al*., 2013). Extracts of *Morinda citriflolia* L., are rich in catechins that are linked to bone regeneration (Shalan *et al*., 2017).

The folk knowledge helps in bridging traditional knowledge with modern molecular tools and also crucial to identify novel sources of medicines (Newmaster *et al*., 2006). Present study also reveals the diminishing awareness of traditional wisdom among the local youth, and this could be due to theexpansion of modern education and modern healthcare facilities (Giday*et al*., 2003; Ragupathy *et al*., 2008). This awareness and knowledge erosion contributes to a lack of appreciation and reliability of traditional healing practices, medical knowledge (Srithi *et al*., 2009) and to the lack of appreciation of cultural heritage and losing their identities that makes the cultures idiosyncratic. The kinship of individuals and communities with the medicinal plant and its utilization is an indispensable part of human-nature relationships, to which habits, knowledge, memories and emotions are connected as people attach a relational value to these medicinal plants (Frede *et al*., 2025). Erosion of traditional knowledge leads to reduction in dependency on local environment and material needs which makes the people disconnected spiritually and intellectually as well (Rao, 2024).

3.3. Conservation status

U. wallicihiana falls under the vulnerable category of the IUCN red list (Fragnière *et al*., 2021) and in the study area itself, *U. wallichiana* is facing extinction threats due to deforestation and haphazard overexploitation for its medicinal, timber, firewood and thatching properties which was also observed in a different region (Nazima *et al*., 2014). Following *in -situ* conservation approach small community- based nurseries can be made in the native habitats which will provide sustainable sources of bark and other plant material without disturbing wild populations. Local plant material collectors can be trained to collect the plant material from only mature trees and that too in non -destructive way, this can significantly prevent plant mortality. Detailed recording of traditional formulations,

preparation steps and plant use, should be incorporated into local People's Biodiversity Registers (PBRs) and the Traditional Knowledge Digital Library (TKDL) to prevent bio-piracy and promote benefit-sharing. Awareness workshops for healers, local communities and forest officials can promote understanding of the ecological and cultural value of medicinal species and encourage responsible resource management.

4. Conclusion

This traditional remedy to heal bone fractures is perceived as safer alternative to synthetic pharmaceuticals, providing a rich history of efficacy on the basis of empirical evidence and cultural practices. This study also raises serious concerns about the lack of knowledge young people have about traditional methods of healing. Scientific validation of traditional formulations through *in -vitro* assays, animal models and clinical trials will be crucial to confirm their efficacy in bone tissue repair. Insights gained from these studies could support the development of novel phytopharmaceuticals, bone graft biomaterials and natural osteoinductive agents. Integrating ethnobotanical knowledge with modern molecular and biomedical research will thus facilitate the translation of traditional *Ulmus*-based remedies into scientifically validated therapeutic applications for bone fracture treatment.

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