

The Multifaceted Role of Zanthoxylum armatum DC.: From Folk Remedies to Modern Pharmacology''

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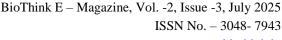
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Abstract

India's rich ethnobotanical heritage and biodiversity have long supported the use of medicinal plants in traditional healthcare, with Zanthoxylum armatum DC. (commonly known as Timur or Toothache Tree) emerging as a plant of significant pharmacological, ecological, and cultural importance. Distributed across the Indian Himalayan Region and parts of the Eastern Ghats, this aromatic, spiny shrub holds a crucial place in indigenous medicinal systems such as Ayurveda and Unani. Nearly all parts of the plant—including fruits, seeds, bark, leaves, and twigs—are utilized for a wide range of therapeutic applications, from treating fever, asthma, and digestive disorders to acting as natural toothbrushes and insect repellents.

Extensive phytochemical and pharmacological studies reveal the plant's antioxidant, anti-inflammatory, antibacterial, antifungal, analgesic, antitumor, and hepatoprotective properties, attributed to its diverse array of bioactive compounds such as essential oils, alkaloids, flavonoids, and terpenoids. Its uses extend beyond medicine into culinary, ecological, and artisanal domains. With a strong foundation in traditional knowledge and growing scientific validation, Z. armatum presents significant potential for sustainable utilization and further pharmacological exploration.

Key words: Z. armatum, Medicinal plants and Traditional medicine.



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Introduction

India possesses one of the most ancient and diverse plant-based medicinal traditions in the world, largely attributed to its rich and varied biodiversity. In many developing nations, including India, medicinal plants continue to play a significant role in primary healthcare systems. These herbal remedies are often preferred due to their affordability, therapeutic effectiveness, and relatively low incidence of side effects (Sekar et al., 2010). As a result, the pharmaceutical industry relies heavily both directly and indirectly—on plantderived materials for the development of medicinal products. The Indian Himalayan Region (IHR), identified as one of the 34 global biodiversity hotspots, is especially noteworthy in this context. This rich ecologically supports area approximately 1,748 species of medicinal plants (Samant et al., 1998). Among these, the genus Zanthoxylum (family: Rutaceae) stands out for its medicinal, ecological, and economic value. Globally, the genus comprises around 250 species, with 11 species recorded in India. One such species, Zanthoxylum armatum DC., is a deciduous shrub or small tree commonly known as Ash. It typically thrives in well-drained alluvial and black soils and is distributed across the warmer valleys of the Himalayas, from Jammu and Kashmir to Assam and the Khasi Hills, as well as parts of the Eastern Ghats in Odisha and Andhra Pradesh at altitudes ranging from 1,000 to 2,100 meters above sea level (Kala et al., 2005).

Zanthoxylum armatum DC. is an aromatic, spiny shrub or small tree that can grow up to 6 meters tall and is botanically distinguished by its compound, aromatic leaves (about 20 cm long), small greenishyellow flowers, reddish fruits around 5 mm in diameter, and bitter, shiny seeds (Verma et al., 2021). Various parts of the plant particularly the fruits, seeds and bark are extensively used in traditional medicine to treat ailments such as dyspepsia, fever, dental disorders, toothache, gum bleeding, asthma and digestive issues (Verma et al., **2021).** The fruit is also known for its waterpurifying and insect-repelling properties, while the plant's strong and durable wood is commonly used to make walking sticks. Due to its antiseptic and antimicrobial properties, Z. armatum is often included in



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the formulation of dental pastes and powders (Verma et al., 2021). Pharmacological research has identified a wide spectrum of bioactivities in the plant, including antioxidant, antinociceptive, antifungal, anti-inflammatory, hepatoprotective, pesticidal, anthelmintic and antiproliferative effects (Sati et al.,

2011; Ramanujam and Ratha, 2008; Mehta et al., 1981; Baquar, 1989). Given its rich therapeutic profile, traditional significance and ecological adaptability, Z. armatum holds significant potential for future pharmacological research and sustainable application in the medicinal plant industry.

Table 1. Regional Distribution, Altitudinal Range, and Natural Habitats of Z. armatum DC. in India.

Region	Altitude Range (masl)	Common Habitat
Jammu & Kashmir to Arunachal Pradesh	900–2,500	Forest margins, subtropical slopes
Assam, Manipur, Meghalaya, Nagaland	1,000–2,400	Forested valleys and village outskirts
Uttarakhand & Himachal Pradesh	1,200-2,200	Temperate forests, slopes
Sikkim & Bhutan	1,000-2,500	Moist forest ridges and slopes
Eastern Ghats (Odisha, Andhra Pradesh)	500-1,000	Hill ranges, scattered rural forests

Taxonomic classification of Zanthoxylum armatum (Annappan et al., 2015)

Z. armatum is systematically classified under

• **Kingdom**: Plantae

• **Sub-kingdom**: Viridaeplantae

• **Domain**: Eukaryote

• **Phylum**: Tracheophyta

• **Sub-phylum**: Euphyllophytin

• **Infra-phylum**: Radiatopses

• Class: Magnoliopsida

• Sub-class: Rosidae

• **Super Order**: Rutanae

• Order: Spindale



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• Sub-order: Rutineae

• Family: Rutaceae

The Rutaceae family is also known for other economically important plants like citrus species and *Z. armatum* shares many

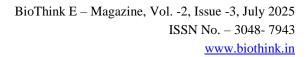
• Genus: Zanthoxylum

• **Species**: *Zanthoxylum armatum* DC. biochemical and ecological features with its citrus relatives.

Traditional / folk uses

Timur is recognized as a significant medicinal plant due to the therapeutic properties found in nearly all its parts. These components are commonly utilized in traditional medicine systems such as Ayurveda and Unani to treat a range of ailments. In countries like Nepal and China, timur has been traditionally used for generations, particularly by local communities often women for various health purposes. The traditional medical system extensively utilizes the bark, fruits and seeds of Z. armatum for their anthelmintic, stomachic and carminative properties. The fruits and seeds are employed as aromatic tonics to treat fever and indigestion and fruit extracts are believed to be effective in expelling roundworms. Due to their deodorizing, disinfectant and antiseptic properties, the fruits are also used in managing dental problems and a lotion made from them is

applied to treat sores. Additionally, the fruits are known to repel houseflies (Gaur, **1999).** Owing to its medicinal attributes, Z. armatum holds a valued place indigenous healthcare practices. Its seeds are a key component of Zuroor-e-Qula, a powdered Unani polyherbal formulation known for its antibacterial and antiinflammatory effects (Paridhavi Agarwal, 2007). In culinary traditions, the fruits are commonly used as spices and flavoring agents, while the young twigs serve as natural toothbrushes. Moreover, the bark has traditionally been used in dyemaking (Gaur, 2008; Sharma and Subedi, 2022). In Uttarakhand, the Bhotiya tribal community is known to use timur more extensively than other ethnic groups, largely due to the plant's accessibility near their winter settlements. They incorporate the fruit into their diet as a spice, condiment and remedy. During the cold months,





families drink a warming soup made from dried timur fruit, locally referred to as *hag*. Another favored preparation is *dunkcha*, a traditional chutney. Additionally, the community brews a form of liquor from

timur, though it is typically consumed only by individuals with a strong tolerance due to its intense taste. For the Bhotiya, timur holds both spiritual and magical significance (**Kumar and Gupta, 2020**).

Table 2: The traditional uses of different parts of Zanthoxylum armatum DC. (Paul et al., 2018).

S. No.	Part used	Traditional use		
1.	Leaves	The leaves are primarily used for catching fish due to their mild toxicity when crushed and spread in water. Medicinally, they help relieve indigestion and cholera. Rich in essential oils and flavonoids, the leaves also exhibit antimicrobial and anti-inflammatory properties.		
2.	Seeds	Traditionally used to treat fever, dyspepsia, cholera, flatulence, and depression. They are aromatic in nature and often used as a tonic to improve digestion. Seeds contain compounds like limonene and linalool, which contribute to their digestive and moodenhancing effects.		
3.	Bark	The bark serves as a powerful carminative, stomachic, and anthelmintic. It is often applied to gums for toothache relief, hence called the "toothache tree." It contains active alkaloids such as berberine and xanthoxylin, known for their analgesic and antimicrobial action.		
4.	Fruit	The juice of the fruit is used to expel roundworms and relieve gastrointestinal issues. It has strong deodorant, antiseptic, and disinfectant properties, making it ideal for dental care. Fruits are also pickled and used to treat colds, coughs, abdominal discomfort, and limb numbness. Fruit powder, when mixed with warm water, helps manage dysentery and diarrhea. The fruits are rich in volatile oils, tannins, and flavonoids that provide antiparasitic and immune-boosting effects.		
5.	Berries	Berries are known for their carminative and antispasmodic properties. They are used topically and internally to treat skin diseases such as eczema and fungal infections. The presence of essential oils and polyphenols enhances their antimicrobial and skin-soothing activities.		



BioThink E – Magazine, Vol. -2, Issue -3, July 2025 ISSN No. – 3048- 7943

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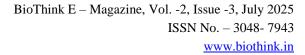
	Whole	The entire plant is utilized for treating scabies and for removing worms from infected		
	plant	ears. It has broad-spectrum antimicrobial and anti-parasitic effects due to its complex mix		
6.		of bioactive compounds including alkaloids, saponins, and terpenes.		

Medicinal properties

Research has shown that the fruits of Timur are the most commonly utilized part of the plant, followed by young twigs and seeds. The leaves have carminative properties and are traditionally used to treat indigestion and stomach pain. Twigs are often employed as natural toothbrushes alleviate toothaches. Additionally, Timur seeds are used to manage fever and cholera and are known to stimulate saliva production (Kanwal et al., 2015). Another study reported that leaf extracts from Timur can induce apoptosis in cancer cells and enhance their sensitivity to chemotherapy drugs (Singh et al., 2015). The plant's extracts are also effective in treating pneumonia and tick infestations. A mixture of powdered Timur fruit, table salt, and Mentha species is used to relieve chest infections and digestive issues. The dried fruits exhibit antiseptic, antifungal, and antibacterial effects.

Timur is associated with various medicinal applications (Paul et al., 2018), such as:

- Asthma and breathing difficulties
 chewing a few seeds is beneficial.
- Arthritis, joint pain, skin diseases, eczema, and blood impurities boiling 5–10 grams of fresh leaves in a glass of water until it reduces to one-fourth and consuming the decoction once or twice daily can help.
- Boils applying a fine paste made from the roots externally is effective.
- Cough drinking a seed-based decoction once or twice a day provides relief.
- Cholera bark decoction is used for treatment.
- Earache ear drops made from a mixture of Timur, dry ginger (Sonth), and asafoetida (Hing) are effective.



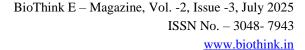


- Bleeding gums massaging bark powder mixed with honey onto the gums helps.
- Mouth freshener chewing the fruits freshens the mouth.
- Swelling applying a poultice of warm leaves topically reduces inflammation.
- **Stomatitis** gargling with a leaf decoction helps soothe the condition.
- Roundworms consuming the seeds in any form assists in expelling roundworms.

Pharmacological and Therapeutic Applications

It is used to treat diseases viz; Asthma, Bronchitis, Cholera, Fever, Fibrosis's, Indigestion, Rheumatism, Skin diseases, Toothache, Varicose veins. Prickly Ash is used in many chronic problems such a rheumatism and skin diseases; cramp in the leg, ulcers. It is also used for low blood inflammation. pressure, fever, and Externally it may be used as stimulation for rheumatism and fibrositis. It has a stimulating effect upon the lymphatic system, circulation and mucous membranes. The fruit and seeds are used to cure in fever dyspepsia and cholera and the bark used for intoxicating fishes. The bark, fruits and seeds are widely used in indigenous system of medicine as a carminative, stomachic and anthelmintic

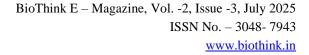
and antifungal. The bark is pungent and used to clean teeth. The fruits and seeds are employed as an aromatic tonic in fever and dyspepsia (Paul et al., 2018). Z. armatum exhibits a diverse range of pharmacological attributed to its properties rich phytochemical composition, as supported by various studies. Its ethanolic and methanolic fruit extracts demonstrate strong antioxidant potential through DPPH radical scavenging activity, highlighting its usefulness as a natural antioxidant source (Batool et al., 2010; Upadhyaya and Ashok, 2010). The plant also possesses significant anti-inflammatory effects; the ethanolic stem bark extract reduces paw edema in male Wistar rats by inhibiting cyclooxygenase activity (Sati et al., 2011)





and the fruit extract inhibits carrageenaninduced paw inflammation in rats, with lignan components contributing to its analgesic action (Mehta et al., 2011; Kaur Guot al.. al..2011: et 2010). Antimicrobial activity has also been documented, with the extract showing a large zone of inhibition (23 mm) against subtilis Bacillus and a minimum bactericidal concentration (MBC) of 2.5 mg/L (Joshi et al., 2009), while its essential oils have demonstrated fungitoxicity against Alternaria brassicicola (Parajuli *et* al.. 2005). Insecticidal and larvicidal activities are evidenced by the effectiveness of seed oil, especially when combined with vanillin and Z. piperitum fruit oil, in repelling female Aedes aegypti, with efficacy comparable to DEET (Kwon, 2011). Additionally, its essential seed oil exhibits larvicidal effects against multiple mosquito species including Culex quinquefasciatus, Aedes aegypti, Anopheles stephensi, Aedes albopictus, and C. pipiens (Tiwary et al., 2007; Yun et al., **2010).** The fruit extract also demonstrates piscicidal activity, acting as a noncompetitive inhibitor of Mg2+-ATPase and Na+, K+-ATPase in various tissues of the

air-breathing catfish Heteropneustes fossilis, indicating its utility in fish nursery management (Ramanujam and Ratha, 2008). Its hepatoprotective capacity is evident from studies showing that ethanolic leaf extract protects the liver in mice CCl₄-induced toxicity against and inflammation (Verma and Khosa, 2010), while bark extract enhances antioxidant levels and regulates enzyme serum enzymes, thereby contributing to liver protection (Ranawat et al., 2009). Furthermore, the plant shows antitumor potential, as crude extracts of leaves and fruits exhibit cytotoxic activity (Barkat et al., 2011), likely due to the presence of lupeol, a monoterpene known for its chemo preventive and anti-inflammatory properties. Lastly, Z. armatum also demonstrates immunomodulatory effects, stimulating the lymphatic system, mucous membranes and circulation, and acting as a liniment for rheumatism and fibrositis, with crude extract also influencing gastrointestinal, respiratory, and cardiovascular functions through modulation of K⁺ and Ca²⁺ channels (Gilani et al., 2010).





Culinary, Ecological and Other Uses

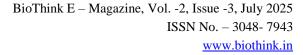
Aside from its medicinal benefits, Z. armatum is integral to several culinary traditions. The fruits are used as spices and condiments in chutneys, soups, and pickles. **Twigs** are employed as natural toothbrushes, especially in rural regions, due to their strong antibacterial properties. The plant's hard, durable wood is used to make walking sticks and simple tools. The bark has traditional use in natural dye production. Moreover, due to its strong aroma and the fruit is also used as an insect repellent, particularly effective against houseflies (Gaur, 1999).

Conclusion

Zanthoxylum armatum DC. stands as a valuable ethnomedicinal resource, wide demonstrating a spectrum of traditional and pharmacological applications across diverse Indian ecosystems. Its therapeutic versatilityspanning gastrointestinal, respiratory, dermatological, and dental conditions coupled with antimicrobial, antioxidant, anti-inflammatory and activities, underscores its relevance to both traditional and modern medicine. Additionally, its roles in indigenous diets, oral hygiene, pest and spiritual management, practices highlight its cultural and practical significance. Scientific studies validate many of its traditional uses and reveal promising avenues for future discovery, particularly in cancer treatment, liver protection, and vector control. Given its ecological adaptability and diverse utility, there is a compelling need to conserve Z. armatum in its native habitats and integrate it more effectively into sustainable healthcare and economic development strategies. Conservation efforts, coupled with focused phytochemical and clinical research, could unlock further therapeutic potentials of this underutilized Himalayan medicinal plant.

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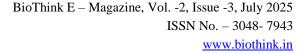


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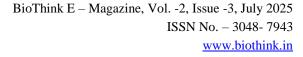
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