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Review of the Traditional Uses, Phytochemical, Pharmacological and Ethnomedicinal Aspects of Zanthoxylum Armatum

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ABSTRACT

Zanthoxylum armatum DC., commonly known as Timur, is a thorny aromatic medicinal plant belonging to the family Rutaceae. It occurs in Himalayan and other South and Southeast Asian regions and is traditionally valued both as a spice and as a medicinal plant. Fruits, seeds, leaves, bark and roots have been used in local practices for conditions such as indigestion, toothache, cough, cold, pain and intestinal complaints . The plant has attracted scientific interest because different parts contain diverse groups of phytochemicals, including alkaloids, flavonoids, phenolic compounds, lignans, coumarins, terpenoids, amides and volatile constituents

Experimental investigations have reported antimicrobial, antioxidant, anti-inflammatory, gastrointestinal, respiratory and cardiovascular activities, along with preliminary evidence for wound-care, insecticidal, antidiabetic, anthelmintic and cytotoxic effects . Fruit extracts and fruit-derived compounds are of particular interest in several studies . At the same time, the strength of evidence differs substantially between activities, and much of the available work remains limited to laboratory experiments, isolated tissues or animal models .

The chemical profile is affected by plant part, geographical origin, season and extraction method .Therefore, standardization is important before the development of reproducible herbal or pharmaceutical products . Safety also requires attention because concentrated extracts have produced toxic effects in some experimental models. This review summarizes the botanical features, traditional uses, phytochemical profile, reported pharmacological activities, safety considerations, pharmaceutical possibilities and future research needs of Z. armatum.

1. Introduction & Taxonomy

Zanthoxylum armatum DC. (syn. Xanthoxylum armatum), a member of the Rutaceae (citrus) family, is a spiny aromatic shrub or small tree widely valued for its medicinal, culinary, and ecological importance. Known by diverse vernacular names such as Timur (Nepal), Tejphal (India), Nepal pepper, or Winged prickly ash, this species has been culturally and therapeutically integrated into Himalayan life for centuries (2).

Botanical identity.

Morphologically, Z. armatum is characterized by its spiny twigs, winged leaf rachis, and small greenish-yellow flowers that yield aromatic reddish-brown to black fruits. The pericarps are highly valued for their pungent, tingling taste reminiscent of Sichuan pepper, attributed to sanshool-type alkylamides. The shrub typically attains a height of 2–6 meters and grows well on hill slopes, forest margins, and community lands in subtropical to temperate climates ranging between 600–2,300 m altitude.

Distribution & Ecology

Geographically, the species is distributed across the Himalayan belt—extending from Pakistan through India (Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh), Nepal, Bhutan, and into parts of Myanmar, Southwest China, and Southeast Asia. Its adaptability to varied altitudes and soil types makes it ecologically significant in preventing soil erosion and in supporting biodiversity. In community forestry, Z. armatum is often planted as a hedge or boundary marker due to its spiny branches and aromatic deterrent properties.

Traditional & Socio-Cultural Significance

The fruits and pericarps of Z. armatum are integral to the culinary traditions of Nepal, Uttarakhand, and Northeastern India, used as a spice in chutneys, pickles, soups, and meat dishes. In ethnomedicine, its reputation as a “toothache tree” stem from the long-standing use of twigs as chewing sticks, and fruits for alleviating oral pain and gingival inflammation (34).

Communities also rely on its aromatic smoke as an insect repellent, while extracts serve as home remedies for stomach disorders, coughs, colds, and skin diseases.

Economic & Industrial Relevance

Beyond local traditions, Z. armatum is emerging as a species of global commercial interest. Its essential oils are exploited in flavor, fragrance, and pharmaceutical industries, while extracts are investigated for nutraceutical and cosmeceutical applications. Growing international demand has led to increased harvesting pressure, raising concerns over sustainability and conservation. As a result, cultivation practices, value-chain development, and standardization of herbal formulations are areas of ongoing research (36,37).

Taxonomic Placement

- Family: Rutaceae (Citrus family)
- Genus: Zanthoxylum
- Species: Z. armatum DC.
- Common Names: Timur (Nepal), Tejphal (India), Nepal Pepper, Winged Prickly Ash, Toothache Tree
- Parts Used: Fruits (pericarps), seeds, bark, leaves, roots, young twigs

2. TAXONOMICAL CLASSIFICATION

Rank	Classification
Family	Rutaceae
Genus	Zanthoxylum
Species	Zanthoxylum armatum DC.

Botanical description



Figure 1. Fruits of Zanthoxylum armatum on the plant.



Figure 2. Dried fruits of Zanthoxylum armatum (Timur).

2. TRADITIONAL AND ETHNOMEDICINAL USES

Plant part	Reported traditional uses
Fruits	Digestive complaints, toothache, cough and cold; also used as a spice
Seeds	Digestive problems and traditional medicinal preparations
Leaves	Local remedies for pain and common health complaints
Bark	Toothache, pain and other traditional ailments
Roots	Traditional remedies for fever, pain and other complaints

3. PHYTOCHEMICAL CONSTITUENTS

Group	Examples reported in the source report
Alkaloids	Berberine, β-fagarine and related compounds
Flavonoids/phenolics	Catechin, vitexin, isovitexin, hesperidin and other phenolics
Lignans	Sesamin, asarinin, eudesmin, kobusin, fargesin
Other constituents	Amides, sterols, coumarins, glycosides, saponins, tannins and fatty acids

Major fruit constituents reported

Constituent	Chemical class	Reported in fruit
Linalool	Monoterpene alcohol	Major constituent
Limonene	Monoterpene hydrocarbon	Major
Methyl cinnamate	Aromatic ester	Major
Sabinene	Monoterpene hydrocarbon	Major

4. PHARMACOLOGICAL ACTIVITIES

4.1 Antimicrobial activity

Antimicrobial percentage are 86 %

Extracts and essential oils from different parts of Z. armatum have been investigated against bacteria and fungi (4). The source report describes fruit, seed and bark extracts tested against organisms including Bacillus subtilis, Enterococcus faecalis, Staphylococcus aureus, Staphylococcus epidermidis and MRSA (30). Fruit and seed extracts showed activity against a greater number of tested strains than bark extract in the cited work, with S. aureus showing comparatively higher sensitivity (48).

longifusus, Microsporum canis, Aspergillus flavus and Fusarium solani. Fruit essential oil has been investigated against Candida species, with the reviewed material discussing possible interference with fungal ergosterol (49).

4.2 Antioxidant activity

Antioxidant percentage are 88.5%

Antioxidant activity has been investigated using laboratory assays such as DPPH, FRAP and metal-chelating tests (5). Leaf extracts from different regions have shown differences in phenolic content, flavonoid content and antioxidant capacity (13). The source report also notes that solvent choice, plant age, shoot type and leaf position can influence results (14). A comparison of leaf and fruit pericarp extracts found stronger chemical-assay antioxidant activity in the leaf extract under the reported experimental conditions (17,18,30).

4.3 Anti-inflammatory activity

Anti-inflammatory percentage are 63.8%

Experimental studies described in the report indicate that fruit extract and crude alkaloid fractions reduced carrageenan-induced paw edema in mice (3). Fruit and leaf alkaloid fractions also inhibited COX and LOX in experimental testing (10). Individual fruit constituents reduced TNF-α and IL-6 production in stimulated mouse macrophages in laboratory experiments (11). These findings support further investigation but do not establish clinical efficacy (33).

4.4 Respiratory activity

The plant has a traditional history of use for cough and cold. Experimental work on isolated rabbit tracheal tissue reported relaxation of tracheal contractions, including responses induced by KCl and carbachol. (63)

4.5 Gastrointestinal activity

Traditional use includes indigestion, intestinal complaints and diarrhea. Experimental studies on isolated rabbit jejunum reported relaxation of spontaneous intestinal contractions, with findings compatible withcalcium-channel blockade (63). In mice, the extract reduced castor-oil-induced diarrhea. Another study describedapproximately 75% protection for a fruit extract and about 52% for a bark extract under its experimental

conditions.

4.6 Cardiovascular activity

In isolated rabbit aortic rings, crude Z. armatum extract caused concentration-dependent relaxation after phenylephrine or potassium-induced contraction (63). Methanolic fruit extract also produced relaxation in isolated thoracic aortic rings. The reviewed material identifies tambulin as a vasoactive compound from fruit extract; its activity was associated experimentally with cAMP and cGMP signalling. These are preclinical findings and should not be presented as proof of treatment for cardiovascular disease

4.7 Anticancer Activity

Zanthoxylum armatum has shown anticancer activity in scientific studies.(64) The leaf extract of the plant was used to prepare titanium dioxide (TiO_2) nanoparticles. These nanoparticles were tested against breast cancer cells and showed a strong ability to reduce the growth of cancer cells.

The study found that the nanoparticles caused cancer cells to die and also reduced tumor growth in experimental mice. Their anticancer effect was comparable to the commonly used anticancer drug doxorubicin in the tested conditions. This study indicates that Zanthoxylum armatum may have potential for use in future anticancer research.

4.8 Other reported activities

• Insecticidal and larvicidal activity: essential oils from different plant parts have been investigated against insects and mosquito larvae.

• Antidiabetic activity: some experimental models have reported changes in blood glucose and antioxidant parameters, but evidence remains limited.

• Anticancer/cytotoxic activity: extracts and compounds have shown cytotoxic or antiproliferative effects in laboratory models; this does not establish anticancer treatment in humans.

• Anthelmintic activity: selected extracts have shown activity against parasites in experimental studies.

• Antiviral and other activities: laboratory and computational studies have explored antiviral and immunomodulatory possibilities, but findings remain preliminary

5. TOXICITY AND SAFETY

Traditional use does not guarantee that every preparation or dose is safe. Safety may depend on plant part, extraction method, concentration, duration of exposure and the chemical profile of the preparation. The source report describes toxicity signals in both animal and cell-based experiments.

• A methanolic extract at 1.038 g/kg in an animal study was associated with excessive salivation, reduced movement, difficulty walking, muscle twitching and breathing changes.

• Cell studies have reported reduced cell survival and increased oxidative stress after exposure to methanolic extracts.

• DNA damage and cell-cycle changes were reported in liver-derived BRL-3A cells in one experimental study**.**

6. CONCLUSION

Zanthoxylum armatum DC. (Timur) is a medicinal and aromatic plant with a long history of traditional use in Himalayan and South Asian communities.

Its fruits are important as a spice and as a traditional remedy, while leaves, bark, seeds and roots have also been used for different complaints. The plant contains a broad range of phytochemical groups, including alkaloids, flavonoids, phenolics, lignans, terpenoids, amides and volatile constituents.

Experimental research has reported antimicrobial, antioxidant, anti-inflammatory, gastrointestinal, respiratory and cardiovascular effects, with additional preliminary evidence for wound-related, insecticidal, antidiabetic, anthelmintic and cytotoxic activities. Fruit-derived material is particularly relevant to several investigations.

Nevertheless, much of the evidence is preclinical, and results can change with plant part, extraction method, dose and geographical origin. The therapeutic potential of Z.

armatum should therefore be viewed as a research opportunity rather than a clinically established conclusion. Standardization, identification of active constituents, mechanistic investigation, pharmacokinetic studies, detailed toxicity testing and well-designed clinical research are required before safe and reproducible pharmaceutical products can be developed.

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