7 Medicinal and pharmacological aspects of *Melia azedarach* L.

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ABSTRACT

Melia azedarach L., commonly known as Chinaberry, is a widely distributed medicinal tree recognised for its diverse therapeutic properties in traditional and modern systems of medicine. The plant has been extensively used to treat various ailments, including skin diseases, inflammation, diabetes and parasitic infections. Phytochemical investigations have revealed the presence of a wide range of bioactive compounds, including limonoids, triterpenoids, flavonoids, alkaloids and phenolic compounds, which contribute to its pharmacological potential. Pharmacological studies have demonstrated that *M. azedarach* exhibits significant antimicrobial, antifungal, antiviral, anti-inflammatory, antioxidant, antimalarial and insecticidal activities. Additionally, the plant possesses notable antiparasitic and insect-repellent properties, making it valuable in both medicinal and agricultural applications. *M. azedarach* represents a rich source of natural bioactive compounds with significant medicinal and pharmacological applications. Further research focusing on the isolation of active constituents and clinical validation is essential to fully explore its potential in drug development.

Keywords: Ethnobotany, pharmacology, phytochemistry, medicinal plant, *Melia*

INTRODUCTION

Melia azedarach L., a member of the family Meliaceae, is a fast-growing deciduous tree widely distributed in tropical and subtropical regions of the world, including India, Southeast Asia, Africa and parts of Australia. Commonly known as Chinaberry, Persian lilac or "Bakain" in India, the species holds significant importance in traditional medicine and agroforestry systems. Its adaptability to diverse environmental conditions, coupled with its rich phytochemical profile, has made it an important subject of ethnobotanical and pharmacological research in recent years (Ramanan et al. 2024).

M. azedarach has been extensively used for treating a wide spectrum of ailments, such as skin diseases, intestinal worms, fever, diabetes and inflammatory disorders. In rural and tribal communities, particularly across India, decoctions, infusions and pastes prepared from the plant are commonly employed as household remedies. These long-standing ethnomedicinal practices indicate the therapeutic potential of the species and provide a valuable foundation for modern pharmacological investigations (Sehar et al. 2024; Anand et al. 2024). The medicinal value of *M. azedarach* is largely attributed to its diverse array of bioactive compounds. Phytochemical studies have revealed the presence of limonoids, triterpenoids, flavonoids, alkaloids, tannins and phenolic compounds in different parts of the plant. Among these, limonoids are considered the most significant constituents, known for their potent biological activities, including insecticidal, antimicrobial and anticancer effects. These compounds play a crucial role in the defence mechanism of plants and contribute to their wide-ranging pharmacological properties (Batubara et al. 2025; Rabbani et al. 2024). Leaf and bark extracts have shown significant antibacterial and antifungal activity against various pathogenic microorganisms, supporting their traditional use in treating infections (Touzout et al. 2023; Dias et al. 2022).

Recent studies have highlighted the potential of *M. azedarach* in emerging areas such as antiviral and anticancer research. Extracts of the plant have demonstrated inhibitory effects against viral pathogens, including SARS-CoV-2, suggesting its possible application in the development of novel antiviral agents. Additionally, certain bioactive compounds isolated from the plant have shown cytotoxic activity against cancer cell lines, indicating their promise in oncology research. These findings highlight the importance of *M. azedarach* as a valuable source of natural compounds for drug discovery and development (Hemdan et al. 2023; Cao et al. 2024).

Despite its numerous therapeutic benefits, it is important to note that *M. azedarach* also exhibits a degree of toxicity, particularly in its fruits and seeds, which contain toxic limonoids. Consumption of these parts in high doses can lead to adverse effects such as nausea, vomiting and neurological symptoms. Therefore, proper dosage regulation and scientific validation are essential to ensure its safe use in medicinal applications (Anand et al. 2024). *M. azedarach* represents a multifunctional medicinal plant with significant ethnobotanical relevance and pharmacological potential. The integration of traditional knowledge with modern scientific research has provided valuable insights into its therapeutic properties.

MORPHOLOGY

M. azedarach is a fast-growing, medium-sized deciduous tree, typically reaching 7-15 m in height, though it may attain up to 20 m under favourable conditions. The tree possesses a spreading, rounded crown with a straight bole and moderate branching (Saxena and Brahmam 1994; Tiwari and Prajapati 2024; Figure 1).

Stem and bark: The trunk is relatively short, with rough, grey to dark brown in color. The bark often exhibits lenticels and may exude a bitter sap when injured.

Leaves: Leaves are alternate, large and bipinnately compound (sometimes tripinnate), measuring 20-50 cm in length. Leaflets are ovate to lanceolate, 2-7 cm long, with serrated or lobed margins and an acuminate apex.

Inflorescence: The flowers are arranged in axillary panicles, which are loose, branched and up to 20 cm long.

Flowers: Flowers are small, fragrant and actinomorphic, typically lilac to pale violet in color. They are bisexual and pentamerous, consisting of five sepals and five petals. The stamens are united into a characteristic staminal tube, with prominent anthers. The ovary is superior, syncarpous and usually 4-6 locular.

Fruit: The fruit is a smooth, globose drupe, about 1-2 cm in diameter, initially green and turning yellow upon maturity. It persists on the tree even after leaf fall. The pulp is fleshy but toxic, enclosing a hard, ridged endocarp.

Seeds: Seeds are enclosed within the stony endocarp and are elongated, hard and brown. Each fruit typically contains 3-6 seeds.

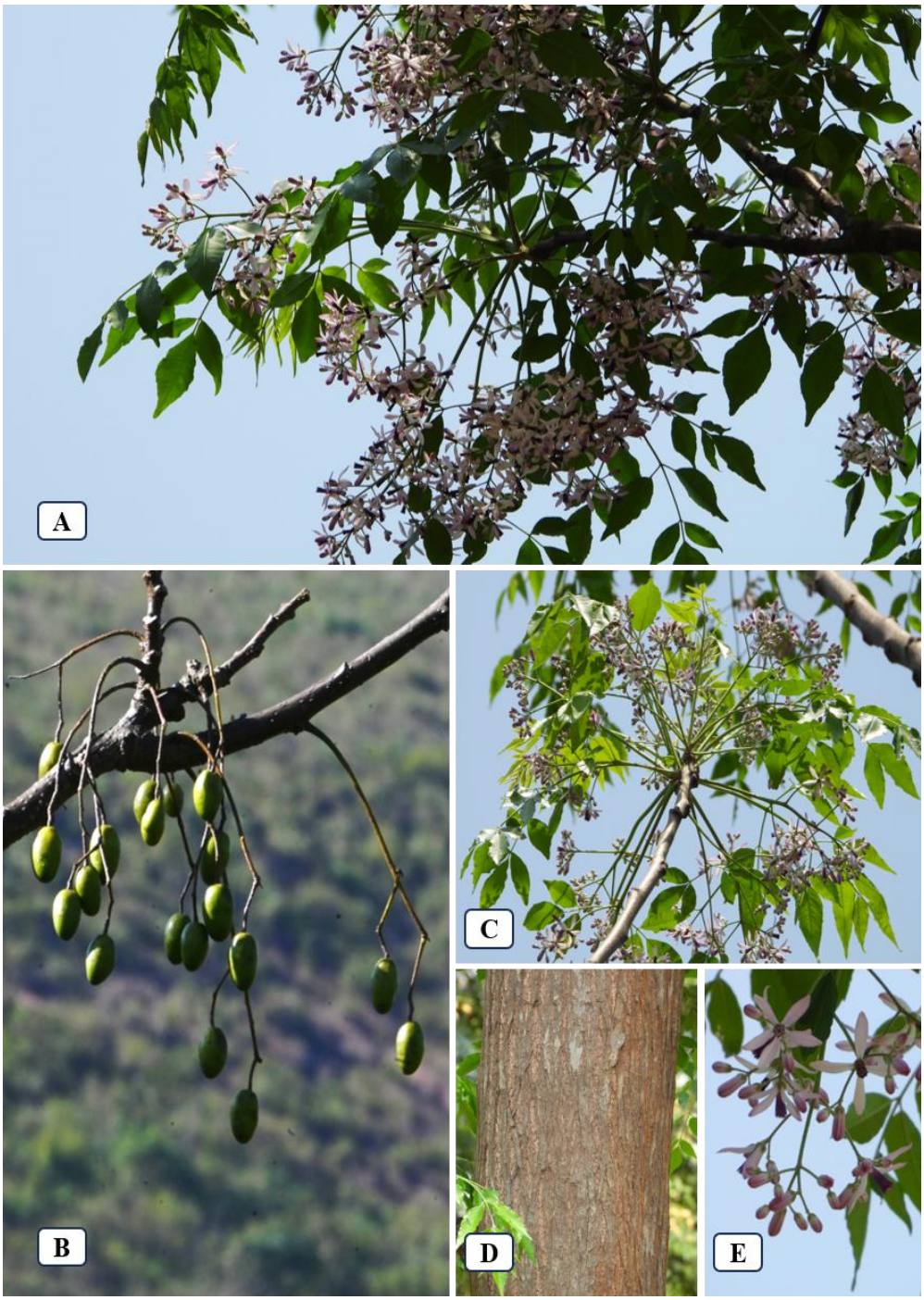


Figure 1: Vegetative parts of *M. azedarach*; A) Canopy, B) Fruits, C) Leaves with flower, D) bark, E) Flowers

MEDICINAL SIGNIFICANCE

Leaves

The leaves of *M. azedarach* are commonly used for treating skin diseases, wounds and inflammatory conditions, where fresh leaf paste or decoction is applied externally to reduce microbial infections and promote healing. Leaves are also used internally in small quantities for fever, malaria and gastrointestinal disorders. In addition, they are employed in respiratory ailments such as asthma and bronchitis due to their anti-inflammatory effects (Hemdan et al. 2023; Touzout et al. 2023; Naveed et al. 2024).

Bark

The bark of *M. azedarach* is traditionally used as a bitter tonic and is particularly important in gastrointestinal and febrile conditions. Decoctions of the bark are administered for diarrhoea, dysentery and intestinal worm infestations due to their anthelmintic properties. It is also widely used in the treatment of fever and malaria in folk medicine. Bark is also used for managing internal inflammation and pain (Rabbani et al. 2024; Shah et al. 2025).

Fruits

The fruits are traditionally known for their strong antiparasitic and insecticidal properties. They are commonly used in rural medicine to expel intestinal worms and are sometimes applied externally for skin diseases and infections. Fruits are also utilised as natural insect repellents in traditional agricultural practices (Shah et al. 2025; Jeewon et al. 2024).

Flowers

The flowers of *M. azedarach* are less frequently used but still hold ethnomedicinal significance. They are traditionally employed as mild laxatives and digestive aids and are sometimes used in remedies for respiratory conditions such as cough and bronchitis. Flower-based preparations are also considered supportive in reducing mucus and mild inflammation (Naveed et al. 2024).

Roots

The roots are used in traditional systems primarily for their analgesic and anti-inflammatory properties. They are prescribed in folk medicine for treating

rheumatism, body aches and nerve-related disorders. In some traditional practices, root preparations are also used as antipyretic agents to reduce fever (Rabbani et al. 2024; Shah et al. 2025).

Seeds

The seeds of *M. azedarach* are known for their potent insecticidal, antiparasitic and antimicrobial properties. They are widely used in traditional veterinary practices to control ectoparasites in livestock and are also applied externally for treating skin infections. Seed oil is sometimes used for scalp conditions, including dandruff and hair-related issues. Due to their high toxicity, internal use is limited and requires caution (Shah et al. 2025; Jeewon et al. 2024).

PHARMACOLOGICAL USES

M. azedarach exhibits a wide range of pharmacological activities due to the presence of bioactive compounds such as limonoids, flavonoids, triterpenoids and phenolics. Recent pharmacological studies confirm that it is a multi-potent medicinal plant with antimicrobial, antioxidant, anti-inflammatory, antiviral and insecticidal properties. These activities are mainly attributed to limonoids, phenolics and flavonoids. However, further clinical trials and toxicity evaluations are required for safe therapeutic applications.

1. Antimicrobial Activity

Extracts of M. azedarach (especially leaves and twigs) show strong antibacterial activity against both Gram-positive and Gram-negative bacteria. Methanolic extracts inhibit *Escherichia coli* and *Bacillus subtilis*, including multidrug-resistant strains (Touzout et al. 2023; Batubara et al. 2025).

2. Antioxidant activity

The plant demonstrates significant free radical scavenging ability due to high phenolic and flavonoid content. Increased levels of phenols, flavonoids and fatty acids enhance antioxidant capacity. These compounds help neutralise oxidative stress and protect cellular components (Dias et al. 2022).

3. Anti-inflammatory activity

Recent studies have identified bioactive limonoids responsible for anti-inflammatory effects. Novel limonoids isolated from fruits exhibit significant

anti-inflammatory potential. These compounds may act by inhibiting inflammatory mediators and pathways (Cao et al. 2025).

4. Antiviral activity

M. azedarach has shown promising antiviral properties in recent research. Leaf extracts demonstrated in vitro activity against SARS-CoV-2 (Hemdan et al. 2023).

5. Antiparasitic and insecticidal activity

The plant is well known for its pesticidal and antiparasitic properties. Extracts exhibit larvicidal, ovicidal and repellent activity against mosquito species, including *Culex pipiens* (Khaldi et al. 2022).

6. Analgesic and antipyretic activity

Bioactive compounds such as triterpenoids contribute to pain-relieving and fever-reducing effects. Studies report its use in treating fever, pain and inflammatory disorders (Rabbani et al. 2024).

7. Antifungal activity

Extracts of *M. azedarach* show inhibitory effects against fungal pathogens. Active compounds disrupt the integrity of fungal cell walls and growth (Carpinella et al. 2003).

8. Antimalarial activity

M. azedarach is traditionally used against malaria and recent studies support its potential. Bioactive metabolites exhibit antimalarial activity (Nathan et al. 2006).

9. Anticancer potential

Certain phytochemicals, like limonoids and flavonoids, show cytotoxic effects against cancer cell lines. These compounds may induce apoptosis and inhibit tumour growth (Nerome et al. 2020).

CONCLUSION

Melia azedarach is a multipurpose medicinal tree that holds significant importance in traditional healthcare systems and modern pharmacological research. The traditional uses highlight the therapeutic relevance of *M. azedarach*. Phytochemical investigations have revealed that *M. azedarach* is

rich in bioactive compounds such as limonoids, flavonoids, triterpenoids, alkaloids and phenolic compounds. These constituents are responsible for its diverse pharmacological activities. Such a wide spectrum of biological activities makes it a potential source for the development of novel drugs and natural therapeutic agents. In addition to its medicinal applications, *M. azedarach* also plays an important role in agriculture and environmental management due to its natural insecticidal and pesticidal properties. This makes it a sustainable and eco-friendly alternative to synthetic chemicals in pest control and crop protection. Further research focusing on clinical validation, toxicity assessment and mechanism of action is necessary to fully explore its potential and ensure its safe and effective utilization in modern medicine.

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