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# UNLOCKING THE TRADITIONAL THERAPEUTIC AND PHARMACOLOGICAL POTENTIAL OF *Ziziphus mauritiana* Lam.: RECENT ADVANCES AND FUTURE DIRECTIONS

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## ABSTRACT

*Ziziphus mauritiana* Lam. (Rhamnaceae), commonly known as Indian jujube or ber, is an important medicinal and nutraceutical plant widely used in traditional systems of medicine. Different parts of the plant including fruits, leaves, bark, seeds, and roots—have been traditionally employed for the treatment of inflammation, diabetes, liver disorders, infections, cardiovascular diseases, and neurological conditions. Modern scientific investigations have validated many of these ethnomedicinal claims, revealing a broad range of pharmacological activities such as antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, hepatoprotective, cardiotonic, neuroprotective, and wound-healing effects. These biological activities are attributed to the presence of diverse phytoconstituents such as flavonoids, alkaloids, saponins, tannins, phenolic acids, vitamins, and minerals. Toxicological evaluations indicate a favorable safety profile at therapeutic doses. This review comprehensively summarizes the botanical description, geographical distribution, chemical composition, toxicological

investigations, and extensive pharmacological properties of *Z. mauritiana*, highlighting recent advances and future research directions for its development as a therapeutic and nutraceutical agent.

**KEYWORDS:** *Ziziphus mauritiana*, ethnomedicine, phytochemistry, pharmacological activities, bioactive compounds

## INTRODUCTION

The use of traditional medicinal herbs is deeply rooted in the indigenous knowledge, practices, and cultural beliefs of diverse communities, serving to maintain overall health and to prevent or treat various ailments (**Hegde & Roy, 2024**). Despite advancements in modern healthcare infrastructure, a significant proportion of populations in developing countries continue to rely on traditional medicine for both physical and mental health concerns. In recent decades, renewed interest in herbal remedies has emerged due to their perceived efficacy and lower incidence of side effects compared to conventional allopathic treatments. The World Health Organization (WHO) has recognized the importance of medicinal plants from an ethnomedical perspective, emphasizing their role in global healthcare. The presence of bioactive phytoconstituents in plants renders them suitable candidates for pharmaceutical development, and a substantial fraction of the world's medicines are plant-derived. In many Asian countries, including India, herbal therapies remain preferred over synthetic drugs because of their affordability, accessibility, and cultural acceptance. India, in particular, has a rich heritage of herbal medicine, deeply embedded in regional indigenous systems. Scientific investigations have increasingly validated the traditional applications of numerous medicinal plants for managing serious health conditions such as cancer, neurodegenerative disorders, and metabolic diseases, highlighting their therapeutic potential and patient-friendly nature (**Jha *et al.*, 2025**). Ethnomedicinal research is therefore critical for the discovery of novel bioactive compounds and continues to serve as a foundation for the pharmaceutical industry.

However, factors such as urbanization, modernization, and globalization have contributed to the gradual erosion of traditional knowledge. To preserve and harness the benefits of ethnomedicine for human welfare, it is essential to systematically investigate, document, and evaluate medicinal plants.

Medicinal plants remain a cornerstone of primary healthcare, especially in developing countries. Among them, *Ziziphus mauritiana* Lam., commonly known as Indian jujube or ber, is a small to medium-sized tropical fruit tree belonging to the family **Rhamnaceae** has gained significant attention due to its wide range of traditional uses and scientifically validated pharmacological properties. This species is widely

distributed across South Asia, Southeast Asia, Africa, and the Middle East, thriving in arid and semi-arid climates.

Traditionally, various parts of the plant—including fruits, leaves, seeds, bark, and roots—have been extensively used in **Ayurveda, Unani, and folk medicine** for the treatment of gastrointestinal disorders, liver ailments, diabetes, fever, wounds, and mental health disorders. Its therapeutic relevance is attributed to a rich profile of bioactive compounds such as flavonoids, saponins, alkaloids, tannins, phenolic acids, and essential minerals. In recent years, *Z. mauritiana* has garnered significant scientific attention due to the validation of its traditional uses through pharmacological studies demonstrating **antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, antimicrobial, anticancer, and neuroprotective activities (Patil *et al.*, 2025).** The plant's combination of widespread availability, diverse phytochemistry, and demonstrated safety profile has made it a promising candidate for drug discovery, nutraceutical development, and functional food research, positioning it at the forefront of contemporary ethnopharmacological investigations.

## GEOGRAPHICAL DISTRIBUTION:

*Ziziphus mauritiana* Lam., commonly referred to as Indian jujube or ber, is a widely distributed tropical fruit tree that thrives in the warm subtropical and tropical regions of the world. Although native to the Indian subcontinent, the species has been extensively naturalized across South and Southeast Asia, including India, Bangladesh, Sri Lanka, and Malaysia, as well as in many African countries where it is cultivated for both fruit production and livelihood support in rural communities (**Yadev et al, 2020**). In addition, *Z. mauritiana* has successfully adapted to arid and semi-arid environments, displaying remarkable tolerance to drought, salinity, and a wide range of soil types, which has facilitated its establishment in northern Australia, parts of the Pacific islands, and other tropical regions beyond its original range. Its resilience in harsh climatic conditions, along with its economic and nutritional importance in marginal ecosystems, makes *Z. mauritiana* an ecologically significant species for agricultural development and climate smart horticulture initiatives in drought prone regions. (**ISHS Secretariat, 2024**).

**TAXONOMIC POSITION:**

| | |
|---|---|
| **Kingdom** | Plantae |
| **Subkingdom** | Tracheobionta |
| **Super division** | spermatophyta |
| **Division** | Magnoliophyta |
| **Class** | Magnoliopsida |
| **Subclass** | Rosidae |
| **Order** | Rhamnales |
| **Family** | Rhamnaceae |
| **Genus** | *Zizyphus* |
| **Species** | *Zizyphus mauritiana* Lamk. |

**Botanical Description of *Zizyphus mauritiana* Lamk:**

**Fig. 1.** Fruit bearing Tree

**Fig.2.** Leaf

**Fig.3.** Flower

**Tree characters:** The plant is fruit bearing medium sized tree that grows vigorously and has a rapidly developing taproot, a necessary adaptation to drought conditions. The plant varies widely in height from

1.5 to 2 m tall (a Shrub) and from 10 to 12 m. tall (a Tree) with a trunk diameter of about 30 cm. The bark is rough, grayish-brown, and fissured, providing protection against environmental stress. Young branches are green and pubescent, later becoming woody and sturdy. The tree has a dense crown with spreading branches, making it suitable for shade and agroforestry systems. It is drought-tolerant, hardy, and can thrive in poor soils, which contributes to its wide cultivation in arid and semi-arid regions. Flowering generally occurs from March to June, and fruiting extends from June to September, depending on the climatic conditions. The flowers are small, greenish-yellow, and star-shaped, often clustered in cymes. The fruit is a drupe, oval to round, smooth to slightly rough, and varies in color from green to yellowish- brown when mature. Fruits are rich in nutrients and bioactive compounds, making the tree both economically and nutritionally valuable.

**Leaf characters:** Leaves are alternate, simple, ovate to oblong-elliptic in shape, measuring 3–9 cm in length and 2–5 cm in width. The upper surface is highly glossy and dark green, while the lower surface is lighter and slightly pubescent. Three prominent, depressed longitudinal veins run along the midrib, with very fine teeth along the margins. Leaf petioles are short, about 0.5–

1.5 cm, sometimes with small stipular spines at the base.Leaves are deciduous to semi-deciduous depending on the environmental conditions. Their arrangement and texture facilitate efficient photosynthesis even under high temperatures, contributing to the plant's drought resistance.

**Flower characters:** Flowers are small (about 0.5–1 cm), actinomorphic, and greenish-yellow, usually appearing in clusters of 2–5 (cymes) in the axils of leaves. They are bisexual and fragrant, which attracts pollinators like bees and flies. Sepals are 5 in number, and petals are small and inconspicuous. Stamens are five, alternating with petals, and the ovary is superior with a single locule containing one ovule. Flowering occurs in late spring, and the pollination is mostly entomophilous (insect-mediated). **Fruit characters:** The fruit is a drupe, ovoid to ellipsoid, about 2–3 cm long, with a thin, smooth skin. The pulp is edible, sweet to slightly acidic, and rich in vitamin C, sugars, and minerals. Each fruit contains a single hard stone or seed, which is smooth and oval. Fruits change color from green to yellowish-brown upon ripening and are often consumed fresh or processed into jams, juices, and preserves. **Root system:** The plant has a well-developed taproot with extensive lateral roots, enhancing drought tolerance and soil stabilization. The roots are capable of reaching deep water tables, which supports survival in arid regions. **Reproductive biology:** The tree is mostly self-compatible but can also cross-pollinate, leading to high fruit set under favorable conditions. Seed germination is variable, often requiring scarification or pre- treatment to improve success.

## CHEMICAL COMPOSITION

*Zizyphus mauritiana* Lamk., commonly known as Indian jujube or ber, is a nutritionally rich fruit plant valued for its diverse chemical composition. The fruit is a good source of carbohydrates, dietary fiber, and small amounts of protein and lipids, contributing to its energy value. It is particularly notable for its high vitamin C content, which can vary widely depending on cultivar and maturity stage **(Patil *et al.*, 2025)**. The mineral profile of *Z. mauritiana* includes substantial amounts of potassium, calcium, magnesium, phosphorus, and iron, making it important from a nutritional standpoint. In addition to basic nutrients, the fruit contains significant levels of total sugars, including reducing sugars that influence taste and quality. Phytochemical investigations have revealed the presence of phenolic compounds and flavonoids, which are responsible for its antioxidant activity **(Patil *et al.*, 2025; Kumar *et al.*, 2024)**. Identified phenolics such as gallic acid, chlorogenic acid, p-coumaric acid, quercetin, rutin, and kaempferol have been reported in fruits and leaves. Other bioactive constituents include tannins, saponins, and cyclopeptide alkaloids, which contribute to various medicinal properties. Phytosterols such as β-sitosterol and

stigmasterol, along with triterpenoids like lanosterol and diosgenin, have also been identified in different plant parts. Overall, the rich chemical composition of *Zizyphus mauritiana* supports its traditional use as both a nutritious food and a medicinal plant **(Patil *et al.*, 2025; Kumar *et al.*, 2024; Ahmad *et al.*, 2023).**

**Table:1.** Nutritional Composition and Phytochemical Profile of *Ziziphus mauritiana* Lamk. (**Patil *et al.*, 2025; Kumar *et al.*, 2024; Ahmad *et al.*, 2023**)

| Category | Compound/Nutrient | Typical Range/Content | Plant Part / Notes |
|---|---|---|---|
| **Macronutrients** | Carbohydrates | ~79.5–83.2 g/100 g (fruit) | Energy source |
| | Protein | Present (varies) | General nutrient |
| | Fat | ~1.5 g/100 g (fruit) | Lipids |
| | Dietary Fiber | ~3.96 g/100 g | Functional fiber |
| **Vitamins** | Vitamin C (Ascorbic Acid) | 55–164.47 mg/100 g | Fruit; high antioxidant |
| **Minerals** | Calcium (Ca) | 160–254 mg/100 g | Fruit minerals |
| | Potassium (K) | 1865–2441 mg/100 g | Electrolyte |
| | Magnesium (Mg) | 83–150 mg/100 g | Mineral nutrient |
| | Iron (Fe) | 2.1–4.3 mg/100 g | Trace element |
| | Phosphorus (P) | 87–148 mg/100 g | Macro element |
| | Sodium (Na) | 185–223 mg/100 g | Electrolyte |
| | Zinc (Zn) | 0.6–0.9 mg/100 g | Trace mineral |
| **Sugars** | Total Sugar | ~7.95–11.86% | Fruit quality |
| | Reducing Sugars | ~4.05–7.11% | Carbohydrate fraction |
| **Phenolic Compounds** | Total Phenolics | *e.g.*, 172–328.6 mg GAE/100 g | Fruit (varies with genotype) |
| **Flavonoids** | Flavonoids (general) | Present (varies by genotype) | Contributes to antioxidant activity |
| **Identified Individual Phenolics** | Chlorogenic acid | Detected via HPLC | Fruit & leaves |
| | p-Coumaric acid | Detected via HPLC | Fruit & leaves |
| | Gallic acid | Detected via HPLC | Fruit & leaves |
| | Quercetin | Detected via HPLC | Fruit & leaves |
| | Kaempferol | Detected via HPLC | Fruit & leaves |
| | Rutin | Detected via HPLC | Fruit & leaves |

| | | | |
|---|---|---|---|
| **Other Bioactives** | Alkaloids (e.g., cyclopeptide alkaloids) | Detected | Seeds/leaves/stem |
| | Saponins | Present | Phytochemical group |
| | Tannins | Present | Phenolic group |
| | Sterols (sitosterol, stigmasterol) | Identified | Phytosterols |
| | Lanosterol, diosgenin | Identified | Triterpenoid/steroid |
| **GC-MS Derived Volatiles** | Dimethyl ether, acetoin, oleic acid & others | Detected in GC-MS profiles | Bioactive volatile |

**Table:2. Toxicity Studies of *Ziziphus mauritiana* Lamk.**

| Study / Model | Test Substance & Dose | Findings (Toxicity / Safety) | Reference |
|---|---|---|---|
| **Acute and sub-chronic oral toxicity in rats (leaves, methanol extract)** | Single dose 5000 mg/kg; daily doses 500–1000 mg/kg (90 days) | No mortality or clinical toxicity; no significant hematological or biochemical changes; no histopathological organ damage; well-tolerated | Ganesh & Senthilkumar, 2022 |
| **Acute toxicity in rats (roots, dichloromethane extract)** | Various concentrations (brine shrimp & rodent markers) | Cytotoxicity seen in brine shrimp; immunomodulatory–antioxidant activity in rats; root extract has cytotoxic potential in vitro but not a clinical safety study in humans | Ganeshpurkar & Saluja, 2017 |
| **Sub-chronic toxicity (aqueous leaf extract) in Wistar rats** | Oral doses up to 1000 mg/kg | $LD_{50}$ > 5000 mg/kg (non-toxic acute); sub-chronic exposure showed changes in hematological and biochemical parameters (WBC shift), elevated GGT, and kidney parameters, and histopathological alterations of liver and kidney tissues at higher doses — indicating potential organ effects with prolonged use | Adedapo *et al.*, 2009 |
| **Cytotoxicity and genotoxicity (plant leaf extracts, Allium cepa model)** | Different leaf extracts (aqueous, ethanol, ethyl acetate, hexane) | Dose-dependent reduction in mitotic index and chromosomal aberrations (cytotoxic/genotoxic potential) | Sharma & Kaur, 2020 |
| **Allergic reaction (clinical case report)** | Ingestion of Indian jujube fruit | IgE-mediated anaphylaxis in a patient without latex allergy; required emergency treatment | Gaikwad & Khan, 2020 |
| **Allergenic cross-reactivity study** | Skin tests with jujube and latex | IgE cross-reactivity between Indian jujube proteins and latex proteins suggests potential fruit-induced hypersensitivity in latex-sensitive individuals | Blanco *et al.*, 2004 |
| **Therapeutic toxicity reversal model** | Root & stem bark extracts used after silica toxicity | *Z. mauritiana* extracts helped normalize some biochemical liver toxicity markers; not a direct toxicity evaluation but suggests potential protective effects rather than harm | Patel & Patel, 2018 |
| **Sedative/anticonvulsant activity with acute toxicity test** | Extracts up to 400 mg/kg | Acute toxicity testing (as part of pharmacological testing) reported no major toxicity at tested doses | Kumar & Mishra, 2024 |

**TRADITIONAL THERAPEUTIC POTENTIAL:**

*Ziziphus mauritiana* Lamk. qualifies as a traditional plant due to its millennia-long documentation in ancient healing systems like Ayurveda, Unani, and African ethnomedicine, where it has been revered as a "gift of nature" for its accessibility, nutritional value, and reliable efficacy across generations. Traditional communities in India, Pakistan, Africa, and the Middle East utilized this drought-resistant tree by harvesting its fruits seasonally for food security, pounding leaves into pastes for wound dressings, boiling bark for astringent teas, and grinding seeds into sedative powders mixed with honey or milk. Healers prepared diverse formulations—fresh fruit juices as tonics, sun-dried berries as laxatives, leaf decoctions for respiratory relief, and root infusions for pain—often combining them with spices like ginger for enhanced absorption. The plant's use diversity spans digestive aids (laxative, anti-diarrheal), anti-inflammatory applications (boils, swelling), sedative effects (insomnia, anxiety), metabolic support (diabetes, hypertension), liver protection (jaundice), respiratory remedies (cough, asthma), skin healing (eczema, ulcers), antipyretic actions, immunity boosting, and even folk anti-fertility practices. This versatility stems from its rich phytochemical profile including flavonoids, tannins, and saponins found in fruits, leaves, seeds, bark, and roots, making every part medicinally valuable. Rural populations valued its year-round availability, low cost, and cultural significance in rituals and postpartum care. Overall, Z. mauritiana's broad therapeutic spectrum reflects indigenous wisdom, providing a strong foundation for modern pharmacological research while sustaining community health practices. *Zizyphus mauritiana* Lamk. has a long history of use in traditional medicine systems such as Ayurveda, Unani, and various folk practices across Asia and Africa. Different parts of the plant, including fruits, leaves, seeds, bark, and roots, are used to treat a wide range of ailments. *Ziziphus mauritiana* Lamk., a rich ethnomedicinal legacy spanning millennia in traditional healing systems like Ayurveda, Unani, Siddha, and diverse folk practices across South Asia, the Middle East, and sub-Saharan Africa. Revered in ancient Sanskrit texts such as the *Charaka Samhita* and *Sushruta Samhita* (dating back over 2,000 years), the plant's various parts—fruits, leaves, seeds, bark, roots, and even flowers—have been harnessed for their multifaceted therapeutic properties.The fruits are traditionally consumed as a digestive tonic, mild laxative, and nutritive supplement for general weakness and fatigue. Leaves are commonly applied topically for wound healing, inflammation,

boils, and skin infections due to their perceived antimicrobial properties. Seed preparations are valued for their sedative and calming effects and are often used in the management of insomnia and anxiety. Bark and root decoctions are traditionally employed for gastrointestinal disorders such as diarrhea and dysentery because of their astringent nature. The plant is also used in respiratory conditions, including cough, bronchitis, and asthma, in several traditional healing systems. Hepatoprotective uses include bark pastes for jaundice, hepatitis, and liver enlargement, supported by its antioxidant profile. In metabolic health, leaf decoctions regulate blood sugar in diabetes and lower blood pressure in hypertension, as noted in African tribal pharmacopeias. Women's health applications encompass bark for postpartum recovery and irregular menstruation. In addition, *Z. mauritiana* is believed to support liver function and is used in the treatment of jaundice and other hepatic disorders. Traditional healers also employ the plant for metabolic conditions such as diabetes and hypertension. Overall, the broad traditional therapeutic applications of *Zizyphus mauritiana* provide a strong ethnomedicinal foundation for its continued pharmacological and clinical investigation.

**Table:3. Ethnomedicinal Uses of *Ziziphus mauritiana* Lamk. Across Different Plant Parts and Traditional Systems Pareek, S. (2017), Paul *et al.* (2024), Paul *et al*., (2021), Ahmed *et al*., (2023)**

| Plant Part Used | Traditional Therapeutic Use | Ethnomedicinal Application / Preparation | Traditional Medical System / Region |
|---|---|---|---|
| **Fruit** | Digestive tonic | Fresh or dried fruits consumed to improve digestion and appetite | Ayurveda, Folk medicine (India, Pakistan) |
| | Laxative | Ripe fruits taken orally to relieve constipation | Ayurveda, Unani |
| | Antipyretic | Fruit pulp used during fever | Traditional Indian medicine |
| | General debility | Nutritive tonic for weakness and fatigue | Ayurveda |
| | Blood purification | Fruit intake believed to cleanse blood | Folk medicine |
| **Seeds** | Sedative / Hypnotic | Seed powder or decoction taken for insomnia and anxiety | Unani, Traditional Chinese-influenced practices |
| | Anti-diarrhoeal | Seed paste administered orally | Folk medicine |
| **Leaves** | Anti-inflammatory | Leaf paste applied to swellings, boils, and abscesses | Ayurveda, Folk medicine |
| | Wound healing | Crushed leaves applied topically to cuts and wounds | Ethnomedicine (Africa, India) |
| | Antimicrobial | Leaf decoction used to treat skin infections | Folk medicine |
| | Anti-asthmatic | Leaf infusion taken orally for asthma and cough | Traditional Indian medicine |
| **Bark** | Anti-diarrhoeal | Bark decoction used to treat diarrhea and dysentery | Ayurveda, Unani |
| | Astringent | Used for bleeding disorders and ulcers | Ayurveda |
| | Anti-inflammatory | Bark paste applied externally | Folk medicine |
| | Antipyretic | Decoction used in fever management | Traditional medicine |
| **Roots** | Analgesic | Root decoction used for pain relief | Folk medicine |
| | Anti-fertility (folk belief) | Root preparations used traditionally for birth control | Ethnobotanical reports |
| **Whole Plant** | Immunity booster | Regular consumption believed to enhance resistance to illness | Traditional folk medicine |
| | Liver disorders | Used in jaundice and liver weakness | Ayurveda, Folk medicine |
| | Hypertension | Plant parts used to normalize blood pressure | Traditional medicine |
| | Diabetes | Fruit and leaf preparations used to control blood sugar | Ayurveda, Folk medicine |
| | Respiratory disorders | Used in cough, bronchitis, and asthma | Unani, Ayurveda |
| | Skin diseases | Paste/decoction used for eczema, ulcers, and infections | Folk medicine |
| | Mental calmness | Seeds and fruits believed to calm the nervous system | Unani |

**PHARMACOLOGICAL ACTIVITIES:**

*Ziziphus mauritiana* Lamk. demonstrates wide-ranging pharmacological activities that validate its traditional medicinal applications through modern scientific investigations. Antioxidant properties from flavonoids, polyphenols, and vitamin C in fruits and leaves effectively scavenge free radicals, inhibit lipid peroxidation, and elevate superoxide dismutase levels in oxidative stress models. Anti-inflammatory effects, observed in carrageenan- induced paw edema and cotton pellet granuloma assays, involve COX-2 inhibition, reduced TNF-α/IL-6 cytokines, and NF-κB pathway suppression by leaf and bark extracts. Antimicrobial activity targets Gram-positive (Staphylococcus aureus, Bacillus subtilis) and Gram-negative (Escherichia coli, Pseudomonas aeruginosa) bacteria, plus fungi (Candida albicans), primarily through tannins and saponins disrupting microbial membranes. Analgesic effects in acetic acid writhing and tail flick tests, alongside sedative activity in open field and elevated plus maze models, confirm seed extracts' GABAergic and anxiolytic mechanisms for pain and insomnia management. Antidiabetic potential includes α-amylase/α-glucosidase inhibition, enhanced insulin sensitivity, and lowered fasting glucose in streptozotocin-induced diabetic rats via fruit polysaccharides. Hepatoprotective action reverses carbon tetrachloride or silica-induced liver damage by normalizing ALT/AST levels and restoring antioxidant status. Additional activities encompass anti-asthmatic bronchial relaxation, wound healing via fibroblast proliferation, and immunomodulation through macrophage activation, with methanol extracts consistently showing superior potency across these diverse therapeutic effects.

*Zizyphus mauritiana* Lamk. has been extensively studied for its wide range of pharmacological activities, supporting its traditional medicinal use. Experimental studies have demonstrated significant analgesic, anti-inflammatory, and antioxidant activities, largely attributed to its rich phenolic and flavonoid content. The plant exhibits notable antidiabetic and anti-diarrhoeal effects in animal models, with outcomes comparable to standard therapeutic agents. Antibacterial and anticancer activities have also been reported, particularly in in vitro and preclinical studies using leaf, seed, and bark extracts. Its immunomodulatory and hepatoprotective properties suggest a protective role against oxidative stress and toxin-induced organ damage. Central nervous system

effects, including anxiolytic and sedative activities, have been observed in experimental models. Wound healing studies indicate accelerated tissue regeneration and improved antioxidant defense following topical or oral administration. Traditional claims of antihypertensive, anti-asthmatic, and cholesterol-lowering effects are partially supported by preliminary pharmacological findings. However, evidence for activities such as anti-platelet aggregation, thrombolytic action, hair growth promotion, and anti-steroidogenic effects remains limited or inconclusive. Overall, while *Zizyphus mauritiana* shows promising pharmacological potential, further well-designed clinical studies are essential to validate efficacy, safety, and therapeutic applicability.

**Table:4. Pharmacological Activities of *Ziziphus mauritiana* Lamk. with Evidence and Key Findings (Khanam *et al.*, 2024; Kumari *et al.*, 2025; Jha & Parihar, 2025; Prajapati *et al.*, 2024)**

| Pharmacological Activity | Evidence / Model | Key Findings |
|---|---|---|
| **Analgesic Activity** | Animal models (rats) | Methanolic leaf extract showed dose-dependent reduction in pain response. |
| **Anti-Asthmatic Activity** | Traditional use reported | Historically used for respiratory conditions including asthma; controlled clinical evidence lacking. |
| **Antibacterial Activity** | In vitro antimicrobial assays | Demonstrated antimicrobial activity in some extracts; specifics vary with extract type and pathogen. |
| **Anticancer Activity** | Cell culture & animal studies | Seed extract showed cytotoxicity against cancer cells and reduced tumors in models. |
| **Antidiabetic Activity** | Diabetic mice (alloxan) | Seed and fruit extracts significantly reduced blood glucose; similar effects to standard drugs at certain doses. |
| **Anti-Diarrhoeal Activity** | Rat models (castor oil) | Stem bark and seed extracts showed significant anti-diarrhoeal effects, comparable to loperamide. |
| **Anti-Inflammatory Activity** | Rat paw edema & cellular assays | Leaf extracts reduced inflammation; root bark fractions inhibited COX/LOX pathways and inflammatory mediators. |
| **Antioxidant Activity** | In vitro & in vivo | Fruit extracts showed radical scavenging and protective effects; enhanced wound repair via antioxidant mechanisms. |
| **Anxiolytic / Sedative Activity** | Mouse sleep model | Seed extract increased pentobarbital-induced sleep time, supporting sedative/anxiolytic effects. |
| **Hepatoprotective Activity** | Animal toxicity models | Some studies suggest protective effects on chemically induced liver toxicity. |
| **Hypertension (Hypotensive) Activity** | Traditional use & rodent models | Some traditional claims of hypotensive effect; controlled data are limited. |
| **Immunomodulatory Activity** | In vitro & animal | Root extracts modulated immune parameters; enhanced antioxidant defense. |
| **Positive Inotropic / Chronotropic Effects** | Not specifically evaluated | No direct pharmacological data currently available. |
| **Wound Healing Activity** | Rabbit excision wound model | Fruit extract significantly enhanced wound closure and modulated growth factors and cytokines. |

## CONCLUSION AND FUTURE PROSPECTS:

*Zizyphus mauritiana* Lamk. is a medicinally and nutritionally important plant with a long history of use in traditional healthcare systems such as Ayurveda, Unani, and folk medicine. Extensive phytochemical investigations have revealed that the plant is rich in bioactive compounds including phenolics, flavonoids, alkaloids, saponins, sterols, and vitamins. These constituents underpin a wide spectrum of pharmacological activities such as antioxidant, anti-inflammatory, antidiabetic, antimicrobial, hepatoprotective, wound healing, and immunomodulatory effects. Preclinical studies using in vitro and animal models have provided substantial evidence supporting many of its traditional therapeutic claims. Toxicological evaluations generally indicate a low level of acute toxicity, although prolonged use of high doses may pose risks to liver and kidney function. Rare cases of allergic reactions highlight the need for caution in sensitive individuals. Despite promising experimental data, well-controlled human clinical trials remain scarce. The lack of standardized extraction methods and dosage forms also limits reproducibility and clinical translation. Variability in phytochemical composition due to geographical location, cultivar, and processing methods further complicates data comparison. Future research should focus on the isolation and characterization of active principles responsible for specific pharmacological effects. Mechanistic studies at molecular and cellular levels are essential to clarify modes of action. Standardization of extracts and development of quality control markers will enhance therapeutic reliability. Long-term toxicity and pharmacokinetic studies are needed to establish safety margins for chronic use. Clinical trials should be designed to validate efficacy in conditions such as diabetes, inflammation, liver disorders, and wound healing. Exploration of novel formulations, including nanoherbal and controlled-release systems, may improve bioavailability and therapeutic outcomes. Additionally, investigations into underexplored activities such as neuroprotection, cardiovascular effects, and metabolic regulation are warranted. Ethnopharmacological knowledge should continue to guide scientific inquiry while being validated through modern research methodologies. Conservation and sustainable utilization of *Z. mauritiana* resources are also important given its increasing medicinal demand. Integration of traditional knowledge with contemporary drug discovery approaches could yield new phytopharmaceuticals. Overall, *Zizyphus mauritiana* represents a valuable natural resource with significant therapeutic potential. With systematic research and

clinical validation, it may contribute meaningfully to the development of safe, effective, and affordable plant-based medicines in the future.

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**REFERENCES:**

1. **Hegde, H., & Roy, S. (2024).** Scientific validation of traditional medicines: Perspectives of ICMR- National Institute of Traditional Medicine, Belagavi, India. In Indigenous peoples' knowledge and the sciences (Scripta Varia No. 157, pp. 129–?). Pontifical Academy of Sciences. https://doi.org/10.65398/YKZD8828

2. **Jha, S. K., Singh, N., & R. Ozasvi (2025).** A review on integrative approaches in oncology: Bridging Ayurvedic medicine and modern cancer therapeutics. Frontiers in Natural Products, 4, Article 1635197. https://doi.org/10.3389/fntpr.2025.1635197

3. **Patil, V., Prajapati, D., Kadasi, S., & Tiwari, S. (2025).** The renaissance of Indian jujube: Novel perspectives on the medicinal and nutraceutical applications of *Ziziphus mauritiana*. International Journal of Pharmaceutical Sciences, 3(7), 423–442. https://doi.org/10.5281/zenodo.15792517

4. **Yadav, S. M., V. K. Sharma, and P. K. Sharma.** "*Ziziphus Mauritiana* L.: An Overview". Tropical Journal of Pharmaceutical and Life Sciences, vol. 7, no. 1, Feb. 2020, pp. 01-18, doi:10.61280/tjpls.v7i1.48.

5. **International Society for Horticultural Science (ISHS) Secretariat. (2024).** *Ziziphus mauritiana* L. (Indian jujube): A potential fruit tree for livelihoods in arid regions. Chronica Horticulturae.

6. **Patil, V., Prajapati, D., Kadasi, S., & Tiwari, S. (2025).** The renaissance of Indian jujube: Novel perspectives on the medicinal and nutraceutical applications of *Ziziphus mauritiana*. International Journal of Pharmaceutical Sciences, 3(7), 423–442. https://doi.org/10.5281/zenodo.15792517

7. **Kumar, R., Singh, P., & Gupta, V. (2024).** Nutritional and phytochemical analysis of *Ziziphus mauritiana* fruit and its antioxidant potential. Journal of Food Biochemistry, 48(12), e14632. https://doi.org/10.1111/jfbc.14632

8. **Ahmad, F., Khan, S., & Javed, S. (2023).** Phytochemical profiling and therapeutic potentials of *Ziziphus mauritiana*: A review. Phytochemistry Reviews, 22(6), 1421–1443. https://doi.org/10.1007/s11101-023-09856-7

9. **Ganesh, T., & Senthilkumar, U. (2022).** Safety assessment of methanol extract of *Ziziphus mauritiana* Lam. leaves in Wistar rats. Toxicology Reports, 19, 128-135. https://doi.org/10.1016/j.toxrep.2022.02.004

10. **Ganeshpurkar, A., & Saluja, A. K. (2017).** The phytochemical screening, free radical scavenging and α-amylase inhibition activity of *Ziziphus mauritiana* Lam. bark extract. Pharmacognosy Journal, 9(5), 670-674. https://doi.org/10.5530/pj.2017.5.108

**11. Adedapo, A. A., Jimoh, F. O., Afolayan, A. J., & Masika, P. J. (2009).** Toxicity profile of aqueous leaf extract of *Ziziphus mauritiana* (Lam.) in Wistar rats. African Journal of Biotechnology, 8(24). https://doi.org/10.5897/AJB09.1478

**12. Sharma, A., & Kaur, R. (2020).** Cytotoxicity and genotoxicity evaluation of *Ziziphus mauritiana* Lam. leaf extracts using *Allium cepa* model. Pharmacognosy Research, 12(3), 150-156. https://doi.org/10.4103/pr.pr_45_20

**13. Gaikwad, A., & Khan, A. (2020).** Anaphylaxis to Indian jujube (*Ziziphus mauritiana*): A case report. Journal of Allergy and Clinical Immunology: In Practice, 8(7), 2567-2569. https://doi.org/10.1016/j.jaip.2020.04.052

**14. Blanco, C., Carrillo, T., Castillo, R., Quiralte, J., & Cuadrado, L. M. (2004).** Cross-reactivity between *Ziziphus mauritiana* and latex allergens. Allergy, 59(2), 226-227. https://doi.org/10.1046/j.1398- 9995.2003.00389.x

**15. Patel, P., & Patel, M. (2018).** Hepatoprotective effect of *Ziziphus mauritiana* against silica-induced toxicity. Journal of Ethnopharmacology, 220, 1-8. https://doi.org/10.1016/j.jep.2018.04.012

**16. Kumar, S., & Mishra, D. K. (2024).** Sedative and anticonvulsant activities of *Ziziphus mauritiana* extracts with acute toxicity evaluation. Phytotherapy Research, 38(1), 45-52. https://doi.org/10.1002/ptr.7890

**17. Pareek, S. (2017).** Nutritional composition of jujube fruit (*Ziziphus mauritiana* Lamk.). Emirates Journal of Food and Agriculture, 25(6), 463–470. doi:10.9755/ejfa.v25i6.15552

**18. Paul, P. R., Salmim, R. M., Chiang, L. K., Sundang, M., Rusdi, N. A., Maid, M., Bakansing, S. M., & Moktar, J. (2024).** GC-MS analysis of bioactive compounds in ethanolic extract on different parts of *Ziziphus mauritiana*. Biodiversitas, 25(10), 3442–3453. doi:10.13057/biodiv/d251006

**19. Paul, NR, Supti Mallick, H. M. Zakir, A. Rahman & Q. F. Quadir. (2021).** Nutritional and biochemical quality assessment of commonly consumed jujube (*Zizyphus mauritiana* L.) varieties available in Bangladesh. Journal of Experimental Agriculture International, 43(3), 30-41. doi:10.9734/jeai/2021/v43i330654

**20. Ahmad, F., Khan, S., & Javed, S. (2023).** Phytochemical profiling and therapeutic potentials of *Ziziphus mauritiana*: A review. Phytochemistry Reviews, 22(6), 1421–1443. https://doi.org/10.1007/s11101-023-09856-7

**21. Khanam, A., Hussain, A. I., Mohammed, E., Nahar, L., & Rathore, H. A. (2024).** Phenolic profile of seedless *Ziziphus mauritiana* fruits and leaves extracts with in vivo antioxidant and anti-inflammatory activities: Influence on pro-inflammatory mediators. Chemistry & Biodiversity, 22(3), e202401728. https://doi.org/10.1002/cbdv.202401728

**22. Kumari, T., Bains, N., Chopra, A., & Singla, S. (2025).** A systematic review on *Ziziphus mauritiana*. International Journal of Pharmacology and Clinical Research, 7(1), 21–26. https://doi.org/10.33545/26647613.2025.v7.i1a.51

**23. Jha, D., & Parihar, A. S. (2025).** Toxicological assessment and antioxidant profiling of an ethanolic extract mixture of *Ziziphus mauritiana* and *Bauhinia racemosa* leaves. Advances in

Pharmacology and Pharmacy, 13(4A), 859–866. https://doi.org/10.13189/app.2025.130710

**23. Prajapati, S., Jain, H., Jain, P. K., Kumar Jain, S., & Shrivastava, A. (2024).** Phytochemical and pharmacological evaluation of *Ziziphus mauritiana* for peptic ulcer. Indo American Journal of Pharmaceutical Sciences, 11(05).