DOI: 10.55522/jmpas.V14I6.6998 ISSN NO. 2320 – 7418

International peer reviewed open access journal

Journal of Medical Pharmaceutical and Allied Sciences

Journal homepage: www.jmpas.com CODEN: JMPACO

Review article

A comprehensive review of *Tamarindus indica* l.: ethnopharmacology, phytochemistry, and multidimensional therapeutic potential

Rakesh Subhash Dhole *

Department of Pharmaceutical Quality Assurance, KVPS Maharani Ahilyabai Holkar College of Pharmacy, Shirpur, Maharashtra, India

Corresponding author: Rakesh Subhash Dhole, ✉ rakeshdhole94@gmail.com, **Orcid Id**: https://orcid.org/ 0009-0003-1490-0616

Department of Pharmaceutical Quality Assurance, KVPS Maharani Ahilyabai Holkar College of Pharmacy, Shirpur, Maharashtra, India

Received - 20-11-2025**, Revised** - 28-11-2025, **Accepted** - 25-12-2025 **(DD-MM-YYYY)**

Refer This Article

Rakesh Subhash Dhole, 2025. A comprehensive review of Tamarindus indica l.: ethnopharmacology, phytochemistry, and multidimensional therapeutic potential. Journal of medical pharmaceutical and allied sciences, V 14 - I 6, Pages - 24 – 28. Doi: https://doi.org/10.55522/jmpas.V14I6.6998.

ABSTRACT

Tamarindus indica L., commonly referred to as tamarind, is a perennial, tropical tree belonging to the Fabaceae family. Revered for centuries across diverse cultures, it serves not only as a culinary ingredient but also as a cornerstone of traditional medicinal systems. This extensive review synthesizes current knowledge from ethnopharmacological surveys, phytochemical analyses, and pharmacological investigations to present a holistic overview of tamarind's therapeutic profile. Traditionally, various plant parts—including fruit pulp, leaves, bark, seeds, and roots—have been employed to treat a wide array of ailments such as gastrointestinal disorders, fever, inflammatory conditions, diabetes, and skin wounds. Phytochemical profiling has identified a rich matrix of bioactive constituents, including polyphenols (epicatechin, procyanidin), flavonoids (orientin, vitexin), organic acids (tartaric, citric), triterpenoids (lupeol), polysaccharides (xyloglucan), and essential oils. Contemporary pharmacological studies substantiate these traditional uses, demonstrating significant antioxidant, antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective, wound-healing, and hypolipidemic activities. This article aims to consolidate the scattered data into a coherent narrative, highlighting the scientific validation of tamarind's ethnomedicinal claims and identifying promising avenues for future research, particularly in drug discovery and the development of standardised nutraceutical formulations.

Keywords: Azadirachta indica, Phytochemistry, Refractive index, Alkaloids, Pharmacognosy, Polypharmacology.

INTRODUCTION

The global healthcare landscape is witnessing a paradigm shift toward integrative approaches that combine conventional medicine with traditional, plant-based therapies. Within this context, *Tamarindus indica* L. emerges as a plant of exceptional interest due to its dual role as a nutritional source and a therapeutic agent. Indigenous to the dry savannas of tropical Africa, the tamarind tree has been disseminated by human activity across the Indian subcontinent, Southeast Asia, and the Americas over millennia. Its remarkable adaptability to arid and semi-arid conditions has made it a valuable agroforestry species, while its multifarious applications have secured its place in the material and cultural fabric of numerous societies [1].

Historical records attest to its longstanding medicinal use. Ancient Indian Ayurvedic texts, the Charaka Samhita and Sushruta Samhita, document its utility as a digestive aid, cardioprotective, and remedy for biliary disorders. In traditional African medicine, it is one of the most frequently cited plants, with uses meticulously documented from Senegal to Sudan and down to Madagascar. Arabic and European pharmacopoeias of the medieval and early modern periods listed tamarind preparations as official laxatives and refrigerants. This cross-cultural and trans-historical consistency in application suggests a robust empirical foundation for its therapeutic effects, one that is increasingly being interrogated and validated by modern scientific methodologies [2].

The contemporary relevance of tamarind is multifaceted. In an era grappling with the dual burdens of infectious diseases and non-communicable, lifestyle-related chronic illnesses, the search for safe, effective, and affordable therapeutic agents is paramount. Plants like tamarind, with broad-spectrum bioactivity and a high margin of safety, offer tremendous potential. This review endeavours to comprehensively collate and critically evaluate the existing body of research on *Tamarindus indica*, spanning its ethnobotanical roots, its complex chemical architecture, and its demonstrated biological activities. By doing so, it seeks to bridge the gap between traditional wisdom and evidence-based science, providing a consolidated resource for researchers, clinicians, and product developers interested in harnessing the full potential of this remarkable species [3-6].

Botanical profile and geographical distribution

Tamarindus indica is a slow-growing, long-lived tree capable of reaching heights of 20 to 30 meters, with a dense, spreading crown that provides valuable shade. The trunk is typically short and stout, with greyish-brown, longitudinally fissured bark. The leaves are paripinnately compound, featuring 10 to 20 pairs of opposite, oblong leaflets that are bright green and glabrous. The flowers are inconspicuous, borne in small racemes, with petals that are pale yellow, streaked with red or purple. The fruit is the most distinctive feature: a brown, indehiscent, pod-like legume, 5 to 15 cm in length, containing a sticky, brownish-red pulp that encases 3 to 12 hard, glossy seeds. This pulp, with its characteristic sweet-sour taste, is the source of its culinary and much of its medicinal value [7].

While its origins lie in tropical Africa, tamarind has become pantropical in distribution due to extensive cultivation. It is found extensively across the Indian subcontinent, in Southeast Asian nations like Thailand and Indonesia, in parts of China, and throughout Central and South America, including Mexico and Brazil. In its native African range, it is a characteristic species of the Sudanian and Sahelian savanna woodlands and agroforestry parklands. Its success is attributed to its drought tolerance and ability to thrive on a variety of soil types, though it requires a pronounced dry season for optimal fruit set [8].

Ethnopharmacology: a tapestry of traditional uses

The ethnopharmacological portfolio of *T. indica* is extraordinarily diverse, with different plant parts employed for specific conditions, often revealing regional patterns of use. A synthesis of data from numerous ethnobotanical surveys, particularly the seminal work by Havinga et al. (2010), allows for a systematic overview.

Fruit pulp

The most universally recognised use of tamarind is as a gentle, effective laxative, a property attributed to its high content of tartaric acid, potassium bitartrate, and mucilage. This use is pervasive from West Africa through to India. The pulp, often dissolved in water and sweetened, is also consumed as a refrigerant beverage to reduce fever (febrifuge) and quench thirst. In many cultures, it is considered a digestive aid and carminative [9].

Leaves

Fresh or dried leaves are extensively used topically for wound healing. They are applied as a poultice, a powdered dressing, or used in a decoction to wash wounds, ulcers, and even circumcision sites, particularly in West Africa. Internally, leaf decoctions or juices are administered for a range of conditions: to treat jaundice and as a blood tonic in Nigeria; for coughs, colds, and sore throats in East Africa and Asia; and for the management of malaria in Ghana and Benin [10].

Bark

The stem bark, rich in tannins, is a prominent astringent. In West Africa, a bark decoction is a standard remedy for diarrhoea and dysentery. It is also used externally, like the leaves, for wound washing and as a skin cleanser. In some regions, bark preparations are used to treat respiratory ailments like asthma and bronchitis [11].

Seeds

After roasting or boiling to remove seed coats, the seeds are consumed in times of famine. Medicinally, seed powder or extracts are used to treat dysentery and chronic diarrhoea, particularly in Ayurveda. The seed polysaccharide (tamarind kernel powder) has found modern application as a soothing agent in eye drops for dry eye syndrome and as a stabiliser in pharmaceutical and food industries [12].

Roots and flowers

Root decoctions are less commonly used but are reported for severe conditions like chest pains, epilepsy, and as an ingredient in anti-venom preparations. Flowers are sometimes used in hepatic disorders [13].

A fascinating ethnopharmacological observation is the regional specialisation in plant part usage. For diarrhoea, West African traditions predominantly use the bark, while East African practices favour the leaves. This may reflect cultural transmission pathways or local experimentation with differentially available resources. Furthermore, the use of the fruit as a laxative appears far more entrenched in West African and Soudano-Sahelian cultures than in East Africa, possibly linked to culture-bound concepts of disease "egress" or purification.

Phytochemical constituents

The chemical basis of bioactivity

The therapeutic efficacy of *T. indica* is rooted in its rich and varied phytochemistry. Advanced analytical techniques have enabled the identification of numerous bioactive compounds across all plant parts.

Fruit pulp

The pulp is a complex matrix. Its sour taste derives from a high concentration (10-20%) of tartaric acid, along with citric, malic, and acetic acids. It contains substantial sugars (25-40%), primarily

invert sugar (glucose and fructose), and pectin (2-8%). The pulp is also a significant source of vitamins (B1, B2, B3, and C) and minerals (potassium, phosphorus, and calcium). Importantly, it houses a range of polyphenols, including (+)-catechin, (-)-epicatechin, procyanidins, and taxifolin, which are primarily responsible for its potent antioxidant activity. Aromatic compounds like benzyl benzoate, cinnamates, and ethyl cinnamate contribute to its flavour and may possess biological activity.

Leaves

Phytochemical screening reveals a diverse profile. Flavonoids are abundant, with glycosides such as orientin, isoorientin, vitexin, and isovitexin being characteristic. Triterpenoids, most notably lupeol and lupanone, are present and are of significant pharmacological interest. The leaves also contain tannins, alkaloids, and several essential oils, including limonene and geraniol. The presence of saponins and glycosides has also been reported.

Seeds

The seeds are composed of about 60-70% polysaccharides, primarily a galactoxyloglucan. This polymer is the basis for tamarind kernel powder (TKP), valued for its mucoadhesive and stabilising properties. The seed coat (testa), often discarded, is particularly rich in antioxidant polyphenols, including oligomeric proanthocyanidins. The kernel itself contains proteins, fats (with fatty acids like oleic, linoleic, and palmitic), and sterols such as campesterol, β-amyrin, and β-sitosterol [14].

Bark and roots

The bark is distinguished by its very high tannin content (reportedly up to 70%), classifying it as a strong astringent. It also contains flavonoids, saponins, and glycosides. Analysis of root bark has identified compounds like n-hexacosane, eicosanoic acid, β-sitosterol, and the cyclitol (+)-pinitol, the latter known for potential insulin-mimetic properties.

This phytochemical diversity means that different extracts (aqueous, ethanolic, methanolic, ethyl acetate) from different plant parts can yield distinct biological activities, underscoring the importance of precise characterisation in research and product development [15].

Pharmacological activities

Scientific Validation of Traditional Claims

A substantial body of in vitro and in vivo research provides compelling evidence for the bioactivities long ascribed to tamarind.

Antioxidant activity

This is one of the most consistently demonstrated properties. Extracts from the fruit pulp, seed coat, leaves, and bark show strong free radical scavenging capacity in assays like DPPH, ABTS, and FRAP. The activity correlates strongly with total phenolic and flavonoid content. This antioxidant potential is mechanistically linked to many of its other protective effects, such as hepatoprotection, cardioprotection, and anti-ageing properties, by mitigating oxidative stress—a key contributor to chronic disease pathogenesis.

Antimicrobial and antiparasitic properties

Multiple studies confirm broad-spectrum activity. Methanolic and aqueous extracts of leaves and bark inhibit the growth of Gram-positive bacteria (e.g., *Staphylococcus aureus*, *Bacillus subtilis*) and Gram-negative bacteria (e.g., *Escherichia coli*, *Salmonella typhi*, *Klebsiella pneumoniae*). Antifungal activity against species like *Candida albicans* has also been reported. The mechanisms likely involve tannin-mediated precipitation of microbial proteins and disruption of cell membranes, as well as flavonoid interference with microbial enzymes. Additionally, seed and bark extracts have shown efficacy against parasitic worms (helminthes), including in models of schistosomiasis.

Anti-inflammatory and analgesic effects

Animal models of inflammation, such as carrageenan-induced paw oedema and arachidonic acid-induced ear oedema, demonstrate significant anti-inflammatory effects for extracts of tamarind leaves, fruit, and bark. The triterpenoid lupeol is a key anti-inflammatory agent, known to inhibit pathways involving cyclooxygenase-2 (COX-2), nitric oxide (NO), and pro-inflammatory cytokines (TNF-α, IL-1β, IL-6). These anti-inflammatory actions directly translate to analgesic (pain-relieving) effects, as shown in models like acetic acid-induced writhing and the hot-plate test.

Antidiabetic and hypolipidemic activities

This is an area of intense research. Aqueous and alcoholic extracts of tamarind seeds have repeatedly been shown to lower fasting blood glucose levels in streptozotocin-induced diabetic rats. Proposed mechanisms include stimulation of insulin secretion from pancreatic β-cells, enhancement of peripheral glucose uptake (via upregulation of GLUT-4 transporters), and inhibition of intestinal α-amylase and α-glucosidase enzymes, slowing carbohydrate absorption. Concurrently, tamarind fruit pulp extract exhibits hypolipidemic effects, reducing serum total cholesterol, triglycerides, and LDL-C while increasing HDL-C in hypercholesterolemic animal models. These combined activities position tamarind as a promising agent for managing metabolic syndrome [16].

Hepatoprotective activity

Pre-treatment with tamarind flower or leaf extracts protects rodent livers from damage induced by hepatotoxins like paracetamol (acetaminophen), carbon tetrachloride, and anti-tubercular drugs (isoniazid/rifampicin). This is evidenced by the significant attenuation of elevated serum markers of liver damage (AST, ALT, ALP) and bilirubin, along with improved histological architecture. The protection is largely attributed to the antioxidant phytochemicals scavenging free radicals generated during toxin metabolism [17].

Wound healing potential

Topical application of tamarind leaf or bark paste accelerates the healing of excision and incision wounds in rats. The process involves faster wound contraction, reduced epithelization period, increased tensile strength of scar tissue, and enhanced collagen deposition. The astringent and antimicrobial properties of tannins, coupled with the anti-inflammatory activity, create a favourable environment for tissue regeneration [18].

Other notable activities

Gastroprotective: Seed and pulp extracts show anti-ulcer activity in models induced by ethanol, stress, or NSAIDs.

Neuroprotective: Antioxidant compounds may offer protection against neurodegenerative processes.

Immunomodulatory: Polysaccharides from seeds can stimulate certain immune functions.

Anticancer/Cytotoxic: Some extracts and isolated compounds (e.g., lupeol) show cytotoxic effects against various cancer cell lines in preliminary studies, though more research is needed.

Toxicological profile and drug interaction considerations

Tamarind is generally recognised as safe (GRAS) for culinary use. Acute and sub-chronic toxicity studies in rodents, such as the 28-day dietary study with tamarind seed polysaccharide cited by Heimbach et al. (2013), have shown no significant adverse effects on body weight, organ weights, haematology, or clinical biochemistry at high doses. However, pharmacological activity implies the potential for interactions with conventional drugs.

Anticoagulants/antiplatelets

Due to possible antiplatelet or coumarin-like constituents, tamarind might potentiate the effects of drugs like warfarin, aspirin, or clopidogrel, increasing the risk of bleeding [18].

Hypoglycemics

Its blood sugar-lowering effect could enhance the action of insulin or oral diabetic medications, risking hypoglycemia. Careful monitoring is advised [19].

Cytochrome P450 enzymes

There is limited data, but the potential for tamarind compounds to inhibit or induce drug-metabolising enzymes exists, which could alter the plasma levels of co-administered drugs.

While serious adverse events are rare, prudence dictates that individuals on medication, pregnant women, and those with specific health conditions consult healthcare providers before using tamarind in concentrated medicinal doses [20].

CONCLUSION

Tamarindus indica L. stands as a paradigmatic example of a medicinal food, seamlessly blending nutritional value with a wide spectrum of scientifically validated therapeutic properties. This review has traversed its journey from ancient ethnopharmacological applications to modern laboratory confirmations, revealing a plant of remarkable chemical complexity and biological potency. The convergence of traditional knowledge—meticulously documented across continents—with contemporary phytochemical and pharmacological analysis provides a powerful validation of its utility.

The evidence is compelling: tamarind possesses legitimate antioxidant, antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective, and wound-healing capacities, among others. These activities are not mere folklore but are grounded in identifiable bioactive compounds like tartaric acid, lupeol, epicatechin, and xyloglucan, acting through discernible biochemical pathways.

However, the journey from traditional remedy to evidence-based medicine is not complete. To fully realise the potential of *T. indica*, future research must focus on several critical fronts:

Bioactivity-Guided Isolation: While many compounds are known, systematic fractionation and isolation studies are needed to identify novel molecules with unique mechanisms of action, particularly for complex conditions like cancer and neurodegenerative diseases.

Standardisation and Quality Control: Developing reliable biomarkers and analytical methods for standardising tamarind extracts is essential for ensuring consistent efficacy, safety, and batch-to-batch reproducibility in commercial products

Advanced Pharmacological and Toxicological Studies: More sophisticated in vivo studies, including those investigating pharmacokinetics (absorption, distribution, metabolism, excretion), chronic toxicity, and genotoxicity, are required. Research on specific drug-herb interactions is also crucial.

Rigorous Clinical Trials: Well-designed, randomised, placebo-controlled human clinical trials are the definitive step needed to establish effective therapeutic doses, treatment durations, and safety profiles for specific health conditions (e.g., type 2 diabetes, hyperlipidemia, wound management).

Synergistic Formulations: Exploring the synergistic effects of tamarind extracts with other botanicals or conventional drugs could lead to more effective combination therapies with lower side-effect profiles.

Sustainable Utilisation and Conservation: As demand increases, strategies for the sustainable cultivation, harvesting, and processing of tamarind must be developed to ensure ecological balance and fair economic benefits for local communities.

In conclusion, *Tamarindus indica* is far more than a souring agent for curries and chutneys. It is a botanical treasure trove, a living repository of chemical diversity honed by evolution and curated by human tradition. By continuing to investigate it through the complementary lenses of ethnobotany, phytochemistry, and molecular pharmacology, we can unlock new therapeutic agents, develop novel

functional foods and nutraceuticals, and ultimately contribute to a more holistic, accessible, and sustainable model of global healthcare. The humble tamarind tree, therefore, represents not just a link to our medicinal past but a promising branch towards a healthier future.

REFERENCES

1. Havinga R M, Hartl A, Putscher J, et al, 2010. Tamarindus indica L. (Fabaceae): Patterns of use in traditional African medicine. Journal of Ethnopharmacology. 127(3), Pages 573–588. Doi: 10.1016/j.jep.2009.11.028.

2. Zohrameena S, Mujahid M, Bagga P, et al, 2017. Medicinal uses & pharmacological activity of Tamarindus indica. World Journal of Pharmaceutical Sciences. 5(2), Pages 121–133. Doi: 10.22270/wjps.v5i2.7.

3. Mukherjee D, Deb J, Deb N K, et al, 2024. Ethnopharmacological, Phytochemical and Pharmacological Review on Tamarindus indica L. Journal of Pharmacognosy and Phytochemistry. 13(1), Pages 120–126. Doi: 10.22271/phyto.2024.v13.i1b.14820.

4. Begam M A, Muhammad Ilyas, M H, et al, 2019. Phytochemical and Antioxidant Studies of Tamarindus indica Extracts. Journal of Emerging Technologies and Innovative Research (JETIR). 6(1), Pages 525–532. Doi: 10.1729/Journal.22798.

5. Singh D, 2014. Tamarindus indica (Imley bark): Ethnobotany, Phytochemistry and Pharmacology. Journal of Medical Pharmaceutical and Allied Sciences. 3(3), Pages 186–190. Doi: 10.55522/jmpas.v3i3.0049.

6. Bhadoriya S S, Ganeshpurkar A, Narwaria J, et al, 2011. Tamarindus indica: Extent of explored potential. Pharmacognosy Reviews. 5(9), Pages 73–81. Doi: 10.4103/0973-7847.79098.

7. De Caluwé E, Halamová K, Van Damme, 2010. Tamarindus indica L. – A review of traditional uses, phytochemistry and pharmacology. Afrika Focus. 23(1), Pages 53–83. Doi: 10.21825/af.v23i1.5038.

8. Maiti R, Jana D, Das U K, et al, 2004. Antidiabetic effect of aqueous extract of seed of Tamarindus indica in streptozotocin-induced diabetic rats. Journal of Ethnopharmacology. 92(1), Pages 85–91. Doi: 10.1016/j.jep.2004.02.002.

9. Martinello F, Soares S M, Franco J J, et al, 2006. Hypolipemic and antioxidant activities from Tamarindus indica pulp fruit extract in hypercholesterolemic hamsters. Food and Chemical Toxicology. 44(6), Pages 810–818. Doi: 10.1016/j.fct.2005.10.011.

10. Komutarin T, Azadi S, Butterworth L, et al, 2004. Extract of the seed coat of Tamarindus indica inhibits nitric oxide production by murine macrophages in vitro and in vivo. Food and Chemical Toxicology. 42(5), Pages 649–658. Doi: 10.1016/j.fct.2004.01.001.

11. Sole S S, Srinivasan B P, 2012. Aqueous extract of tamarind seeds selectively increases glucose transporter-2, glucose transporter-4, and islets' intracellular calcium levels and stimulates β-cell proliferation. Pharmaceutical Biology. 50(1), Pages 74–80. Doi: 10.3109/13880209.2011.613846.

12. Lim C Y, Mat Junit S, Abdulla M A, et al, 2013. In vivo biochemical and gene expression analyses of the antioxidant activities and hypocholesterolaemic properties of Tamarindus indica fruit pulp extract. PLoS ONE. 8(7), Pages e70058. Doi: 10.1371/journal.pone.0070058.

13. Jindal V, Dhingra D, Sharma S, et al, 2011. Hypolipidemic and weight reducing activity of the ethanolic extract of Tamarindus indica fruit pulp in cafeteria diet- and sulpiride-induced obese rats. Journal of Pharmacology and Pharmacotherapeutics. 2(2), Pages 80–84. Doi: 10.4103/0976-500X.81895.

14. Paula F S, Kabeya L M, Kanashiro A, et al, 2009. Modulation of human neutrophil oxidative metabolism and degranulation by extract of Tamarindus indica L. fruit pulp. Food and Chemical Toxicology. 47(1), Pages 163–170. Doi: 10.1016/j.fct.2008.10.029.

15. Uccello-Barretta G, Balzano F, Vanni L, et al, 2013. Mucoadhesive properties of tamarind-seed polysaccharide/hyaluronic acid mixtures: A nuclear magnetic resonance spectroscopy investigation. Carbohydrate Polymers, 91(2), Pages 568–572. Doi: 10.1016/j.carbpol.2012.08.070.

16. Nwodo U, Iroegbu C, Ngene A A, et al, 2011. Effects of fractionation and combinatorial evaluation of Tamarindus indica fractions for antibacterial activity. Molecules, 16(6), Pages 4818–4827. Doi: 10.3390/molecules16064818.

17. Imgjerdingen K, Nergård C S, Diallo D, et al, 2004. An ethnopharmacological survey of plants used for wound healing in Dogonland, Mali, West Africa. Journal of Ethnopharmacology. 92(2), Pages 233–244. Doi: 10.1016/j.jep.2004.02.021.

18. Khalid S, Widodo S, Taher M, 2010. In vivo analgesic effect of aqueous extract of Tamarindus indica L. fruits. Medical Principles and Practice. 19(4), Pages 255–259. Doi: 10.1159/000312715.

19. Heimbach J, Egawa H, Marone P, 2013. Tamarind seed polysaccharide: A 28-day dietary study in Sprague-Dawley rats. International Journal of Toxicology. 32(3), Pages 198–208. Doi: 10.1177/1091581813483384.

20. Azman K F, Amom Z, Azlan A, et al, 2012. Anti-obesity effect of Tamarindus indica L. pulp aqueous extract in high-fat diet-induced obese rats. Journal of Natural Medicines. 66(2), Pages 333–342. Doi: 10.1007/s11418-011-0590-2.