

*Review article***A Scientific Review of Tamarind (*Tamarindus indica*) Usage in Traditional Medicine: Evidence-Based Perspectives**

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ABSTRACT

Tamarindus indica, a widely used medicinal plant in traditional systems such as Siddha medicine, possesses diverse therapeutic properties supported by both ancient knowledge and modern scientific evidence. Various parts of the tamarind tree—including leaves, flowers, bark, fruits, and seeds—have been traditionally employed to treat ailments ranging from digestive disorders to infections and inflammation. Phytochemical analyses reveal the presence of bioactive compounds such as flavonoids, triterpenoids, tannins, and organic acids, which contribute to its antioxidant, anti-hyperlipidemic, antimicrobial, analgesic, and spasmolytic activities. Experimental studies corroborate many traditional uses, highlighting tamarind's potential in managing oxidative stress, cardiovascular risk factors, microbial infections, and pain. Despite promising preclinical data, further clinical trials are essential to validate its safety, efficacy, and optimal dosage. This review emphasizes *Tamarindus indica* as a valuable natural therapeutic agent bridging traditional wisdom and evidence-based medicine.

KEYWORDS: *Tamarindus indica*, Siddha medicine, Tamarind, Puli, Literature review

INTRODUCTION

The relationship between humans and plants is ancient and deeply rooted in history (1). The medicinal use of plants can be traced back to prehistoric times. Across various civilizations, especially in India, traditional medicine has thrived for millennia, supported by a vast repository of plant-based knowledge in healthcare. Countries like China, India, and others have developed highly evolved systems of traditional medicine built on the therapeutic use of plants (2-4).

Among these, the Siddha system, primarily practiced in South India, is one of the oldest and most significant traditional medical systems. It defines medicine as any substance that improves physical vitality, maintains physiological balance, and aids in the treatment and prevention of diseases (5). References to plant-based remedies are found in the Rig Veda, the oldest Hindu scripture, dating between 3500 B.C. and 1800 B.C., highlighting the long-standing use of herbal treatments in Indian culture. The enduring application of traditional medicine, passed down through generations, reflects both its safety and therapeutic effectiveness (6,7).

Tamarind (*Tamarindus indica* L.), a member of the Fabaceae family, is one such plant widely used in both folk and traditional medicine. It has been utilized for centuries across different

regions for its medicinal properties. In Tamil Nadu, tamarind is locally known as "Puli" and is extensively used in traditional treatments, both as an internal remedy and for external applications. Classical Siddha texts such as Agasthiyar Gunavagadam, Theraiyar Venba, and Theraiyar Tharu mention its therapeutic uses. Healers have traditionally employed various parts of the plant—leaves, flowers, bark, fruits, and seeds—for treating a range of ailments (8).

This review aims to explore and compile the traditional applications of tamarind, especially within the Siddha medical system, while also evaluating the scientific evidence available through clinical research to support its medicinal value.

MATERIALS AND METHODS

A focused review was conducted using selected classical Siddha texts, including Agasthiyar Gunavagadam, Theraiyar Venba, and Theraiyar Tharu, to extract traditional formulations and therapeutic uses of *Tamarindus indica* L. Emphasis was placed on identifying plant parts used, preparation methods, dosage forms, and routes of administration. Additionally, electronic databases such as PubMed, Scopus, and Google Scholar were searched using keywords like “*Tamarindus indica*,” “Siddha medicine,” “traditional medicine,” and “pharmacological activity.” Inclusion criteria were limited to plant-based applications involving tamarind with relevance to therapeutic use. Data from traditional sources were cross-referenced with contemporary scientific literature to evaluate the pharmacological basis and clinical relevance of the identified traditional claims. Only scientifically supported and clearly documented uses were considered for analysis in this review. The scientific classification of *Tamarindus indica* is presented in Table 1, based on standard botanical taxonomic references.

Table 1: Description Scientific classification

S.No	Category	Classification
1	Kingdom	Plantae
2	Subkingdom	Tracheobionta
3	Super division	Spermatophyta
4	Division	Magnoliophyta
5	Class	Magnoliopsida
6	Subclass	Rosidae
7	Superorder	Rosanae
8	Order	Fabales

9	Family	Fabaceae
10	Subfamily	Caesalpinoideae
11	Tribe	Detarieae
12	Genus	<i>Tamarindus</i>
13	Species	<i>Tamarindus indica</i>

Vernacular Names:

Puli (Tamil), Tamarind (English), Puli (Malayalam), Hunasemara (Kannada), Tintrani (Sanskrit), Imli (Hindi) (9)



Figure 1: *Tamarindus indica*

Morphology of *Tamarindus indica* L

The tamarind tree can attain a height ranging from 25 to 30 meters. It is an evergreen species with a dome-shaped canopy and a profusely branched structure. In terms of foliage, it

resembles the Indian gooseberry (*Phyllanthus emblica*), featuring small, pinnately compound leaves. However, there are notable differences between the two: the Indian gooseberry has longer, light green leaflets that are relatively slender, whereas tamarind leaves consist of shorter, broader leaflets that appear dark green. The flowers of the tamarind are aromatic, measure approximately 3 cm in length, and are yellow in color (10). Its fruits are pod-like, generally straight or slightly curved, and exhibit a sub-cylindrical shape with swollen, rounded ends, usually appearing brown or greyish-brown. The tree's wood displays two distinct zones—sapwood, which is pale yellow, and heartwood, which is dense, dark purplish-brown, and highly durable. This heartwood is also known for its resistance to insect and pest attacks (11).

The chemical constituents of *Tamarindus indica* L. are summarized in Table 2 (12-14)

Table 2: Chemical constituents of *Tamarindus indica* L

Morphological Part	Chemical constituents
Leaves and Flowers	It contains a variety of bioactive compounds including essential oils, both free and conjugated fatty acids, and a range of flavonoids. Additionally, it is rich in trace minerals such as selenium and other microelements. Notable phytochemicals include limonene, benzyl benzoate, pentadecanol, and hexadecanol. The plant also comprises triterpenoids like lupanone and lupeol. Nutritionally, it provides proteins, fats, dietary fiber, and essential vitamins such as thiamine, riboflavin, niacin, vitamin C (ascorbic acid), and β -carotene.
Stem bark	n-hexacosane, eicosanoic acid, b-sitosterol, octacosanyl ferulate, 21-oxobehenic acid, and (+)-pinitol, flavonoids, cardiac glycosides, alkaloids, saponins, tannins.
Bark	Tannins, polyphenols like N-Hexacosane, eicosanoic acid, b-sitosterol, octacosa nyl

	ferulate, 21-oxobehenic acid, and (+) - pinitol and phenolic antioxidants, cat echin, procyanidin B2, epicatechin, procyanidin trimer, procyanidin tetramer, procyanidin pentamer, procyanidin hexamer, taxifolin, apigenin, eriodictyol, luteolin and naringenin
Pulp	Tartaric acid, reducing sugars, pectin, tannin, fibre, cellulose, organic acids like oxalic acid, succinic acid, citric acid, quinic acid, ascorbic acid, free amino acids namely proline, serine, β -alanine, phenylalanine and leucine, minerals like potassium, phosphorus, calcium, iron, magnesium, sodium, copper and zinc, vitamins like riboflavin, thiamine and niacin, volatile constituents such as 2-phenyl acetaldehyde and TI (trypsin inhibitor).
Seeds	Protein, fibre, tannins, crude protein, crude fibre, crude fat, tannins, TI, carbohydrate, starch, phytic acid and albuminoid tannins.

The Siddha literature of *Tamarindus indica* L. is summarized in Table 3 and 4 (8).

Table 3: Siddha Literature of *Tamarindus indica* L

Parts	Taste	Potency	Division	Action
Leaves	Sour	Hot	Pungent	Stimulant
Flower	Sour	Hot	Pungent	Stimulant
Fruit	Sour	Hot	Pungent	Carminative, Anti-bilious
Bark	Astringent	Hot	Pungent	Mild Astringent, Tonic
Seeds	Astringent	Hot	Pungent	Astringent

Table 4: Traditional usages of *Tamarindus indica*

Parts	Traditional methods
Leaves	<ul style="list-style-type: none"> ❖ Tamarind and neem leaves are boiled in water and the decoction is used for wound cleansing. ❖ The leaves are boiled in water and applied externally as a poultice (pattru) to relieve arthritis-related swelling. ❖ An iron rod is dipped in the leaf juice, and the juice is then filtered and administered for the treatment of dysentery. ❖ The leaves are traditionally used in the purification of Sembu (copper), Mandooram (ferrosoferric oxide), and Venkalam (bronze).
Flowers	<ul style="list-style-type: none"> ❖ A decoction prepared by boiling the flowers in water is applied around the eyes to relieve redness and irritation. ❖ The flowers are fried in ghee to prepare a chutney that is consumed as an edible food.
Fruit	<ul style="list-style-type: none"> ❖ A paste made by grinding the fruit with salt is applied as a treatment for tonsillitis ❖ A mixture of fruit and Karisalankanni (<i>Eclipta prostrata</i>) is ground, and a punnaikai quantity is administered daily for 8 days as a treatment for prolapse. ❖ The peel of the tamarind fruit is burned to ash, then mixed with ground Sarakondrai (<i>Semecarpus anacardium</i>) Puli and applied externally for the treatment of liver disease. ❖ A decoction of <i>Tamarindus indica</i> leaves is used to wash Tinea pedis (athlete's foot), and the unripe fruit is burned and applied as a bandage. ❖ A paste prepared by grinding Serankottai (<i>Semecarpus anacardium</i>), Puli (<i>Tamarindus indica</i>), and Palm jaggery is traditionally applied for the treatment of Kandamaalai (cervical lymphadenitis) and Araiappu (inguinal lymphadenitis)

Seeds	<ul style="list-style-type: none"> ❖ The seeds are first fried and de-skinned, then ground into a flour with a waxy, dough-like consistency (kali). This preparation is used medicinally, particularly for treating abscesses. ❖ The outer skin of the seeds is powdered and used for treating dysentery. ❖ Seed powder, administered at 250–300 mg mixed with sugar or honey, is used for the treatment of diarrhoea, ulcers, urinary tract infections, leucorrhea, and venereal diseases. ❖ The powder is used for brushing to strengthen the teeth.
Bark	<ul style="list-style-type: none"> ❖ The bark and salt are placed in a pot and incinerated to obtain ash, which is used to treat indigestion and ulcers. ❖ The bark ash is mixed with water and filtered, then used as a gargle to treat sore throat. ❖ A decoction is prepared by boiling the ashes of tamarind bark, piper, pungu leaf, veliparuthi leaf, and nayurivi leaf along with omam in water, used for managing thirst in children. ❖ The bark powder of <i>Tamarindus indica</i> is used in fumigation as a traditional treatment for hemorrhoids.

Pharmacological actions

Anti-oxidant activity

Tamarindus indica L fruit has been identified as a rich source of phenolic compounds and exhibits strong antioxidant properties. These antioxidant effects may help protect against various degenerative diseases in humans that are associated with damage caused by oxygen free radicals. Consequently, tamarind fruit or products derived from its pulp have the potential to function as functional foods, offering health benefits to consumers (15).

Seeds of *Tamarindus indica* L are notable for their antioxidant properties, containing compounds such as 2-hydroxy-3',4'-dihydroxyacetophenone, metdihydroxybenzoate, (-)-epicatechin, and 3,4-dihydroxyphenylacetate, along with oligomeric proanthocyanidins

(OPCs). These OPCs exhibit strong antioxidant, anti-inflammatory, antihistaminic, and ultraviolet-protective effects. Additionally, OPCs help maintain the stability of elastin, collagen, and other ground substances in the skin (16). Comprehensive research on the chemical makeup of *T. indica* seeds has been conducted to assess their antioxidant capacity, fatty acid composition, and tocopherol content. These findings have sparked interest in utilizing tamarind seed extracts in cosmetic applications (17).

Anti-Hyperlipidemic Activity

Administration of *Tamarindus indica* L pulp extract to obese rats resulted in a reduction of plasma total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglyceride levels, while simultaneously increasing the level of high-density lipoprotein (HDL) cholesterol (18).

Anti-microbial activity

Phytochemical analysis of the *Tamarindus indica* L leaf extracts revealed the presence of saponins, alkaloids, and glycosides. These extracts demonstrated antimicrobial activity against both Gram-positive and Gram-negative bacteria (19). A study revealed that both aqueous and fluid extracts of fresh and dried tamarind leaves contain phenols and flavonoids. The phenolic compounds exhibited activity against *Bacillus subtilis* cultures, but showed no effect on other microorganisms (20).

Analgesic activity

Phytochemical analysis indicated that the extract contains sterols and triterpenes, suggesting that these compounds in *Tamarindus indica* L plant parts may contribute to its analgesic effects (21).

Spasmolytic Activity

The aqueous extract of *Tamarindus indica* L was observed to cause spasms, while a separate study demonstrated that the methanolic extract of tamarind fruits exhibits spasmolytic properties (22,23).

Antidotal Effects

Tamarindus indica L leaf decoction is traditionally used in Ayurveda to neutralize the toxins of *Semecarpus anacardium* (marking nut), acting both as an antidote for poisoning and a means to detoxify the nut before therapeutic use (24, 25). The fruit pulp should be dissolved in vinegar and boiled. The steam is then deliberately allowed to be exposed to the bite site. This method

was practiced to neutralize the scorpion venom and thereby alleviate the localized symptoms of the sting. In traditional Siddha medicine, equal parts of slacked lime and tamarind (*Tamarindus indica* L) pulp were homogenized into a paste and applied topically to spider-bite wounds (24)

Tamarindus indica L has historically been utilized for cleaning verdigris, a green patina comprising basic copper carbonate [$\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$] that develops on copper vessels due to prolonged exposure to moisture, air, and carbon dioxide. Tamarind pulp contains high concentrations of organic acids, primarily tartaric and citric acids, which chemically react with verdigris in an acid-base reaction. This interaction converts the insoluble carbonate into soluble copper salts, facilitating the removal of tarnish. The cleaned surface regains its metallic sheen, making this method both effective and environmentally safe.

Tamarindus indica L has demonstrated protective effects against fluoride toxicity. Leaf extracts reduced oxidative damage via their antioxidant and anti-peroxidative properties, restoring enzymatic antioxidant defense in the liver and kidneys of fluoride-exposed rats. Fruit pulp extracts lowered plasma fluoride levels, mitigated renal and hepatic damage, and enhanced fluoride excretion in vivo. Additionally, treated tamarind fruit shell-derived carbon materials effectively removed fluoride (up to ~91%) and other heavy metals such as nickel and lead from drinking water (26). Research has shown that *Tamarindus indica* L seed extracts inhibit key venom enzymes—such as phospholipase A₂, proteases, hyaluronidase, l-amino acid oxidase, and 5'-nucleotidase—in a dose-dependent manner. In vitro, the extract prevented venom-induced degradation of the β chain of human fibrinogen and indirect hemolysis, while modestly prolonging clotting time. In vivo, pre- or post-treatment with the extract significantly mitigated venom-induced edema, hemorrhage, myotoxicity, and lethality, supporting its traditional use as an alternative or adjunct to antiserum therapy (27).

Anticancer activity

Tamarindus indica L exhibits pronounced anticancer potential through multiple bioactive constituents in its seeds and bark. Seed extracts, particularly polysaccharide PST001, have demonstrated tumor-growth inhibition and immunomodulation in vivo (e.g., A549, MCF-7, KB, DLA/EAC models), while n-butanol seed fractions showed cytotoxicity against MCF-7 cells ($\text{IC}_{50} \approx 68.5 \mu\text{g/mL}$). Ethanolic bark extracts also displayed significant in vitro cytotoxicity, inducing apoptosis in lines such as HeLa, PA-1, and HT29, with potent activity at low concentrations. Collectively, these findings indicate that *T. indica* may serve as a valuable

source of natural anticancer agents, meriting further isolation, characterization, and clinical investigation (27).

RESULTS AND DISCUSSION

Tamarindus indica (Tamarind) has a long-standing history of use in traditional medical systems like Siddha, where various parts of the plant—such as the pulp, leaves, bark, seeds, and ash—are utilized for their therapeutic properties. The convergence between traditional applications and modern pharmacological evidence highlights the scientific rationale behind its efficacy and continued use.

Phytochemical investigations have identified key constituents including flavonoids, triterpenoids, tannins, organic acids, polyphenols, oligomeric proanthocyanidins, and essential oils. These compounds account for a wide range of biological activities. For instance, the potent antioxidant activity observed in the seeds and fruits is attributed to polyphenols and proanthocyanidins, which play a crucial role in neutralizing free radicals and preventing oxidative stress-related diseases. This substantiates the traditional use of tamarind in preventing degenerative disorders and further justifies its inclusion in functional foods and skincare products.

In Siddha medicine, tamarind is not only a dietary ingredient but also a therapeutic agent. The pulp is commonly added to cooked food for its sour taste (Pulippu), which is believed to preserve vitamins and stimulate digestive functions (28). The sour taste, associated with the *Panchabootham* of Earth (Mann) and Fire (Thee), is said to increase Saaram (nutrient fluid), Kabam (Kapha), and Pitham (Pitta), while balancing Vatham. It aids in appetite stimulation, manages anaemia, tastelessness, constipation, and relieves flatulence. Furthermore, it promotes salivary secretion and helps in oral cleansing (29,30).

Modern studies have demonstrated the lipid-lowering properties of tamarind pulp in animal models, supporting its traditional application in managing hyperlipidemia and cardiovascular risks. These findings open opportunities for clinical validation and integration into therapeutic protocols targeting metabolic syndromes. The antimicrobial activity exhibited by leaf extracts, especially against Gram-positive bacteria, reinforces traditional practices of using tamarind in wound healing and infection control. This suggests the presence of bioactive molecules with potential in antimicrobial drug development.

Additional pharmacological actions such as analgesic and spasmolytic effects have been attributed to the presence of phytosterols and triterpenes, which align with traditional uses for pain relief and the treatment of gastrointestinal spasms—common conditions managed in Siddha medicine.

Moreover, the traditional antidotal uses of *Tamarindus indica* are well-documented. The ash is employed in cases of *Croton tiglium* (Nervaalam) poisoning, while the leaves, when boiled with water and tender coconut, are used as an antidote for *Semecarpus anacardium* (Serankottai) poisoning. The bark is also traditionally used as a remedy for rat bites, showcasing its diverse applications in Siddha toxicology (24). Additionally, variations in phytochemical content due to geographical and environmental factors must be considered for consistent therapeutic outcomes. Thus, *Tamarindus indica* L exhibits broad-spectrum detoxifying and therapeutic properties—ranging from neutralizing fungal, venomous, and heavy-metal toxins (e.g., copper carbonate, fluoride, lead, nickel, and snake/spider/scorpion venom) via enzyme inhibition, antioxidant effects, and biosorption, to demonstrating anticancer cytotoxicity and immunomodulatory activity—validating its ethnomedicinal uses and highlighting its potential for pharmacological exploitation.

Despite promising preclinical evidence, the need for well-designed clinical trials remains critical to establish standardized dosage, safety profiles, and therapeutic efficacy. Furthermore, factors such as geographical and environmental variation can influence the phytochemical composition, potentially affecting consistency in pharmacological outcomes. Standardization of raw materials and preparation methods will be essential for effective integration of *Tamarindus indica* into evidence-based medicine.

CONCLUSION

In conclusion, *Tamarindus indica* L exemplifies a medicinal plant where traditional knowledge and modern science converge, providing a valuable resource for developing natural therapeutics. Its multifunctional pharmacological profile warrants further research aimed at validating and optimizing its use in contemporary healthcare.

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ETHICAL APPROVAL

As the present study is a Literature review, it does not involve the use of human or animal subjects and therefore, ethical clearance is not applicable.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

AUTHOR CONTRIBUTION

Conceptualization: SR; Data collection and compilation: SR & AB; Manuscript Writing: SR, AB, ME & KAP; Proofreading and editing: SR, AB, ME & KAP

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