



# A BRIEF REVIEW ON TRADITIONAL USES, PHYTOCONSTITUENTS, AND PHARMACOLOGICAL POTENTIAL OF THE STEM BARK OF TAMARINDUS INDICA LINN.

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**Abstract:** This comprehensive review explores the traditional uses, morphological description, phytoconstituents, and pharmacological potential of *Tamarindus indica*, focused specifically on its bark. The tall evergreen tree, native to tropical regions, has versatile applications in medicine, industry, and cuisine. The bark, rich in phytochemicals such as alkaloids, flavonoids, tannins, and terpenoids, exhibits various pharmacological activities. The traditional uses of the bark of *Tamarindus indica* extend to diverse cultures, addressing conditions like wounds, diarrhea, asthma, and indigestion. Phytochemical analysis reveals a variety of compounds contributing to its antibacterial, anthelmintic, hepatoprotective, analgesic, anti-diabetic, anti-depressant, anti-microbial, anti-inflammatory, and antioxidant properties. Additionally, the bark shows promise in Alzheimer's disease treatment, thrombolytic activity, anti-viral effects, and even potential anti-cancer properties. This review emphasizes *Tamarindus indica's* bark potential as a valuable resource in herbal medicine, offering a holistic and environmentally conscious approach to health. With its accessibility, affordability, and low risk of side effects, *T. indica* stands out as a promising nutritional aid and therapeutic agent, aligning with the growing global interest in herbal remedies.

**Keywords-** *Tamarindus indica* bark, Phytoconstituents, Pharmacological properties, extract, traditional, anti-microbial.

## I. INTRODUCTION

Traditional medicine, deeply intertwined with cultural heritage, reflects the lifestyle and ancient practices of societies. Highly Throughout history, people have relied on plants as their primary source of medicine. However, with modern Western medicine's advancement, herbalism's practice declined in all cultures. Synthetic chemicals were believed to be the most effective treatment for illness and disease. But now, with an increased focus on living a healthier lifestyle and being environmentally conscious, people are once again recognizing the healing power of herbs. Natural products and herbal remedies are now widely available, and herbalism is regaining popularity. The advantage of herbal remedies is that they work without many unpleasant side effects of modern medicines [1].

*Tamarindus indica* commonly known as tamarind is an economically important multipurpose tree [2]. It is recognized for its ameliorative effects on various diseases. It can be an affordable and accessible nutritional aid for malnourished individuals [3]. *Tamarindus indica* is a large tree belonging to the Caesalpiniaceae family and Leguminosae order. It is native to tropical regions, including Africa and the Americas, and is cultivated in various countries such as China, India, and Spain [4]. It is grown in almost all states of India, except for the Himalayas and western arid regions [5]. The *Tamarindus indica* plant is a versatile and useful plant

with numerous benefits. Every part of the plant, including the leaves, fruit, stems, bark, and roots, is rich in nutritional value and has broad usage areas in medicine, industry, and economics [3]. The tamarind heartwood is sturdy and dense, which makes it ideal for furniture and wood flooring production. The tamarind fruit pulp has been a culinary ingredient in India for a long time and is extensively used in Tamil Nadu, Karnataka, and Andhra Pradesh cuisines, especially in the preparation of Rassam, Sambhar, Vatha Kuzhambu, and Puliogare. Additionally, tamarind trees provide shade on country roads and serve as ornamental trees [6]. Most of the previous reviews provide a broad overview of various ethnopharmacological applications, diverse pharmacological properties, and multifaceted therapeutic potential of *Tamarindus indica*. However, several articles focused on specific compounds from a particular part of the tamarind tree such as its seeds, fruit, or leaves. The purpose of this work is to critically analyze the available literature to provide a comprehensive overview of the phytoconstituents and the pharmacological potential of the bark of *Tamarindus indica*.

## II. PHYTOCHEMISTRY

*Tamarindus indica* is a tall, evergreen tree that can grow up to 30 meters in height [7]. It has a short, thick, and seldom straight trunk. The bark is rough, with a scaly texture and a brownish-grey colour. It has fissures that run both lengthwise and crosswise [8]. The leaves of this plant are arranged alternately and are compound, with 10-18 pairs of leaflets that are opposite to each other. The leaflets are narrowly oblong, measuring 12-32 × 3-11 mm, and the petiole and rachis are finely haired. The midrib and net veining are more or less noticeable on both surfaces. The flowers are borne in a lax raceme, with an attractive pale-yellow colour with pink strips. The flower buds are completely enclosed by 2 bracteoles, which fall very early. The flowers are bisexual, with 4 sepals and 5 petals, the upper 3 well developed and the lower 2 very small. The fruits get ripen in winter and have brown bark, while the immature ones have the colour of green bark. They are pod-shaped, indehiscent, subcylindrical, 10-18 × 4 cm, straight or curved, and velvety. The pulp inside is soft and blackish-brown in color. Each pod contains up to 3-12 obovate and oblong mature seeds that are Ex albuminous. The seeds are oblong, with a hard, shiny, and smooth Testa [9,10,11]. The production of tamarind depends on both genetic and environmental factors. Production is higher in cross-pollination compared to open-pollination. High-yielding varieties can produce 600-800 kg of fruits per tree per year [12].

## III. TRADITIONAL UTILISATION OF *Tamarindus indica* BARK:

For many centuries, different civilizations have acknowledged and utilized the healing potential of medicinal plants [13]. *Tamarindus indica* is one of the medicinal plants used in the treatment of various diseases traditionally [14]. The bark of the tamarind tree is highly valued for its diverse traditional uses across different cultures. In Nigeria, the decoction made from the bark serves as an astringent for treating wounds and diarrhoea, while the ash is used for treating urinary discharge, and gonorrhoea, and promoting ulcer healing. The bark of the tamarind tree is highly valued for its diverse traditional uses across different cultures. In Nigeria, the decoction made from the bark serves as an astringent for treating wounds and diarrhea, while the ash is used for treating urinary discharge, and gonorrhoea, and promoting ulcer healing. [15]. Notably, the tamarind bark plays a role in treating colic and indigestion, often combined with salt for optimal effectiveness. In various regions, it has been used to treat asthma, eye inflammation, and gingivitis by making decoctions. Local applications include the creation of poultices and creams to address caterpillar rashes and open sores [16]. The inner bark of the tamarind tree is dried in the sun, ground into powder using a stone grinder, and then sieved. The resulting powder is stored in a container and can be consumed daily to help alleviate peptic ulcers and other stomach disorders [17]. The bark is used topically for loss of sensation in paralysis [18]. The bark decoction is known for its effectiveness in managing excessive menstruation, especially in West India. One notable application involves using a combination of tamarind bark decoction and *Mangifera indica* to treat malaria. In India, people consume a mixture of tamarind leaf and bark, along with water and pepper, as a remedy for sorcery [15]. These traditional uses highlight the versatile and culturally significant role of the bark of *Tamarindus indica* in addressing various health concerns and ailments.]

## IV. PHYTOCONSTITUENTS IN *Tamarindus indica* BARK:

Phytochemicals (Greek: phyton = plant) are chemical compounds naturally present in plants attributing to positive or negative health effects [19]. Phytochemicals individually or in combination, determine the therapeutic value of a medicinal plant [20]. Several biologically active plant compounds have been identified, such as alkaloids, flavonoids, steroids, glycosides, terpenes, tannins, and phenolic compounds [21]. The identification of these phytochemicals can be used to predict a plant's pharmacological activity [22]. The plant *Tamarindus indica* has been found to possess a variety of pharmacological activities, which are attributed to the presence of several phytochemicals. Phytochemical investigations conducted on *T. indica* bark extracts have revealed the existence of active constituents such as alkaloids, flavonoids, terpenoids, glycosides, tannins, saponins, anthraquinones, steroids, lipids, peroxidase, and phenols. [15, 23 & 24]. Especially The bark is rich in tannins reaching up to 70% which include proanthocyanidins, procyanidin B2, procyanidin tetramer, procyanidin pentamer, procyanidin hexamer also consists of different flavonoids namely catechin, epicatechin, taxifolin, apigenin, eriodictyol, luteolin and naringenin, terpenoids like Sitosterol, lupeol, lupeonone, beta-Amyrin Stigmasterol, lupeol acetate, beta-sitosterol and fatty acids N-Hexacosane, eicosanoic acid, 21-oxo behenic acid, also other chemical constituents namely octacosanol ferulate, pinitol, hordenine [25,26,27].

## V. PHARMACOLOGICAL STUDIES ON *Tamarindus indica* BARK:

### Anti-bacterial:

Aliyu et al. evaluated the antibacterial activity of *Tamarindus indica* bark extract against *Escherichia coli* and *Staphylococcus aureus* using the agar well diffusion method. They inoculated sterile petri dishes with Muller Hinton agar and punched equidistant wells. The extract was added to wells at concentrations of 100mg/ml, 50mg/ml, 25mg/ml, 12.5mg/ml, and 6.25mg/ml, followed by incubation at 37°C for 24 hours. Sensitivity to the extracts was recorded in duplicates. The Minimum Inhibitory Concentration (MIC) was determined using the broth dilution method. The bark extract of *Tamarindus indica*, at various concentrations, demonstrated notable anti-bacterial potential against both *S. aureus* and *E. coli*. Ethanol extract exhibited mean zones of inhibition ranging from moderate to substantial for both bacterial strains, while aqueous extract showed a similar trend albeit with slightly wider ranges. These findings underscore the promising antibacterial properties inherent in *Tamarindus indica* bark extract [28].

### Anthelmintic:

Das et al. reported the Anthelmintic effect of both aqueous and ethanolic extracts of *Tamarindus indica*. The study examined the effects of *Tamarindus indica* bark extracts on two types of worms, *Pheretima posthuma*, and *Tubifex tubifex*, and compared them to piperazine citrate, a reference standard for anthelmintic activity. Both extracts showed a dose-dependent anthelmintic activity, but the alcoholic extract was found to be more effective. It caused paralysis and death of both worms earlier compared to the aqueous fractions and reference drug. The aqueous and alcohol extract from *Tamarindus indica* stem bark exhibited wormicidal activity against earthworms, indicating effectiveness against parasitic infections in humans. [29].

### Hepatoprotective:

Meena et al. conducted a study to evaluate the ethanolic extract of *Tamarindus indica* stem bark (EETI) for hepatoprotective activity in Sprague Dawley rats with drug-induced hepatotoxicity. The hepatic damage was induced by co-administering antitubercular drugs isoniazid and rifampicin. The negative control group showed a significant increase in aspartate transaminase, alanine transaminase, serum bilirubin, lactate dehydrogenase, alkaline phosphatase, and cholesterol levels, while the total protein and albumin levels were reduced compared to the normal group. However, when EETI was administered at 100mg/kg and 200mg/kg dosage levels, it significantly restored the liver-specific enzymes and biochemical markers altered due to co-administration of INH and RIF to normal in a dose-dependent manner. EETI at a dosage of 200mg/kg body weight showed better protection to the liver than EETI at a dosage of 100mg/kg body weight and was comparable to the positive control group administered with the standard drug silymarin at a dosage of 100mg/kg body weight. This finding was further supported by histopathology of liver tissues. Hence, EETI may have a significant impact on developing clinically practical strategies to treat patients with hepatic damage. [30].

### Analgesic:

Ukwuani and Hassan investigated the analgesic properties of different fractions of stem bark of *Tamarindus indica*. The fractions (hexane 13.6%, ethyl acetate 12.1%, methanol 7.9%, and water 6.7%) were obtained through sequential fractionation. The analgesic activity of these fractions was tested using acetic acid-induced writhing and tail immersion tests in albino rats, with a dose of 200 mg/kg. All the fractions significantly ( $P < 0.001$ ) inhibited acetic acid-induced writhing, while only the methanol and water fractions significantly ( $P < 0.05$ ) prolonged the reaction latency to thermally induced pain in rats through the tail immersion test. The fractions contained phytochemical constituents such as flavonoids, saponins, alkaloids, tannins, and glycosides, which might be responsible for their observed analgesic activity. The results suggested that *Tamarindus indica* stem bark fractions have effective analgesic properties that work via peripheral and central mechanisms [31].

### Anti-diabetic:

Agnihotri and Singh evaluated the antidiabetic activity of the alcoholic extract of the stem bark of *Tamarindus indica* in alloxan-induced diabetic rats. They studied biochemical parameters such as blood glucose, serum cholesterol, triglycerides, serum albumin, total protein, and creatinine. The results showed a significant decrease in blood glucose levels in diabetic rats treated with the alcoholic extract of *Tamarindus indica*. The diabetic rats also experienced significant weight loss compared to normal rats. However, the administration of the extract of *Tamarindus indica* and a standard drug (gliclazide) improved the body weight as compared to the control diabetic rats. In the diabetic control group, there was a significant upsurge in plasma glucose levels from 88.29 mg/dL on day 1 to 238 mg/dL on day 14 of the study. In the drug-treated groups, the plasma glucose level differed from 87.14 mg/dL to 99.14 mg/dL for *Tamarindus indica*. At the end of the study, serum cholesterol, serum triglycerides, serum creatinine, serum albumin, and total protein levels were recovered to normal levels. The study concluded that *Tamarindus indica* stem bark has the potential to act as a hypoglycaemic agent [32].

### Anti-depression:

Yunasa et al. conducted a study on the antidepressant properties of the methanol stem bark extract of *Tamarindus indica* on mice. They used the Tail Suspension Test (TST) and Forced Swimming Test (FST) models to investigate the extract's antidepressant effects. The study found that the stem bark extract of *Tamarindus indica* significantly and dose-dependently reduced the immobility time in the TST models at the doses of 75 and 150 mg/kg body weight as compared to the control group. In the FST model, the extract significantly reduced the immobility time only at the highest tested dose (150 mg/kg) compared to the placebo group. These findings suggest that *Tamarindus indica* can be used to treat mental disorders, including depression [33].

**Anti-microbial:**

Srinivas and Kumar evaluated the antimicrobial properties of the ethanolic extract of *Tamarindus indica* bark. Specifically, they tested the extract's effectiveness against three human pathogens: *Streptococcus pneumoniae*, *Escherichia coli*, and *Salmonella paratyphi*. To do this, they cultured the pathogenic strains on Muller-Hinton agar plates and inoculated them with different concentrations of the extract dissolved in phosphate buffer (pH 7). They also included a control using only phosphate buffer solution. After incubating the plates at 37°C for 24 hours, they measured the zone diameter of inhibition. The results showed that the ethanol bark extract exhibited antimicrobial activity against all three pathogens. This study highlights the potential of *Tamarindus indica* bark extracts as a natural antimicrobial agent [34].

**Anti Alzheimer's:**

Biswas et al. investigated the *Tamarindus indica* bark crude methanolic extract's (CMEs) cholinesterase inhibitory activity for treating Alzheimer's Disease (AD). The crude methanol extract was prepared through a cold extraction method and evaluated for acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE) inhibitory activities using the Ellman method. Ellman's colorimetric method was used to determine the AChE inhibitory activity of the plant extract. This method measures the amount of thiocholine released when ACh is hydrolyzed by the AChE enzyme. DTNB is a colouring agent that binds to ACh and forms a colour. In this test, the colour indicates the presence of free ACh, which was not hydrolyzed by AChE in the reaction mixture. A significant hallmark of AD is the decrease of ACh in the hippocampus and cortex. Inhibition of AChE ensures more ACh in the brain. It was observed that *Tamarindus indica*'s AChE inhibitory activity was concentration-dependent. The activity increased with the increase of the concentration. Donepezil was used as a reference standard. BuChE can hydrolyze ACh and can act both itself and synergistically with AChE. Modified Ellman's method was also used to quantify the BuChE activity of the plant extract. The inhibitory activity of BuChE was quite similar to that of AChE. The results showed that the Crude methanolic extract of bark had moderate cholinesterase inhibitory activity worth further investigation to identify the promising molecule(s) potentially useful in treating AD [35].

**Anti-oxidant:**

Borquaye et al. evaluated the anti-oxidant potential of aqueous extract of *Tamarindus indica* [AETI]. The phosphomolybdenum (PM) assay, 2, 2—diphenyl—1—picrylhydrazyl (DPPH) radical and hydrogen peroxide scavenging assays were used to examine antioxidant potential. The ability of the extracts to scavenge free radicals and ROS was evaluated in the DPPH and hydrogen peroxide assays. The extract showed a better scavenger activity of the DPPH radical than hydrogen peroxide. The total antioxidant capacity (TAC) was determined using the phosphor-molybdenum assay. Since AETI extract contains several different phytochemicals, the antioxidant effect exhibited is most likely a result of the synergistic action of the various constituents [36].

**Anti-inflammatory:**

Borquaye et al. conducted a study to evaluate the anti-inflammatory properties of the ethanolic extract of *Tamarindus indica*'s stem bark. They used the carrageenan-induced paw edema model of inflammation in chicks to assess the extract's anti-inflammatory activity. The researchers observed a steady increase in foot volume in the first 90 minutes upon administering carrageenan. Afterward, the extract or a drug was given, leading to a general decrease in foot volume until the fourth hour. The control group, which only received saline, showed minimal reduction in foot volume, and significant edema was observed even at the fourth hour. Both the standard drugs and extract treatments showed a dose-dependent effect. The obtained ED50 values indicated that the stem bark extract had promising anti-inflammatory activity [37].

**Other activities:****To treat clotting disorders:**

Biswas et al. conducted a study to test the thrombolytic potential of the crude methanolic extract (CMEs) of *Tamarindus indica* bark. To evaluate the thrombolytic activity, the researchers used 1.0 ml venous blood from healthy volunteers to form clots. The bark extract (100 mg) was dissolved in distilled water and added to the clots following serum removal. The clots were incubated for 90 minutes, and then the released fluid was removed, and the clots were reweighed to determine clot lysis percentage. The results unveiled that the positive control (SK, 30,000 IU) demonstrated 72.95% clot lysis, the negative control (distilled water) showed 3.60%, and *T. indica* bark extract exhibited 30.17% clot lysis. The percentage of weight loss indicates the thrombolytic activity, and the extract showed promising results in clot lysis compared to the negative control [35].

**Anti-viral:**

Okoh et al. evaluated the antiviral properties of EETI extract. The ethanol extract from the stem bark of *Tamarindus indica* completely inhibited the hemagglutinating activity of velogenic Newcastle disease virus (NDV) in chicken embryos when tested at a concentration of 250mg/mL. A preliminary antiviral investigation using spot HA assay indicated that a fraction of crude extract inhibited NDV multiplication at 125mg/mL. Further titration of allantoic fluid confirmed antiviral activity at all levels. Different extracts, fractions, and sub-fractions showed varying degrees of inhibition, indicating the presence of potent antiviral components [37].

**Anti-cancer:**

Shirisha and Varalakshmi evaluated the potential of *Tamarindus indica* bark and its bioactive fractions on HeLa and PA-1 cancer cell lines. The dichloromethane extract of tamarind bark was found to be toxic to HeLa and PA-1 cells. Further in vitro assays revealed that the bioactive fraction induced caspase-9-mediated apoptosis in the cells and reduced the total cell count, as evidenced by flow cytometry analyses. The gas chromatography-mass spectrometry analysis of the bioactive fraction revealed the existence of cantharidin, an anticancer compound previously reported from blister beetles. It can be inferred that the presence of cantharidin might be accountable for inhibiting the proliferation of cancer cells and inducing apoptosis [38].

**Wound healing:**

Abba et al. conducted a study on the wound-healing properties of *Tamarindus indica* Methanol Stem Bark Extract in Albino Rats. Wounded rats were treated with an ointment formulated from *Tamarindus indica* stem bark extract (10% and 50% w/w) and penicillin cream for 24 days. The groups treated with the extract had a significant, dose-dependent increase in wound size reduction and epithelization rate compared to the control group. Significant wound contraction was observed in both penicillin and extract-treated groups on day 9. This study confirms that *Tamarindus indica* methanol stem bark extract has wound-healing properties. [39-41].

**Spasmogenic:**

Souza and aka investigated the effects of the aqueous extract of stem bark of *Tamarindus indica* (AETI) on the guinea pig taenia coli, the smooth muscle part of its large intestine, exploring its potential use in traditional medicine for constipation treatment. Various concentrations of AETI demonstrated a dose-dependent increase in spontaneous contractile activity in the guinea pig taenia coli. Interestingly, this activity was not influenced by atropine. In high potassium (K<sup>+</sup>), a calcium-free solution containing EDTA, AETI-induced tonic contraction similar to acetylcholine, which was used as a control. This implies that the extract's spasmogenic effect does not involve a cholinergic mechanism of action. Overall, the results indicate that the bark stems of *Tamarindus indica* have a spasmogenic effect on the intestinal smooth muscle of guinea pig taenia coli. These findings provide scientific evidence supporting that the *Tamarindus indica* stem bark can be employed as a laxative for the treatment of constipation [42].

**VI. FUTURE DIRECTIONS**

*Tamarindus indica* bark, a cornerstone of traditional medicine, boasts a rich phytochemical profile. To unlock its full therapeutic potential, future research should focus on isolating and characterizing specific bioactive compounds. This in-depth analysis will pave the way for targeted therapies with enhanced efficacy and minimal side effects. Additionally, mechanistic studies are crucial to understanding how the bark interacts with the body. Delving into the pathways behind its diverse effects will refine and optimize its therapeutic use. Finally, well-designed clinical trials are necessary to validate traditional applications and provide scientific backing for their integration into mainstream medicine. This comprehensive approach promises to transform *Tamarindus indica* bark into a powerful tool for improving human health and well-being.

**VII. CONCLUSION**

*Tamarindus indica* (tamarind tree) boasts rich nutritional content and diverse applications due to its bark, leaves, fruit, stems, and roots. Valued for its febrifuge, astringent, and therapeutic properties, traditionally it's used for wound healing, diarrhea, gingivitis, and more. Phytochemical analysis reveals alkaloids, flavonoids, and tannins, suggesting anti-bacterial, anti-inflammatory, and anti-diabetic properties. With potential in wound healing, anti-cancer effects, and low risk of side effects, *Tamarindus indica* is a promising candidate for further research and development in healthcare.

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