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Review Article

A Comprehensive Review on *Tectona grandis* and Its Medicinal Aspects

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ABSTRACT

Tectona grandis L.f, widely known as teak, is not only valued for its durable timber but also for its broad medicinal importance across traditional healing systems. The plant contains diverse phytochemicals such as alkaloids, phenolic glycosides, and steroids. Growing scientific interest in teak has led to extensive studies aimed at isolating bioactive compounds and verifying their therapeutic roles. Different parts of the plant have been explored for multiple biological activities, including antioxidant, antipyretic, analgesic, hypoglycemic, wound-healing, and cytotoxic effects, among others. Bringing together this information is essential to provide a comprehensive reference that highlights both the pharmacological and phytochemical aspects of teak. This review compiles findings on chemical constituents, extraction and identification techniques, biological activity evaluations, toxicological studies, allergy-related reports, and associated patents. Such an overview may help researchers identify existing gaps and guide future investigations.

INTRODUCTION

Plants represent crucial sources of medicinal compounds, and scientific research on natural products often emphasizes exploring their therapeutic potential by integrating traditional knowledge with modern investigations. Many plant-derived phytochemicals serve as key structural templates for the discovery and optimization of lead molecules. It is estimated that nearly 25% of pharmaceuticals in developing countries originate from plants or their derivatives

[1]. Considerable research has focused on evaluating the phytochemistry and pharmacological activities of different plant species. One such plant of significant medicinal interest is *Tectona grandis* L.f, commonly known as teak, a member of the Verbenaceae family. This tall deciduous tree, reaching 30–40 meters in height, is easily recognized by its fluted trunk with basal buttresses in mature trees. Its bark is light grayish-brown, while the large, opposite, shiny elliptic leaves are grayish underneath due to glandular hairs. The plant bears small, white,

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bisexual flowers arranged in panicles, and produces irregularly shaped, green, hairy drupes [2]. Teak is native to South Asia, and multiple parts of the plant—including roots, bark, flowers, wood, and oil—have been employed in traditional medicine. Ethnopharmacologically, these have been used in treating conditions such as colds, headaches, wounds, bronchitis, scabies, and constipation. Reported pharmacological effects include laxative, diuretic, antidiabetic, anti-inflammatory, antioxidant, and lipid-lowering activities. Some of these effects are further enhanced when teak extracts are combined with other herbal formulations, and such combinations have been patented [3]. The present review compiles available data on the phytoconstituents identified from different plant parts, extraction solvents used, analytical techniques for quantification, and biological activities investigated. It also discusses toxicological evaluations, potential allergic reactions, and notable patents linked to this species [4].

Tectona grandis Linn., locally known as Sagwan, is also classified under the Lamiaceae family. Globally, it is one of the most valued hardwood species, admired for its durability, decorative grain, and natural resistance to termite and fungal attacks. This resilience is largely attributed to bioactive molecules such as tectoquinone, lapachol, and deoxylapachol. The plant is particularly rich in naphthoquinones, anthraquinones, and isoprenoid quinones—metabolites associated with diverse pharmacological properties [5]. In addition, teak contains other important phytochemicals such as triterpenoids, steroids, lignans, fatty esters, and phenolic compounds. Pharmacological studies have confirmed that *Tectona grandis* exhibits antioxidant, anti-inflammatory, antipyretic, cytotoxic, analgesic, hypoglycemic, wound-healing, and antiplasmodial activities. This review, therefore, seeks to provide a consolidated overview of its phytochemical profile and therapeutic potential [6].



Fig 1. *Tectona Grandis*

Traditional uses:

Teak (*Tectona grandis* Linn.) is one of the most valued tropical hardwoods, recognized for its outstanding physical attributes, with an average wood density of about 650 kg/m³. Its natural durability and excellent dimensional stability

make it widely used in ship and boat construction, building materials, decorative veneers, furniture, cabinetry, musical instruments, and fine woodcarving [7]. Apart from its industrial significance, teak also plays an important role in traditional medicine. Extracts derived from various parts of the plant have been reported to

possess expectorant, anti-inflammatory, and anthelmintic properties. In traditional practices, teak has been employed in the treatment of conditions such as bronchitis, bilious disorders, hyperacidity, diabetes, leprosy, and parasitic infections. Additionally, a paste prepared from teak wood powder is often applied externally to relieve bilious headaches and reduce localized swellings [8]. In Ayurveda, teak wood is described as acrid, cooling, and laxative, and is also believed to exert a sedative influence on the gravid uterus. Traditionally, it has been employed in the management of ailments such as piles, leukoderma, dysentery, and excessive thirst, and is particularly valued for its anthelmintic and expectorant properties. Moreover, the leaves of *Tectona grandis* are widely utilized in folk medicine for wound healing, with special significance in the treatment of burn injuries [9].

Distribution and description:

The natural distribution of *Tectona grandis* Linn. (teak) spans the Indian subcontinent, Myanmar, and Thailand, where it thrives primarily in deciduous forests with well-drained alluvial soils. India contributes nearly one-third of its natural range, with the species occurring sporadically across Peninsular India below 24°N latitude, especially in Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka, and Kerala. In Myanmar, teak is distributed throughout the country up to 25°N latitude, while in Thailand, it is found up to 17.5°N and between 97°–101°E, mainly along the Mae Khong, Salween, and Chao Phraya River basins. Beyond its native range, teak has been successfully introduced as a plantation species in about 36 tropical countries across Asia, Africa, Central, and South America [10]. Under favourable conditions, *T. grandis* develops into a large deciduous tree often exceeding 30 meters in height. Its crown is open with numerous slender branches, while the

trunk typically exhibits buttresses and fluting, producing clear bole growth up to 15 meters before the first branching occurs. The stem is usually cylindrical in younger trees but becomes fluted and slightly buttressed with age. The bark is light brown to gray, fibrous in texture, and characterized by shallow longitudinal fissures [11]. The root system of teak is generally shallow, rarely extending beyond 50 cm in depth, though lateral roots may spread as far as 15 meters from the trunk. The tree is deciduous, shedding its large, four-sided leaves for 3–4 months during the latter part of the dry season, leaving the smaller branches bare. Mature leaves typically measure about 30 × 20 cm, with a glossy upper surface and a hairy underside, featuring a distinct vein network. They are broadly ovate to oval in shape, tapering at the base with blunt or shortly pointed tips. In contrast, young leaves can attain lengths of up to 1 meter [12].

The flowers of teak are relatively small, measuring about 8 mm in diameter, and range in color from mauve to white. They are arranged in large terminal inflorescences, approximately 45 cm long, borne on the uppermost branches exposed to direct sunlight. The fruit is a hard, woody drupe with four chambers, enclosed within an inflated, bladder-like calyx. It is pale green when immature and gradually turns brown upon ripening. Each fruit may contain between 0 and 4 seeds, with an estimated 1,000 to 3,500 fruits per kilogram [13].

Chemical Constituents:

Tectona grandis, commonly known as teak, is a tropical hardwood species valued not only for its highly durable timber but also for its wide spectrum of naturally occurring chemical constituents. These phytochemicals are distributed across various plant parts—including leaves, bark, heartwood, roots, and seeds—and are associated with diverse biological activities. Traditionally,



teak has been employed in medicine for its therapeutic effects, many of which are attributed to these compounds. Moreover, these constituents also play a crucial role in the tree's natural resistance to pests and decay, thereby contributing to the exceptional durability of teak wood [14]. Among the most significant compounds isolated from teak is tectoquinone, a naphthoquinone predominantly found in the heartwood. This metabolite imparts strong protection against termites, fungi, and microbial degradation, which explains teak's enduring value for outdoor and construction uses. Other related naphthoquinones, such as lapachol and deoxylapachol, are present in the wood and foliage. Lapachol has been particularly studied for its promising antimicrobial and anticancer activities [15]. The leaves of *T. grandis* are rich in flavonoids like luteolin and apigenin, which exhibit antioxidant properties by neutralizing free radicals and providing anti-inflammatory benefits. They also contain tannins, compounds with well-documented astringent and antimicrobial effects, traditionally applied in wound care, skin ailments, and gastrointestinal disorders [15]. The bark and roots harbor phenolic acids and triterpenoids, with betulinic acid standing out as a notable bioactive molecule. Betulinic acid has demonstrated anti-inflammatory, antiviral, and antitumor properties in experimental models, making it a candidate for therapeutic development. Additionally, the presence of alkaloids and steroidal compounds contributes to further pharmacological benefits, including analgesic and immunomodulatory effects [15]. The seeds of teak are another important source of bioactive molecules, especially essential fatty acids such as oleic, palmitic, and linoleic acids. These compounds support skin and cellular health while also exerting anti-inflammatory effects [16]. In summary, *Tectona grandis* is more than just a source of premium-quality timber. Its phytoconstituents—

ranging from naphthoquinones, flavonoids, and tannins to triterpenoids and fatty acids—highlight its significance in both traditional healing systems and modern pharmacological research. These bioactive molecules not only account for the resilience of teak wood but also show potential applications in pharmaceutical, antimicrobial, and anti-inflammatory therapies. Continuous research is expanding the understanding of this versatile species and its role in medicine [17].

Toxicological Studies:

Acute toxicity studies are fundamental in identifying the dose at which a substance may induce death or severe adverse effects after a single administration or repeated dosing within a short timeframe. These evaluations are critical for establishing the safety margin of potential therapeutic agents. Several toxicological investigations have been performed on different parts of *tectona grandis* (tg). Experimental doses generally ranged from 1,000 mg/kg to 5,000 mg/kg body weight, with extracts prepared using solvents such as water, methanol, and ethanol [18]. Across these studies, no significant signs of toxicity were observed, even at doses as high as 5,000 mg/kg. Nonetheless, many researchers typically restricted the maximum dose tested to 2,000 mg/kg. A summary of the available acute toxicity studies—detailing the plant part tested, solvent used, and the animal models employed—is presented in the table below [19].

Pharmacological Activities:

In recent years, the global reliance on herbal products has grown considerably, as plants continue to provide an important reservoir of medicinal compounds. Despite their long history of use, unraveling the complex molecular interactions and precise bioactive mechanisms of plant extracts and their constituents remains a



scientific challenge. *Tectona grandis* Linn. (teak) has been extensively studied and is recognized for its wide range of pharmacological effects. A concise summary of its pharmacological properties is outlined below [20].

Cytotoxic activity:

The cytotoxic potential of *Tectona grandis* extracts has been investigated using different solvent systems. The methanol extract of teak wood and the hexane extract of its leaves were evaluated through the MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide] assay. Furthermore, the chloroform extract of teak bark demonstrated strong cytotoxic effects against chick embryo fibroblast (CEF) and human embryonic kidney (HEK 293) cells, with inhibition rates of 87% and 95.3%, respectively. Phytochemical investigations of the concentrated petroleum extract from the root heartwood revealed the presence of hydroxynaphthoquinone [21]. This extract exhibited significant cytotoxicity in brine shrimp assays, which prompted isolation and characterization of its active constituents. A new compound, 5-hydroxylapachol, was identified alongside known compounds such as lapachol, dehydro- α -lapachone, methylquinizarin, and squalene. Both 5-hydroxylapachol and lapachol exhibited cytotoxic properties, with 5-hydroxylapachol being particularly noteworthy. The additional hydroxyl group in this molecule may enhance solubility, while its lower toxicity profile compared to lapachol suggests potential as a more favorable lead compound for further development as a cytotoxic agent [21].

Antibacterial activity:

The bark of *Tectona grandis* Linn. has been studied for its antibacterial potential, particularly against *Listeria monocytogenes* and methicillin-resistant *Staphylococcus aureus* (MRSA), using

the disc diffusion method. The active compound 5-hydroxy-1,4-naphthalenedione (Juglone) was identified through gas chromatography-mass spectrometry, complemented by ^1H and ^{13}C NMR analyses [22]. Further investigations demonstrated that Juglone effectively inhibited several oral pathogens, including *Streptococcus mutans*, *Streptococcus sanguis*, *Porphyromonas gingivalis*, and *Prevotella intermedia*. These findings provide a scientific basis for the traditional practice of using teak twigs and sticks for oral hygiene in parts of Africa and the Middle East [22].

Antioxidant activity:

The antioxidant potential of *Tectona grandis* Linn. has been extensively evaluated using various extracts and assay systems. Hexane, chloroform, ethyl acetate, and methanol extracts from the leaves, bark, and wood were tested using DPPH and ABTS⁺ free radical scavenging assays. Among these, the ethyl acetate extract of the wood exhibited the highest activity, achieving 98.6% inhibition against both radicals. Crude ethanol extracts also demonstrated significant antioxidant effects, including H_2O_2 scavenging activity and positive responses in DPPH and FRAP assays [23].

Further studies assessed the antioxidant activity of teak leaf extracts using four in vitro methods: total phenolic content, reducing power, superoxide radical scavenging, and inhibition of H_2O_2 -induced erythrocyte hemolysis. These investigations highlighted the plant's potential as both a dietary supplement and a medicinal resource. Additionally, when evaluating 17 commonly used Indian medicinal plants for their ability to regulate nitric oxide (NO) levels in vitro (using sodium nitroprusside as an NO donor), *T. grandis* ranked among the most effective extracts [24].



Hair growth activity:

In traditional Indian medicine, the seeds of *Tectona grandis* Linn. are valued as a natural hair tonic. A study investigated the effect of petroleum ether extracts of teak seeds on hair growth in albino mice. Extracts at concentrations of 5% and 10% were incorporated into a simple ointment base and applied topically to shaved skin. The time required for initiation and completion of the hair growth cycle was recorded, with a 2% minoxidil solution serving as the positive control. Treatment with the teak seed extracts significantly accelerated the onset of hair growth, reducing the initiation time by half compared to the control group. Additionally, the extracts promoted a greater number of hair follicles in the anagen phase, outperforming minoxidil [25].

Hypoglycaemic activity:

Tectona grandis Linn. has demonstrated potential in managing insulin resistance, partly due to its antioxidant properties and ability to enhance glucose uptake. In studies where dexamethasone induced significant increases in blood glucose and triglyceride (TG) levels, treatment with *T. grandis* resulted in a dose-dependent reduction of both parameters. The bioactive compound betalaphachone, present in teak, exhibits glucocorticoid antagonistic activity, which may contribute to these effects. Additionally, other constituents such as terpenoids and tannins are known for their antihyperglycemic properties. Treatment with *T. grandis* also improved insulin-assisted glucose uptake, indicating enhanced insulin sensitivity [26,27].

In separate investigations, the methanol extract of teak roots exhibited significant hypoglycemic activity in alloxan-induced diabetic albino rats, comparable to the standard antidiabetic drug glibenclamide. Similarly, oral administration of

bark extracts in control and diabetic rats produced a notable reduction in blood glucose levels, confirming the anti-hyperglycemic potential of *T. grandis* [28].

Anthelmintic activity:

The ethanolic extract of *Tectona grandis* Linn. fruits has been evaluated for its anthelmintic potential using the Indian earthworm *Pheretima posthuma* as the test organism. The study measured the time required for paralysis and death of the worms, with piperazine citrate serving as the standard reference drug. At a concentration of 50 mg/ml, the crude ethanolic fruit extract exhibited significant anthelmintic activity, comparable to that of piperazine citrate [29].

Diuretic activity:

The acute diuretic potential of an aqueous extract of *Tectona grandis* Linn. leaves was evaluated in Wistar rats by measuring urine volume and electrolyte excretion. The results demonstrated a significant, dose-dependent increase in both parameters, comparable to the effects of standard diuretics such as furosemide and hydrochlorothiazide [30].

Anti-inflammatory Activity:

The methanol extract of *Tectona grandis* Linn. flowers (METGF) was evaluated for its anti-inflammatory potential using the carrageenan-induced inflammation model. The extract demonstrated significant activity, particularly during the second phase of inflammation. This effect is suggested to result from the inhibition of the release of inflammatory mediators by the flower extract [30].

Analgesic Activity:



The methanol extract of *Tectona grandis* Linn. flowers (METGF) was evaluated for analgesic activity using acetic acid-induced writhing and Eddy's hot-plate tests. These models were employed to assess both peripheral and central analgesic effects. The results demonstrated that METGF produced dose-dependent inhibition of pain in both models, suggesting involvement of opioid receptors in mediating its analgesic action. The observed effects are likely attributed to the presence of phenolic compounds and tannins in the flower extract [31].

Hepatoprotective Activity

In rat models subjected to carbon tetrachloride (CCl₄) and paracetamol-induced hepatotoxicity, administration of *Tectona grandis* extracts—particularly from the bark and leaves—restored the levels of liver enzymes, including AST, ALT, and ALP. Histopathological analyses further confirmed regeneration of hepatic tissues, indicating a protective effect against oxidative and chemically induced liver damage [32].

Wound Healing and Dermatological Use:

Topical application of *T. grandis* leaf paste or methanolic extract accelerated wound closure in excision and incision models in rats. It promotes:

- Fibroblast proliferation
- Collagen synthesis
- Angiogenesis

These effects support its traditional use in the treatment of cuts, burns, and ulcers.[33]

CONCLUSION:

Tectona grandis Linn. (teak) is an important medicinal plant with a wide range of bioactive

compounds present in its leaves, bark, roots, seeds, heartwood, and flowers. These compounds contribute to various pharmacological activities, including antioxidant, anti-inflammatory, analgesic, antibacterial, cytotoxic, hepatoprotective, antidiabetic, anthelmintic, diuretic, and hair growth-promoting effects. The traditional uses of teak in medicine are supported by scientific studies, which show that its extracts are generally safe at tested doses. The plant's bioactive constituents not only explain its therapeutic potential but also its natural durability and resistance to pests and decay. Overall, *Tectona grandis* is a valuable plant with both medicinal and industrial importance, and further research could help develop new drugs and natural therapies based on its active compounds.

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