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Pharmacological, and Phytochemical Profile of *Tectona grandis linn* (Verbenaceae) – A Comprehensive Review

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ABSTRACT

Tectona grandis, commonly known as teak, holds a prestigious status among timber plants globally and is a member of the Verbenaceae family. Teak wood is highly valued for its exceptional qualities, including durability, stability, and aesthetic appeal, making it a preferred choice for various applications such as furniture, flooring, shipbuilding, and construction valued for its remarkable hardness and resistance to deterioration even in the absence of paint or preservatives. Although this plant is locally referred to as Sagon, Sagwan, it is popularly called teak. Furthermore, teak is regarded as a key component in a large number of traditional remedies. It is known that teak has a significant role in numerous traditional remedies, underlining its historical importance in traditional healing practices. In addition, teak is regarded as a key ingredient in some traditional remedies. *Tectona grandis Linn*. commonly known as teak, possesses a plethora of pharmacological properties, making it a valuable resource in traditional and modern medicine. Research indicates that teak exhibits antipyretic, analgesic, antibacterial, antioxidant, antifungal, anti-inflammatory, and anti-diuretic hypoglycaemic effects when utilized medicinally. These diverse pharmacological activities stem from the rich phytochemical composition of teak, including phenolic compounds, flavonoids, tannins, terpenoids, and alkaloids.

Keywords- *Tectona grandis linn*., phytochemistry, traditional uses, pharmacology.

Introduction

Medicinal plants are indispensable. study on natural products is typically aimed at determining therapeutic properties by studying obtainable scientific information and traditional applications. the phytochemicals extracted from medicinal plants serve as valuable templates for the development and optimization of lead compounds in drug discovery. it is well-documented that a significant proportion of medications used in underdeveloped countries are

based on plants and their derivatives. Estimates suggest that around 25% of prescription drugs worldwide are derived from natural products, including plants. In underdeveloped countries, where traditional medicine plays a crucial role in healthcare due to limited access to modern pharmaceuticals, the reliance on plant-based medicines is even more pronounced.[1]

Tectona grandis, or teak, as it is usually called, is indeed a tree with various medicinal properties utilized in traditional medicine systems like Ayurveda. Different parts of the teak tree, including leaves, bark, and roots, have been used in herbal remedies for treating various ailments.[2] numerous research organizations have investigated the phytochemical and pharmacological characteristics of a number of plants. *Tectona grandis* is a noteworthy example of such a plant.[3,4]

It is a globally renowned timber recognized for its stability in dimensions. in the topic area, the alien species *Tectona* is prevalent. India and other South Asian nations also have a high prevalence of it.[5] Natural goods are now an essential component of the healthcare system for humans due to widespread concern about the dangerous effects and sensitivity of contemporary pharmaceuticals. India is indeed recognized as one of the 12 leading biodiversity hotspots globally, boasting an impressive diversity of flora and fauna. With approximately 45,000 plant species, India's rich botanical heritage makes it a treasure trove of medicinal plants and natural resources. Plants have been the most abundant and significant source of medications across various domains. comprising nutraceuticals, food supplements, modern medicines, folk medicine, traditional medicine, and pharmaceutical intermediates. Globally the use of traditional medicinal plants for primary healthcare has been progressively increasing in recent years.[6]

There are indeed other species within this genus that are native to specific regions. two such species are ***Tectona hamiltoniana*** and ***Tectona philippinensis***, which are situated in Myanmar and the Philippines, respectively are only found in a few isolated locations and have a limited natural range. Because *Tectona grandis* is a superior wood, it is used for a variety of construction projects, including building boats, ships, and bridges, furthermore for musical instruments, furniture, cabinets, and other handicrafts, decoration, and construction.[7]when conditions are favorable, the *Tectona grandis* can grow to a height of 30 meters. a crown with several short branches, some of which are 15 meters long. Strong at the base, the stem is cylindrical.[8] Bark is shallow or longitudinally creviced, fibrous, and light brown. Although the root system is shallow, with a depth of no more than 50 cm, it can spread outward from the

shoot up to 15 m. The vein network is plainly seen in the leaf's glossy from above and hairy from below.[9] The opposing, whole, sharp leaves might be elliptic or ovate. Young leaves can be as long as one meter. The little blooms are situated on the upper branches in the area of the crown that is not shaded white, and arranged in voluminous, blooming heads.[10]The heartwood is advised for treating lipid disorders and threatening abortions, according to the Indian Ayurvedic Pharmacopoeia. the wood contains a lot of anthraquinones, naphthalene, and tri- and hemi-terpene chemicals. recent work in phytochemical and Pharmacological research has indeed yielded successful treatments for certain ailments where the synthetic drug industry has faced challenges.[11]

PLANT PROFILE

TAXONOMY AND NOMINCLATURE

Plant name- *Tectona grandis*

Teak, known for its sturdy and durable qualities, is celebrated under various names across different languages. In Hindi, it goes by the names "Sagwan" or "Sagaun", while in Bengali, it is referred to as "Segunngachh". Gujarati speakers call it "Sag", "Saga", or "Sagach". In the southern Indian state of Kerala, Malayalam speakers use terms like "Tekka", "Maram", "Tekku", and "Sagun" to describe this majestic tree. Even in Sanskrit, the ancient language of India, teak is recognized as "Anila", "Arna", or "Arjunapama".[12]

Teak, scientifically classified as *Tectona grandis*, is a member of the plant kingdom. Within this kingdom, it belongs to the sub-kingdom Tracheobionta and the super-division Spermatophyta. Further down the taxonomic hierarchy, teak falls under the division Eudicots and the class Magnoliopsida. Its sub-class is Astridae, and its order is Lamiales. Teak is part of The Verbenaceae family.[13]

Fig1 (a) Tectona grandis whole plant

Fig2 (b) Tectona grandis leaves

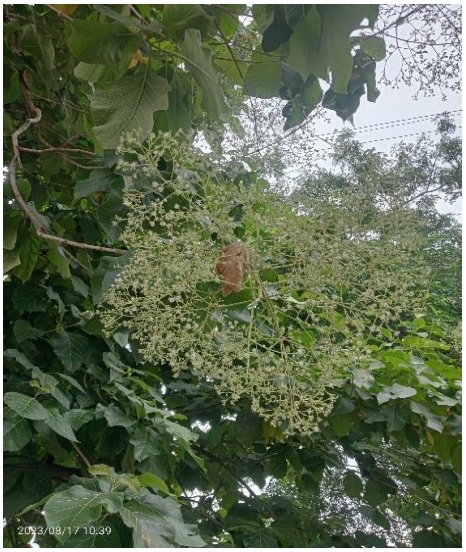


Fig3 (c) Fruits of *Tectona grandis*

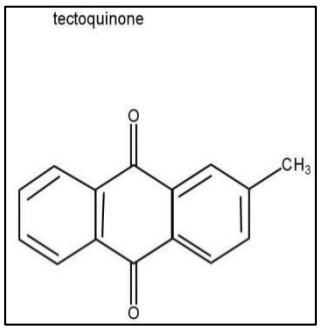
Fig4 (d) Bark of *Tectona grandis*

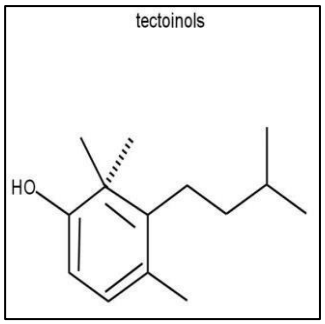
Cultivation and Collection

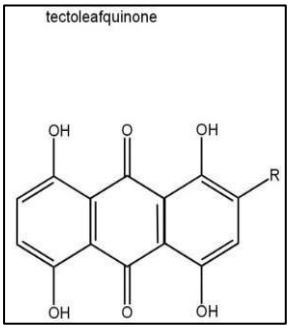
This enormous deciduous tree that is between 10 and 20 meters tall. Its branchlets have four angles and are heavily covered in a yellowish-grey tomentum. The opposite leaves measure30–50 cm, represents the width of the boards, 15–20 cm, represents the thickness of the boards with a triangular base. They are ovate-elliptic to oval. The leaves of teak trees are notably large, typically 4-sided, and shed for a period of about 3 to 4 months during the year, often in response to changes in climate or seasonality, bisexual, tiny flowers are pale in colors.[14] as many as a few thousand flower buds can be seen in each of their huge panicles, which appear in groups of a few over the 2- 4-week flowering period. The calyx is 2.5–3 cm long in the flower, but it becomes larger and is bladder-like in the fruit, measuring up to 2–2.5 cm. Fruit is a spherical, rigid, and woody drupe with four chambers; it is covered in a coating that resembles an inflated bladder and is originally light green in colour. before turning brown as it ages. No more than four seeds per fruit. Brown, oblong seeds with a bony endocarp surround the plant.[15]The stem of the teak tree tends to be cylindrical when young but develops a fluted and sometimes buttressed appearance at the base as it matures. The bark of the tree is typically brown or grey, fibrous in texture, and displays shallow, longitudinal fissures.[16]Teak trees have a superficial root system, generally not extending deeper than 50 cm into the soil. However, their lateral roots can spread quite extensively, reaching up to 15 meters away from the stem. This allows the tree to acquire a substantial area for nutrient absorption and stability.[17]

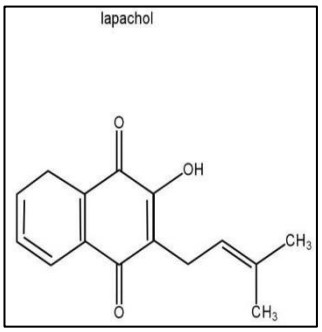
PHYTOCHEMICAL CONSTITUENTS-

Leaves-Tectoleafquinone, Tannins (6%) and dye, proteins (7.1%), crude fibres (22.3%), Calcium (3%), phosphorus (0.46%), monoterpene, betulinic acid, anthraquinones, tectoinolos-B (14), lapachol, tectoquinone etc.

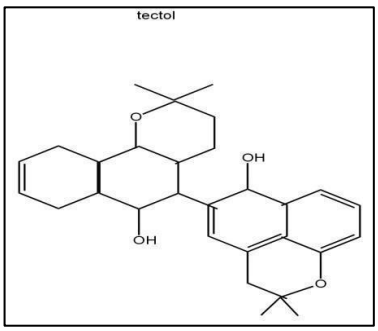


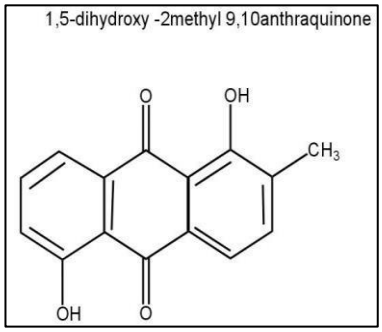


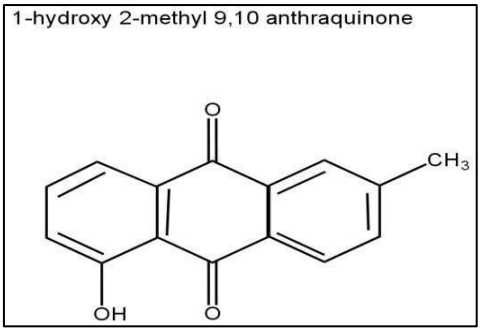




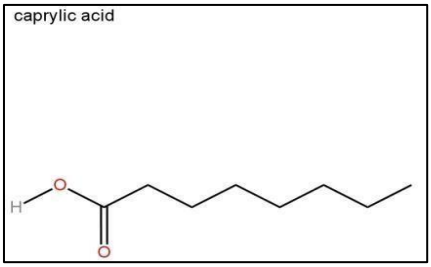
Root- Tectoquinone, b-sitosterol, new diterpene, 1-hydroxy-2 methyl anthraquinone, each basin, tectol, tectograndinol, 5-dihydroxy 2methyl9, 10 anthraquinone.[18]

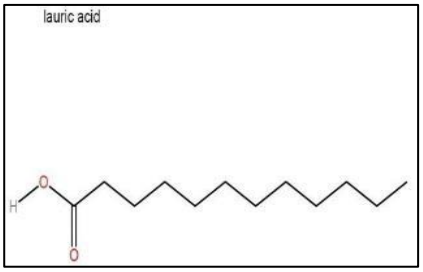






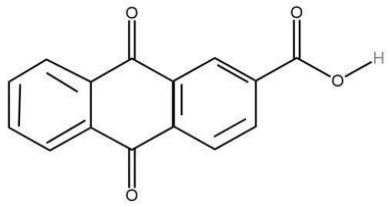
Seed- Seed oil contains the amount of fatty acid as caprylic acid (1.45%), capric acid (0.76%), lauric acid (6.77%), myristic acid (2.86%), palmitic acid (12.12%), stearic acid etc.



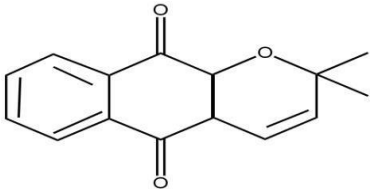


Wood- Resin, silica, calcium phosphates, ammonium phosphates, magnesium phosphates, anthracene-2- carboxylic acid, triterpenes, and hemiterpenes, Dehydro- a -lapachone (7,8) lapachol, 5-hydroxy-lapachol, methylquinizarin, 5- hydroxy- 2 -methyl-9,10- anthraquinone etc. [19]

anthraquinone carboxylic acid



dehydro alpha lapachone



Bark- Tannin (7.14%), 5-hydroxy-1,4- napthalenedione(VI) (juglone), Obtusifolina, (7.14 %) 5-hydroxy-1,4-napthalenedione(VI)(juglone),Obtusifolina(VII), Desidro-α-lapachona(VIII).[20]

Traditional uses –

It can be used as a depurative, anthelmintic, astringent, and to help with constipation. It is useful for helps with burning feelings, diabetes, leprosy, bronchitis, hyperacidity, dysentery, burning sensations, difficult labours, and skin disorders. the bark of the teak tree is used to address digestive disorders, including diarrhoea and dysentery.

The medicinal properties of leaves include cooling, homeostasis, purification, anti-inflammatory, and vulnerability. They are beneficial for inflammatory conditions,pruritus, stomatitis, indolent ulcers, haemorrhages, and haemoptysis. Teak leaves are often employed to reduce fever and inflammation due to their febrifuge and anti-inflammatory properties.

During pregnancy, laxative, cooling, acrid, and sedative to the uterus, effective for treating dysentery, leukoderma, and piles. The best oil for headaches, biliousness, and searing sensations is that which is taken from the wood, especially when the pain is localized over the liver.[21] there are advantageous for anuria and urine retention.they are bitter, dry, and caustic, and they treat biliousness, urine discharge, and bronchitis. According to the Unani medical system, oil produced from the blossoms is beneficial for scabies and encourages hair development. teak extracts are used to alleviate skin issues like eczema, itching, and rashes due to its antibacterial and anti-inflammatory qualities.[22]

Pharmacological Activities-

The study Aim to investigate the both aqueous and methanolic extract of *Tectona grandis* leaves possess analgesic properties[23, 24]the rationale behind this investigation stemmed from the existence of phenolic compounds and tannins, as identified in the preliminary phytochemical analysis of the extracts.[25] The results revealed that animals administered with METGF exhibited significantly longer reaction times, particularly at doses of 100mg/kg and

200 mg/kg, compared to the control group. These findings suggest that METGF[25] demonstrates promising effects in prolonging reaction times in both the hot plate and acetic acid methods, indicating its potential as an analgesic agent.[26]

This study set out to determine *Tectona grandis Linn*. floral methanol extract possesses acute Anti-Inflammatory qualities (METGF) in relation to inflammation induced by carrageenan.[27,28] the study concluded that the extract had a beneficial effect, especially in the second phase of inflammation, furthermore, the study suggests that the observed the effect of the methanol extract of *Tectona grandis Linn*. flowers may be attributed to the inhibition of inflammatory mediators released by the extract. These inflammatory mediators have a significant part in the inflammatory response and are involved in processes such as vasodilation, immune cell recruitment, and tissue damage.[29]

The primary focus of the study is to investigate the Hypoglycaemic activity of the methanolic extract obtained from the roots of *Tectona grandis*[30]. The study uses alloxan-induced diabetic rats as an experimental model. It is compared with that of Glibenclamide, a known antidiabetic drug.[31]The research shows that there is a notable hypoglycaemic effect from the methanolic extract at 500 mg/kg. This suggests a dose-dependent relationship, where higher doses of the extract lead to more pronounced effects on lowering blood glucose levels.[32,33]

The aim of study to investigate the *Tectona grandis linn* leaf extract was investigated for its Antibacterial properties. The outcomes also demonstrate the effectiveness of leaf extracts in preventing the growth of pathogenic fungus as well as gram positive and gram-negative bacteria. Thus, more research will be needed to ascertain the applications of Tectona grandis Linn as an antibacterial agent.[34]

The aim of study to investigate the Antioxidant activity of the plant *Tectona grandis* extracts obtained from the leaves, bark, and wood.[35] The ability of the extracts to scavenge free radicals is analysed using 1,2-diphenyl 1-picryl hydrazyl (DPPH). DPPH is a common method used to evaluate the free radical scavenging activity of antioxidants.[36,37] The antioxidant status of the extracts is also checked using DPP (possibly referring to another method) and ABTS+ free radical assays. [38]The results indicate that the ethyl acetate extract of wood exhibits the maximum activity against both DPPH and ABTS+ free radicals. Importantly, the activity of this wood extract is reported to be higher than the standards quercetin and trolox. Quercetin and trolox are commonly used as reference standards in antioxidant studies.[38,39,40]

The study aimed to conducted the Hepatoprotective activity of preliminary phytochemical analysis on the *Tectona grandis* leaves, confirming the existence of specific bioactive compounds like saponins, carbohydrates, tannins, and flavonoids.[41] the group of rats treated with carbon tetrachloride (CCl4) showed an increase in the concentrations of liver enzymes and serum bilirubin. Elevated amounts of bilirubin, SGPT, SGOT, ALP, and other enzymes are indicative of liver damage. sit is compared with the standard drug silymarin (administered at 100 mg/kg), produced a significant decrease in the elevated levels of liver enzymes and bilirubin compared to the control group.[42] Silymarin is a known hepatoprotective agent commonly used in liver disorders. The findings indicate that in rats with CCl4-induced liver injury, Tectona grandis leaves demonstrate significant hepatoprotective action.[43]

The study assessed the Antibacterial activity of the extracts against four bacterial strains: Staphylococcus aureus, Klebsiella pneumonia, Salmonella paratyphi, and Proteus mirabilis. The activity was determined using a disc diffusion assay.[44] A carrier-soaked disc served as a negative control. The results were compared with the standard antibiotic ciprofloxacin, which is commonly used to treat bacterial infections.[45] The antibacterial activity was expressed as the diameter of the inhibition zone, which is the area around the disc where bacterial growth is inhibited. Larger inhibition zones generally indicate stronger antibacterial activity. the chloroform extract of the leaf was found to be outstanding, showing good activity against Staphylococcus aureus (14 mm) and Klebsiella pneumonia (8 mm) at the highest concentration tested (500 μg). The methanol extract of the leaf and the ethyl acetate extract of the wood also demonstrated fairly good activity against both gram-positive (Staphylococcus aureus) and gram-negative (Klebsiella pneumonia) bacterial species**.**[46]

The aim of study was Anti- Anaemic activity motivated by the traditional oral report that *Tectona grandis Linn*. is used in the treatment of anaemia in Togo.The results show that the oral administration of the ethanol extract at both doses significantly increases the concentration of haemoglobin (Hb), the number of red blood cells (RBCs), haematocrit, and the rate of reticulocytes, particularly 7 days after phenyl hydrazine administration. The study suggests that the *Tectona grandis* leaf extract could stimulate the process of erythropoiesis, the formation of red blood cells, leading to an increase in the number of young red blood cells (reticulocytes).[47]

The purpose of the study was to assess the ethanolic extract's Anthelmintic activity. of *Tectona grandis* fruits and leaves. Indian earthworm Pheritima posthuma was used as the model organism for assessing anthelmintic activity. The effectiveness of the ethanolic extract was

assessed by measuring the time of paralysis and time of death of the earthworms.[48] the study compared the anthelmintic activity of the crude ethanolic extract with that of the standard reference drug, piperazine citrate. The results indicate that the crude ethanolic extract of *Tectona grandis* fruits shows significant anthelmintic activity at a concentration of 50 mg/ml. The term "significant activity" suggests that the extract demonstrated a notable effect in comparison to the standard drug.[49]

The primary aim of the study was to assess the Diuretic activity of the aqueous extract of *Tectona grandis* leaves. the evaluation involved measuring two main parameters - urine volume and urine electrolyte levels to determine the diuretic effects of the extract. The results of the study revealed a significant increase in urine volume and urine electrolyte excretion. This increase occurred in a dose-dependent manner, meaning that higher doses of the aqueous extract lead to a more pronounced diuretic effect.[50] the study compared with the two standard diuretics drug, furosemide, and hydrochlorothiazide. the study suggests that the aqueous extract of *Tectona grandis* leaves demonstrated acute diuretic activity in Wistar rats.[51]

The aim of study was the Hydrochloric extract of *Tectona grandis,* specifically its frontal leaves, has potential Wound healing properties. animals treated with *Tectona grandis* leaf extract showed a significant reduction in the period of epithelization (the process of forming the outer layer of skin) in excision wounds. In burn wound models, there was also a significant reduction in the period of epithelization and 50% wound contraction.[52] Animals treated with the extract showed a significant increase in the breaking strength in incision wounds. the conclusion drawn from the study is that *Tectona grandis* leaf extract, whether it has the ability to promote wound healing when applied topically or taken orally.[53] The extract appears to contribute to faster epithelization, increased wound contraction, improved breaking strength, and enhanced granulation tissue formation.[54]

The purpose of the study is to determine whether teak leaf extract, which is made from *Tectona grandis*, has Antifungal properties against A. phaeospermum, a species that is known to cause deterioration in wood.[55] Using potato dextrose agar (PDA), a popular medium for fungal culture, the well diffusion approach was employed to assess the teak leaf extract's antifungal properties. [56] the outcomes demonstrated that the teak leaf extract considerably inhibited the development of A. phaeospermum, even at low concentration of 0.5% (w/v). In addition to preventing fungal radial growth, the teak leaf extract significantly affected A. phaeospermum sporulation and total biomass.[57] the study comes to the conclusion that the fungus A.

phaeospermum, which causes wood rot, is effectively inhibited by the methanol extract of teak leaves.[58,59]

Conclusion- The significance of various pharmacological activities associated with *Tectona grandis Linn.* While there is a substantial volume of research on this plant. the majority of studies seem to have focused on its extracts and isolates. the review suggests that despite the existing research, there is still a need for an extensive number of studies to fully explore the potential commercial applications of products derived from T. grandis Linn. Not only it possesses significant value for its hardwood, but it also serves as a unique source of various compounds with diverse chemical structures. The review highlights a spectrum of pharmacological activities associated with *Tectona grandis*, ranging from antibacterial and antioxidant properties to actions that include wound healing, anti-ulcer, antinociceptive, anti-tumor, anti-metastatic, analgesic, diuretic, hypoglycaemic, antidiabetic, antipyretic, and hair growth.

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