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TECTONA GRANDIS LINN: A GLOBAL OVERVIEW

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ABSTRACT

Tectona grandis Linn.(*T. grandis* Linn.) belonging to family- Verbenaceae is one of the most well-known timber plant in the world and is renowned for its, extreme durability, dimensional stability & it's hard nature. Medicinally, it has various pharmacological activities like antibacterial, antioxidant, antifungal, anti-inflammatory, anti-pyretic, analgesic, anti-diuretic, hypoglycemic, anti-hyperlipedemic and antiulcer. *T. grandis* Linn also has various phytoconstituents like Triterpenins, Lignins, Quinone, Steroids, Phenolic acids, carbohydrate, tannins, alkaloids, saponins, proteins and flavonoids. So, it finds application in various infectious diseases. The goal of this review represents Phytochemical constituents and pharmacological activities of the *T. grandis* linn. Considering literature review it is suggested that herbal preparations containing extract of frontal leaves of *Tectona grandis* (TG) linn which is non-toxic, safe, and effective and improves patient compliance by the utilization of herbal extracts which would be highly acceptable.

KEYWORDS: Teak, *T. grandis* Linn., Pharmacology activity, Phytochemical constituents.

INTRODUCTION

T. grandis linn. (Family - Verbenaceae) is one of the most famous timbers in the world and is renowned for its dimensional stability, extreme durability, strength & insect resistance property. This plant is commonly called as teak and locally known as sagon, sagwan. It is one

of the most important heart woods of the world over. Phytochemicals are used as templates for lead optimization programs, which are intended to make safe and effective drugs. In the developed countries, 25% of the medicinal drugs are based on plants and their derivatives.[1] The first teak plantation in Thailand was established, on trial, in 1910 and a number of pilot plantations of this species were established thereafter. It occurs naturally only in India, Myanmar, Thailand and it is naturalizedin Java, Indonesia, where it was probably introduced some 400 to 600 years ago. In addition, it has been established throughout tropical Asia, as well as in tropical Africa and Latin America and the Caribbean. Teak has also been introduced in some islands in the Pacific region and in northern Australia at trial levels.[2]

Taxonomical classification[3]

Kingdom: Plantae – plants

Subkingdom: Tracheobionta – Vascular plants

Divison: Mangnoliphyta – Flowering plants

Class: Magnoliopsida – Dicotyledons

Subclass: Astridae

Order: Lamiales

Family: Verbenaceae

Synonyms

Shaaka, Bhuumisaha, Dwaaradaaru, Varadaaru, Kharachhada, Saagawaan, Saagauna, Atipatraka, Grahadruma, Halimaka. Krkachapatra, Jyeshtakashtha, Mahisaka, Sthirasaara.

Vernacular names[4]

English: Indian Teak, Teak.

Hindi: Sagwan, Sagauna, Sagu, Sagun, Sakhu.

Bengali: Segunngachh, Segun.

Gujarati: Sagwan, Sag, Saga, Sagach,

Kannada: Tegu, Sagawani, Thega, Jadi, Tega, Tyagadamara, Tekka-maram

Malyalam: Thekku, Tekka-maram, Tekku, Tekka.

Punjabi: Sagwan, Sagun.

Tamil: Tekku, Tekkumaram, Tek, Kalindi.

Telgu: Teku, Pedda, Tek, Peddateku, teku-manu, Adaviteku, Teechekka.

Assam: Chingjagusagun.

Oriya: Saguana, Sagan, Sagun, Singuru.

Persian: Saj, Sal.

Sind: Loheru.

Urdu: Sagwan

Botanical description

Bark: A large deciduous tree which, under favorable conditions, may reach a height of 30-40 m. In dry habitats growth becomes more stunted and branching more widespread and bushy. On good sites, clear boles of 15-20 m or more can usually be obtained, as lower branches are shaded out. Fluting and buttresses are often found at the base of older trees. The bark is thick, grey or light grayish-brown.

Leaves: The leaves are large, shiny, 25-50 cm long and 15-35 cm wide, opposite, elliptic or obviate the underside grey and densely covered with red glandulous hairs but young leaves are up to 1m long. The very large, 4-sided leaves are shed for 3-4 months during the latter half of the dry season, leaving the branchlets bare.

Flowers: The flowers are small (6-8 mm in diameter), whitish and bisexual. They appear in large panicles containing up to a few thousand flower buds, which open only a few at a time during the flowering period of 2-4 weeks.[5] Teak normally starts to flower 6-8 years after planting. The flowers appear from June to September and fruits ripen from November to January. Flowering takes place in the rainy season, starting about one month after the first rains. Teak usually flowers every year, but with large variation in intensity between years. Pollination is by insects. Sometimes flower and fruit setting is greatly disturbed by defoliating insects which also eat the flower buds.[6,7]

Fruit: Fruit is a green, hairy, round, woody, irregularly rounded drupe. When it is young, the fruit's color is pale green and brown when it is mature. One fruit can produce up to 4 seeds and there are 1,000-3,500 seeds per kilogram. It varies in size from 5-20 mm, the most common size being between 11 and 17 mm. Its structure consists of a thin papery outer layer (the persistent calyx), a thick corky middle layer (mesocarp) and a stony inner part, (endocarp) which contains the 4 seed chambers. Number of fruits per kg varies around 1100-3500 with an average of approx. 2000 fruits/kg. This corresponds to approx. 500 fruits per liter. The fruit attains its full size in approximately 50days, but it is not mature until 120-150 days after fertilization. A sign of maturity is that fruits can be shaken from the tree, or fall to the ground naturally.[8]

Seed: Seeds are oval and about 6 x 4 mm. usually only one seed per fruit manages to develop into a seedling. Teak seed stores well and may keep its germination capacity for several years provided the seed has low moisture content before storage and is protected against fluctuations in temperature and humidity during storage. If seeds are to be used in the same planting season, no special storage is needed. Seed can be piled in a convenient place near the nursery, preferably in a shed or in a storeroom, but not necessarily dried. Seed can be stored this way for maximum 3-4 months. Seed can be stored for up to two years at around 12% moisture content and stored in airtight containers (glass jars or sealed plastic bags) and kept in a dry, shaded and relatively cool place. If stored at low moisture content and in a cold store (0-4°C), the germination capacity of the seed can be maintained for 5-10 years.[9]

BIOLOGY[10, 11, 12, 13, 14]

T. grandis is 96-100% self-incompatible. The species is hermaphroditic and pollinated by insects such as black ants, horse flies, and particularly by bees. Fruits mature about 4 months after fertilization. Premature shedding of fruit is a problem. Up to 60% fruit set has been reported following cross-pollination of teak. The individual flower has a 1-day cycle; optimum pollination period is between 1130 h and 1300 h. The height of the tree at the moment of first flowering is important in silviculture. When it is long (it may reach up to 10 m), the final bole form is positively affected, but early-flowering trees may develop extremely widecrowns and short boles. This characteristic is clearly undesirable in timber crop species and warrants strong selection against flowering in conjunction with increased effort to develop commercial methods of vegetative propagation. The time of the 1st inflorescence is determined by both genetic and environmental factors. In Thailand, flowering normally starts at the age of 8 to 10 years. However, trees have been observed to flower at the age of 3 months, while a few specimens of superior phenotype did not flower until the age of 27 years. Flowers usually appear during the rainy season and trees tend to flower synchronously. In Thailand, flowering occurs in June-September and fruiting in November-January. In Java, trees flower every year at the beginning of the rainy season (October-November) and only a few flowers (about 1%) develop into fruits. Fruits fall gradually during the dry season. Although natural fruit set in Thailand is low (0.5-5%), 6 to 60% of fruit set can be achieved by artificial pollination. Fruits develop to full size about 50days after pollination. They are dispersed by wind over 10-15 m and also by running water after heavy rainfall.

Fig 1: Straight and cylindrical bole of *T. grandis*.

Fig 2: A plantation of *T. grandis*

Fig 3: Leafof *T. grandis*. is broadly ovate

Fig 4: Fruit of *T. grandis*

Fig 5: Three-month-old seedlings tended nursery.

Fig 6: Flower of *Tectona grandis* linn in a

ECONOMIC IMPORTANCE[15]

In India, leaves are used in the preparation jackfruit dumpling. In Java, Indonesia, leaves are used in the preparation of grudge (a dish of young jackfruit) providing the dish with a dark brown color. Both the root-bark and young leaves yield a yellowish-brown or reddish coloring matter, which is used for paper, clothes and matting. In the West Indies, young leaves are similarly used for dyeing. Wood is very durable, resistant to fungi. Used for poles, beams, trusses, columns, roofs, doors, window frames, flooring, planking, paneling and staircases, and other constructional work. It is one of the best timbers for furniture and cabinet-making, wagon and railway carriages. Due to its better shape-retention ability, teak is popular in marine constructions and is a class by itself for boat- and ship building, particularly for decking. On account of its resistance to chemicals, teak articles are used in chemical laboratories, suitable for casks and vats for shipping corrosive liquids and for storing vegetable oils, fruit syrups, chutneys etc. Teak is employed for sound – boards of musical instruments, keys etc. and for different grades of plywood. Wood waste in the form of wood- shavings and sawdust is used for chip-boards, fibre boards and plastic.

CHEMICAL CONSTITUENTS[16]

T. grandis has reported for several classes of phytochemicals like alkaloids, glycosides, saponins, steroids, flavonoids, proteins, carbohydrates and secondary metabolites (Table No.1) such astectoquinone, 5- hydroxylapachol, tectol, betulinic acid, betulinic aldehyde, squalene, lapachol.

Heartwood contains a resin, tectoquinone. Exhibits cracks and cavities lined with white crystalline deposit consisting of hydrocalcic orthophosphate with 11.4% ammonio-magnesium phosphate. Contains a higher percentage of carbon and hydrogen and together with its calcium, phosphate and silica content, may account for the hardness of the wood.

Leaves contain 6% tannin, dry weight. Phytochemical screening of methanol and water extracts yielded carbohydrates, reducing sugars, alkaloids, glycosides, flavonoids, sterols and saponins. Acetovanillone, E-isofuraldehyde, Evofolin, syringaresinol, medioresinol, balaphonin, lariciresinol, zhebeiresinol, 1- hydroxypinoresinoltogether with two new compounds Tectonoelin A and Tectonoelin B were extracted from the leaves of Tectonagrandis.

Table 1: Details of secondary metabolite constituents of *T. grandis* Linn.[17,18,19,20,21]

Secondary Metabolites	Secondary Metabolite constituents	Part of the plant
Phenols and Phenolic acids	TG1, 2, 3 and 4, Gallic acid Ellagic acid, Acetovanillone, E-isofuraldehyde, 3-hydroxy-1-(4-hydroxy-3,5-dimethoxyphenyl)propan-1- one, evofolin A, and syringaresinol	Leaves
Norlignans	Tectonoelin A (or (7Z)-9'nor-3',4,4'-trihydroxy-3-methoxylign-7-ene-9,7'-lactone), Tectonoelin B (or 7Z)-9'nor-3',4,4'-trihydroxy-3,5-dimethoxylign-7-ene-9,7'-lactone), medioresinol, 1-hydroxypinoresinol, lariciresinol, balaphonin and zhebeiresinol	Stem, leaves seed & wood
Flavonoids	Rutin and quercitin	Leaves
Anthraquinones	Possible anthraquinone moieties for dyeing property	Leaves
Glycosides	Apocarotenoids: tectoionols A and B Steroidal glycoside: beta-sitosterol-beta-D-[4'-linolenyl-6'-(tridecan-4'"-one-1'"-oxy)] glucuranopyranoside	Seed, leaves Stem bark
Alkaloids	Quinones: 9,10-dimethoxy-2-methyl anthra-1,4-quinone. 1,4-anthraquinone, tectoquinone, lapachol, dehydro-a-lapachone, tecomaquinone, Naphthoquinone and anthraquinonederlvatives Naphthotectone and anthratectone	Heart wood Leaves
Steroids	Steroidal compounds, squalene, polylsoprene, cr-tolylmethyl ether, betulinic acid	Heart wood
Fatty esters	7'-hydroxy-n-octacosanoyl n-decanoate, 20'-hydroxy eicosanyllinolenate and 18'-hydroxy n-hexacosanyl n-decanoate	Stem bark

ETHNOBOTANICAL CLAIMS[22,23,24]

- **Leaves** are cooling, haemostatic, depurative, anti-inflammatory and vulnerary. They are useful in inflammations, leprosy, skin diseases, pruritus, stomatitis, indolent ulcers, haemorrhages and haemoptysis. Decoction of fresh or dried leaves used for menstrual disorders, haemorrhages in general, haemoptysis, used as a gargle for sore throat, Decoction of fallen yellow leaves used for anaemia. Leaves contain about 6% tannin and a dye; also used for thatching. Oily product obtained by distillation of wood chips applied to eczema.
- **Bark:** is used as astringent, constipation, anthelmintic and depurative. It is used in bronchitis, hyperacidity, dysentery, verminosis, burning sensation, diabetes, leprosy and skin diseases. The stem bark is powdered and mixed with water, given to women at the time of delivery to reduce hip pain.

- **Wood:** Acrid, cooling, laxative, sedative to gravid uterus, useful in treatment of piles, leucoderma and dysentery. Oil extracted from the wood is best for headache, biliousness, burning pains particularly over a region of liver. Paste of powdered wood applied for acute dermatitis; especially, that due to contact with caustic oleoresin of Anacardium occidentale. The charred wood in poppy juice, reduced to a smooth paste, is used for eyelid swelling and believed to strengthen the sight.
- **Roots:** are useful in anuria and retention of urine
- **Flowers:** are acrid, bitter dry and cures bronchitis, biliousness, urinary discharge. According to Unani system of medicine, oil extracted from the flowers is useful in scabies and promotes the hair growth.

PHARMACOLOGICAL ACTIVITY OF *TECTONA GRANDIS LINN*

Table No. 2: Pharmacological Activity of *Tectona grandis Linn*

Pharmacological activity	Part / Extract	Screening method employed
Antibacterial activity	Bark	1. Against Listeria monocytogenes and methicillin resistant Staphylococcus aureus (MRSA) by employing disc diffusion method. 2. Inhibitory to oral pathogens, notably Streptococcus mutans, Streptococcus sanguis, & Prevotella intermedia by disc diffusion method.[25,26]
Antibacterial activity	Leaf and wood extracts	1. Against Staphylococcus aureus, Klebsiella pneumoniae, Salmonella paratyphi and Proteus mirabilis by disc diffusion assay method [27,28,29]
Synergistic in-vitro antibacterial activity	Wood : Methanol extract	1. Methanol extract in combination with Tetracycline using different Gram- positive and Gram-negative bacteria and those are associated with various forms of human infections by disc diffusion method[30,31]
Cytotoxic activity	Methanol extract of wood, hexane extract of leaf and chloroform extract of bark	1. MTT assay and Against chick embryo fibroblast (CEF) and human embryonic kidney cells assay[32,33]
Cytotoxic activity	Root heart wood: petrol extract	Against brine shrimps assay[34]
Anti-heamolytic anaemia activity	Leaf: ethanol extract	Phenyl hydrazine induced anemia rat model[35,36]
Antifungal activity	Stem heartwood	*In-vitro* bioassays against Trametes versicolor[37,38,39,40,41]
Anthelmintic activity	Fruits: ethanol extract	*In-vitro* anthelmintic activity using earthworm *Pheritima posthuma*[42]
Adverse cutaneous Reaction activity	Wood dust	*In-vivo* cutaneous reaction method[43]
Hair growth activity	Seeds: petroleum ether extract	Hair growth activity on albino mice[44]

Analgesic activity	Flowers: methanol extract	Acetic acid induced writhing response and Eddy's hot-plate method[45,46,47,48,49]
Gastroprotective activity	Leaf: ethanol extract and active butanolic fraction	Verbascoside Gastric protection in rats via inhibiting proton pump activity[50]
Antioxidant activity	Leaf, bark and wood of Hexane, chloroform, ethyl acetate and methanol extracts	*In-vitro* DPPH and ABTS free radical assays[51,52,53,54,55,56]
Diuretic activity	Leaf: aqueous extract	Acute diuretic activity in Wistar rats[57]
Antinociceptive Activity	Leaf, bark and wood	Male Swiss albino mice[58,59]
Wound healing activity	mature leaves	wound and burn wound model of rat[60,61,62,63]
Antiasthmatic Activity	Bark extract	antiasthmatic activity by using different *in-vivo* animal models like clonidine induced catalepsy in mice, haloperidol induced catalepsy in mice, milk induced leucocytosis and eosinophilia.[64]
Antitumor Activity	Leaf, bark and Wood extract	Antitumor Activity in rats[65,66]
Antidiabetic activity	methanol extracts of flowers	Antidiabetic activity by streptozotocin induced diabetic rats [67,68,69]
Hypoglycaemic Activity	extract of root	Alloxan induced diabetic rats[70]

DISCUSSION AND CONCLUSION

Tectona grandis, is a medicinal plant with versatile nature, apart from possessing high value of hardwood, it is also the unique source of various types of compounds having diverse chemical structure. The extract of the different parts of the plant shows various activities like antibacterial, antioxidant, antifungal, anti-inflammatory, anti-asthmatic, analgesic, diuretic, hypoglycemic, antidiabetic, antipyretic, anti-ulcer, anthelmintic, anti-metastatic and hair growth activity. In Ayurveda this plant is not much highlighted for its medicinal values and people are less aware towards its medicinal importance too. Hence there is a need to further highlight and discovered pharmacological effects on Ayurvedic background.

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