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An Overview of *Tectona grandis*: Chemistry and Pharmacological Profile

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ABSTRACT

Tectona grandis (Saka) has been widely used as medicine is Ayurveda. The chemical constituents reported from this plant belong to different classes such as tannins, proteins, fatty acids, steroidal compound, resins, anthraquinone-napthquinone pigments, diterpens and dye. Sagwan has number of medicinal uses, many of which have been verified by scientific methods. This review article summarizes the chemistry and pharmacological profile of *Tectona grandis*.

KEY WORDS: Tectona grandis, Phytochemistry, Pharmacological activities.

INTRODUCTION

Tectona grandis Linn. (Verbenaceae) is a large deciduous tree. Branchlets are quadrangular, channeled and stellately tomentose. The tree is growing in higher situations, native to central India, Konkan, Western Deccan peninsula, South India and Burma (1). It is commonly known as sagwan (Hindi), saka (Sanskrit) and teak tree (English) (2,3). Teak is a hardwood species of worldwide reputation (4).

Leaves are 30-40 by 15-30 cm, elliptic or obovate acute or acuminate. Upper surface of leaf is rough but usually glabrous and the lower clothed with dense stellate grey or tawny tomentum. Flowers are shortly pedicellate with lanceolate bracts at the forks. Fruits are 1-3 cm in diameter, subflobose; pericarp is soft with dense felted stellate hairs (1).

Root contains lapachol, tectol, tectoquinone, β-sitosterol and a diterpene, tectograndinol (5). Roots are used in the treatment of anurea and urine retention (6). The flowers are acrid, bitter and useful in the treatment of bronchitis, biliousness and urinary discharges. Bark is astringent, acrid, sweet and useful in the treatment of bronchitis. The wood is acrid, sedative, anthelmintic, expectorant and useful in the treatment of gravid uterus, piles, leucoderma, dysentery, headache and burning pain over liver region. The ashes of wood applied to swollen eyelids and are said to strengthen the sight. The oil of nuts promotes the growth of hair and removes itchiness of skin. The flowers and the seeds are diuretics (1).

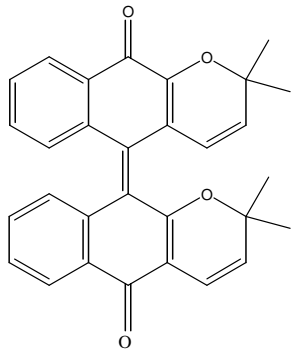
CHEMISTRY

Various chemical constituents isolated from different parts of plant *T. grandis* have been given in table-I and structures of some constituents are given in figure-I.

Table 1: Phytoconstituents of *T. grandis*

Sr. No.	Plant Part	Chemical constituents isolated
1.	Wood	Resin, silica, calcium phosphate, ammonium phosphate, magnesium phosphate (2). Anthraquinone-2-carboxylic acid, anthraquinone-2-carboxaldehyde (5). Triterpenic and hemiterpenic compound (6). 9,10-dimethoxy-2-methyl-1,4-anthraquinone, 5-hydroxy-2-methyl-9,10-anthraquinone, 1-hydroxy-5-methoxy-2-methyl-9,10-anthraquinone 1,5-dihydroxy-2-methyl-9,10-anthraquinone, tecomaquinone-I(**I**), tectoquinone, dehydro-α-lapachone (7,8). lapachol, 5-hydroxy-lapachol, methlyquinizarin, squalene (9). Dehydro-α-isodunnione (10). Lignins (11).
2.	Root	Lapachol, tectol(**II**), dehydrotectol, tectoquinone, β-lapachone, dehydro-α-lapachone, β-sitosterol, new diterpene, tectograndinol(**III**) (12,13) Non-structural carbohydrates (14) 1-hydroxy-2-methyl anthraquinone, pachybasin, obtusifolina, betulinic acid (15).
3.	Leaves	Tectoleafquinone (6).

		Tannins (6%) and dye (16). Tectoionols-B(**IV**), tectoionols-A(**V),** monoterpene, apocarotenoids (17). Protein (7.1%), crude fiber (22.3%), calcium (3%), phosphorous (0.46%) Steroidal compound squalene, polyisoprene-α-tolylmethyl ether and betulinic acid, a anthraquinone-napthaquinone pigment, tectograndone (7,18).
4	Seed	Seed oil contain fatty acids as caprylic (1.45%) , capric (0.76%), lauric acid (6.77%), myristic acid (2.86%), palmitic acid (12.12%), stearic acid (9.52%), oleic acid (23.33%) and linoleic acid (43.22%)(5). Xanthene (19).
5.	Bark	Tannin (7.14%)(6). 5-hydroxy-1,4-napthalenedione(**VI**) (juglone) (20). Obtusifolina(**VII**), Desidro-α-lapachona(**VIII**)[21].
6.	-	Endophtic, Gallic acid, ferulic acid, caffeic acid (22). Tectochinon(**IX)**, 2-hydroxymethyl-anthrachinon (23). Hydroxyl lapachol(**X**) (24). Deoxylapachol (25). Colour component (25.88%) (26). Heavy metal (27). Ral (2.93%) (28).



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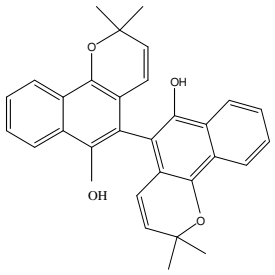

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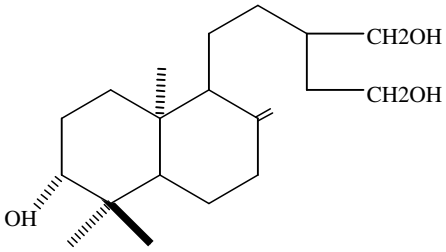

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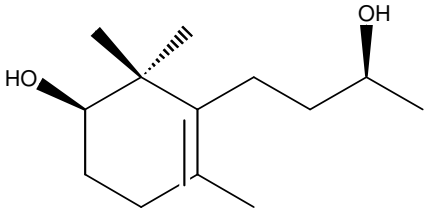

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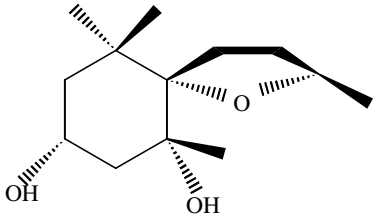

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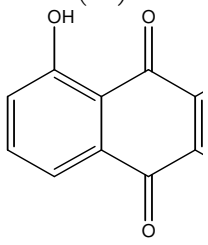

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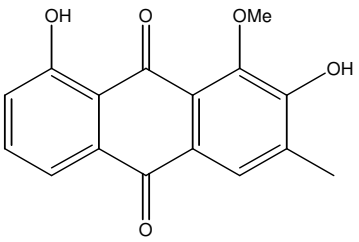

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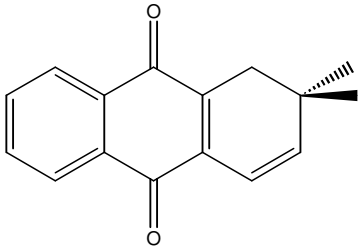

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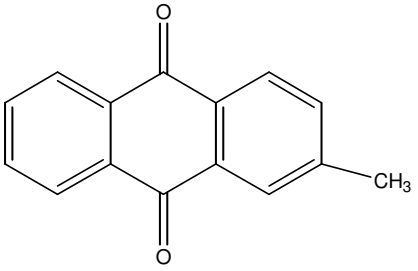

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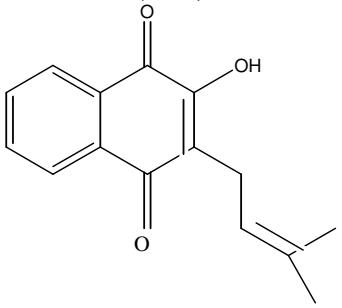

(X)

PHARMACOLOGICAL ACTIVITY

Antibacterial activity

The methanol extracts of teak bark were inhibitory to *Listeria monocytogenes* and MRSA (Methicillin Resistant *Staphylococcus aureus*) by means of disc diffusion. GCMS analyses revealed that the inhibitory compound having MW-174 and a structure of 5-hydroxy-1,4-naphthalenedione (juglone) (20).

T. grandis sawdust extract exhibited the growth of *Aspergillus niger*. Endophtic isolated from *T. grandis* could produce inhibitory substance effective against *Bacillus Subtilis, S. aureus, Escherichia Coli* and *Candida albicans* in vitro (22).

Cytotoxic activity

The petrol extract of the root heart wood of *T. grandis* were showed a high level of activity in cytotoxicity test against *Atremia salina* (Brine shrimp) with an LC_{50} of 5ppm. The isolation and identification of a new compound 5-hydroxy lapachol along with reported compound lapachol found to be cytotoxic (8). Expression from *T. grandis* plant were found to reduce the genotoxicity of three mutacarcinogens viz. methylmethane sulfonate, mitomycin-C and dimethylnitrasamine (29). Antimitotic activity was evaluated using the meristematic cells of *Allium cepa* root. The *A. cepa* bulbs were sprouted in tap water at room temperature. The sprouted root tips were then treated with ethanol and aqueous extracts (10 mg/ml) for 1 hour. The sprouted root tips treated with distilled water and methotrexate (0.1 mg/ml) were used as control and standard, respectively. The root were fixed and stained with carmine stain and mitotic index was calculated. Results showed that 70% ethanol extract exhibited significant antimitotic activity (30).

Antiulcerogenic activity

Lapachol (a naphthaquinone) isolated from the roots of *T. grandis* given at a dose of 5 mg kg-1 p.o. twice daily for 3 days was found to have an anti-ulcerogenic effect on subsequently induced experimental gastric and duodenal ulcers in rats and quinea-pigs. Its action appears to be associated with an effect on the protein content of gastric juice, and it reversed aspirin-induced changes in peptic activity, protein and sialic acid (31,32).

Antianaemic effect

The extract of *T. grandis* leaves is evaluated on anaemic model of rat induced by intraperitoneal injection of phenylhydrazine at 40mg/kg for 2 days. Oral administration of *T. grandis* extract at 1 g/kg/day, to the rats previously treated with phenylhydrazine, increased the concentration of haemoglobin, red blood cells number, haematocrit and reticulocytes rate. Moreover, the extract of *T. grandis* enhanced the osmotic resistance of the red blood cells that confirm the important presence of young red blood cells. These results support partially the traditional use of *T. grandis* in the treatment of anaemia (33).

Wound healing activity

The present study was carried out to evaluate the effect of hydrochloric extract of *T. grandis* on experimentally induced wounds in rats and compared the effect observed with a known healing agent, *Aloe vera*. The models selected were excision wound, incision wound, burn wound and dead space wound. A suitable gel formulation was selected for the application using cellophane membrane penetration. In the excision wound and burn wound models, animals treated with *T. grandis* leaf extract showed significant reduction in period of epithelisation and wound contraption 50%. In the incision wound model, a significant increase in the breaking strength was observed. *T. grandis* leaf extract treatment orally produced a significant increase in the breaking strength, dry weight and hydroxyproline content of the granulation tissue in dead space wound. It was concluded that *T. grandis* leaf extract applied topically (5% and 10% gel formulation) or administered orally (250 and 500 mg/kg body weight) possesses wound healing activity (34).

Fatty infiltration in liver - The influence of protein, isolated from teak seed upon albino rats with respect to some of their

serum, liver and intestinal enzyme and liver lipid has been studied. The protein in question contains aspartic acid, thereonine, serine, glutamic acid, praline, glycine, alanine, valine, isoleucine, leucine, tyrosine, lysine, phenylalanine, histidine and arginine as determined by amino acid analyzer. After feeding experiment an increase in body weight including the liver weight was noted in the test animals due to excess protein in the diet. A marked increase was observed in G.O.T., G.P.T. and total lipid of liver, whereas G.O.T. and G.P.T. of serum were decreased. The observed increased concentration of lipid in liver may be due to excess addition of protein in diet. The overall observation is an indication of probable fatty infiltration in liver of test animals(35).

Antioxidant activity

The present study deals with *in-vitro* antioxidant activity of ethanolic extract of *Tectona grandis* Linn. (TG) by using DPPH (1,1-Diphenyl-2-picryl-hydrazyl**)** assay, Ferric Reducing Antioxidant power (FRAP) scavenging assay and H_2O_2 radical scavenging assay. The IC_{50} value observed in DPPH and H_2O_2 radical scavenging assay were 37.5 µg/ml, 32.0 µg/ml respectively, and 50 % reduction in ferricynide complex at 190 µg/ml concentration. The results were compared with ascorbic acid as a standard. Hence antioxidant property of TG may be due to presence of tannins and saponins. These results clearly indicate that TG is effective against free radical mediated diseases (36).

Antifungal activity

The antifungal activity of methanolic crude extract of *T. grandis* was studied at different concentrations (1000, 2000, 3000, 4000 and 5000 ug/ml). The extract of *T .grandis* showed 90.00% and 86.84% inhibition growth against *Alternaria cajani* and *Helminthosporium*. The higher concentration of methnolic extract impart maximal antifungal activity (22,37).

Antiviral activity

The extract of *T. grandis* showed high percentage about 85% of inhibition of Tomato Spotted Virus (38).

Anti fertility agent

T. grandis plant along with *Lawsonia intermis, Butea monosperma* and *Carica papaya* shows antifertility action for birth control (39).

Nitric oxide scavenging activity

The hexane extract of *T. grandis* was examined for their possible regulatory effect on Nitric oxide (NO) levels using sodium nitroprusside as an NO donor in vitro. The plant extract tested demonstrated direct scavenging of NO and exhibited significant activity (40).

Miscellaneous

Myanmar timber extract of *T. grandis* was showing potent leishmanicidal activity. The chemical constituent of the plant was found quinone derivatives (41).

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