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# Phytochemistry and Pharmacological Activities of *Swietenia macrophylla King* (Meliaceae)

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**Abstract** **Review Article**

Mahogany is a Meliaceae family exotic plant that includes three species: *Swietenia macrophylla king, S mahogany L. Jacq.*, and *S. humulis Zucc.* This genus is predominantly found in the humid zone of the New World and the Amazon region of South America. The purpose of this review article is to look at its taxonomical classification, vernacular names, pharmacological activities and its phytochemistry. Scientific studies have found that the crude extract from S. macrophylla seeds has antibacterial, anti-malaria, anti-hepatitis, anti-diarrheal, antioxidant, anti-diabetic, anti-inflammatory, anti-mutagenic, antinociceptive, and anticancer properties. Phytochemical investigations have shown that limonoids and their derivatives are the major constituents of *Swietenia macrophylla*.

**Keywords:** *Swietenia macrophylla*, Taxonomy, Phytochemistry, Pharmacology, Vernacular Names.



## 1. INTRODUCTION

Swietenia macrophylla is a member of the Meliaceae family. Open rain forests, semideciduous woodlands, and deciduous forests are the most common habitats for S. macrophylla (which lose their leaves in a partial way or total respectively, during the dry season). The term "macrophylla" comes from the Greek words "macros" (large) and "phyllon" (leaf) (leaf). It is often called to as "sky fruit" because its fruit looks to point upwards to the sky. This economically valuable wood tree has long been used to treat a range of diseases, including hypertension, high blood pressure, and diabetes. Antibacterial, anti-malaria, anti-hepatitis, anti-diarrheal, antioxidant, anti-diabetic, anti-inflammatory, anti-mutagenic, antinociceptive, and anticancer effects have been discovered in the crude extract from S. macrophylla seeds, according to scientific investigations. The purpose of this review article is to look at its taxonomical classification, vernacular names, pharmacological activities and its phytochemistry. Table No. 1 showed Vernacular Names of *Swietenia macrophylla.* Many weeds in our environment are highly effective medicinal plants that can help with a variety of significant health issues (Parihar and Sharma, 2021; Chaudhary *et al*., 2021; Telrandhe *et al*., 2021). India has long been known as a great store of natural remedies among ancient cultures (Parihar and Sharma, 2021; Parihar and Sharma, 2021; Parihar and Sharma, 2021).

## 2. PLANTS DETAILS / PHARMACOGNOSTICAL DESCRIPTION

***Taxonomy***

**Botanical name:** *Swietenia macrophylla* King

**Family:** Meliaceae

**Subfamily:** Swietenoideae

**Synonyms:** *Swietenia belizensis* Lundell, *Swieteniacandollei* Pittier, *Swietenia krukovii* Gleason, *Swieteniamacrophylla* King var. *marabaensis* Ledoux et Lobato, *Swietenia tessmannii* Harms.

**Table-1: Vernacular Names of *Swietenia macrophylla Vernacular/common names***

| Trade Name | Mahogany |
|---|---|
| Indonesia | Mahoni |
| Bangladesh | Bara Mahauni, Bara-mahagoni, Mahagni |
| England | Mahogany ,Big-leaf mahogany, Bastard mahogany |
| Germany | Echtes Mahagoni (German) |
| France | Acajou du Honduras, Acajou du Venezuela |
| Italy | Mogano (Italian) |
| Malaysia | Cheria mahogany (Malay) |
| Netherland | Mahok, Mahonie (Dutch) |
| Portugal | Mogno (Portuguese) |
| Thailand | Mahokkani |

(https://en.wikipedia.org/wiki/Swietenia_macrophylla, "The Plant List: A Working List of All Plant Species". Retrieved 20 December 2014)

**3. Phytochemistry / phytoconstituent**

It contains alkaloids, terpenoids, anthraquinones, cardiac glycosides, saponins, phenols, flavonoids, volatile oils, phospholipid and long chain unsaturated acid [7]. Phytochemical investigations have shown that limonoids and their derivatives are the major constituents of *Swietenia macrophylla*. Limonoids are derived from tetracyclic triterpenes similar to euphol (H-20β) or tirucallol (H-20α) by a series of oxidative changes, interspersed with molecular rearrangements. Tetranortriterpenoids with a 4,4,8-trimethyl-17-furanyl steroidal skeleton is an alternative name for limonoids because in the process of oxidative changes, the side chain is eventually oxidised to a β-substituted furan ring by the loss of four carbon atoms (Sahgal *et al*., 2009)**.** Table No. 2 showed Chemical compounds from various organs of *Swietenia macrophylla.*

**Table-2: Chemical compounds from various organs of *Swietenia macrophylla***

| PLANT PART USED | COMPOUNDS | CLASS |
|---|---|---|
| SEED | swietenine, swietenolide, swietemahonin E,F,G. | Limonoid |
| | Scopoletin | Coumarin |
| | stearic acid methyl ester | Fatty acid ester |
| | beta-sitosterol | Steroid |
| BARK | catechin, epicatechin, swietemacrophyllanin | Polyphenol |
| LEAVES | swietephragmin H, I, J | Limonoid |
| | germacrene A, D<br>swietenine J | Essential oil<br>Limonoid |
| TWIG | swietenitin A – X | Limonoid |
| STEM | 3-hydroxycaruilignan C | Lignan |

**4. TRADITIONAL USES / ETHNOMEDICINAL USES**

Traditional medicine uses almost all components of the Swietenia macrophylla to cure a variety of human diseases. It has been used to cure a variety of disorders in Asia and other nations due to its antibacterial, anti-inflammatory, antioxidant, antimutagenic, anticancer, antitumor, and antidiabetic properties. Commercially, the fruit of Swietenia macrophylla has been utilised to promote blood circulation and skin condition in health care goods. The seed of Swietenia macrophylla, in particular, has substantial therapeutic characteristics. The seeds' infusion is used as a tonic, pain reliever, and anti-typhoid fever treatment, and cosmetic items can be made from the seeds' oil. Diarrhea, febrifuge, colds, and catarrh have all been treated with leaves in the past.

It has limonoids have antifungal properties. Because of its agonistic action to PPAR, it could be employed as a potential diabetic treatment. The limonoids from this plant have recently been discovered to have antifeedant properties. The seeds have long been used in Malaysia to treat hypertension, diabetes, and pain. Cancer, amoebiasis, coughs, chest pains, intestinal parasitism, diabetes, hypertension, and malaria have all been treated using S. macrophylla seeds in Indonesian folk medicine. Because of the rich red colour it imparts, the bark extract has been used as an astringent for wounds and occasionally for tanning. A decoction of the bark has been used as an antipyretic (fever reducer) and as a febrifuge, which could be linked to its usage as an antimalarial medication. It can also be taken as a tonic (increases body tone). It is also used to tan leather and cloth because it has a high content of tannins (Sahgal *et al*., 2009; Orwa *et al*.,

2009; Krisnawati *et al*., 2011; life.ku.dk and www.dfsc.dk)**.**

**5. Pharmacological activity / biological activity**

Swietenia macrophylla was largely composed of limonoids, which have been linked to antifungal, antimalarial, and insect antifeedant properties. Many plants have been employed for their antibacterial properties, which are attributable to biological active chemicals such as phenols, terpenoids, alkaloids, and flavonoids, which are formed in the plant's secondary metabolism. 2 Some of S. macrophylla's pharmacological effects have been investigated, including (Sahgal *et al*., 2009; Ahmad *et al.*, 2013; Krisnawati *et al*., 2009; Francis *et al*., 1991; Grandtner *et al.*, 2005; Pallab *et al*., 2011; Mayur *et al.*, 2011).

***I. Antibacterial activity***

Swietenolide (1) and 2-hydroxy-3-Otigloylswietenolide (2) are two substances isolated from Swietenia mahagoni seed methanolic extract. The antibacterial activity of these compounds was tested using the disc diffusion method against eight multidrug-resistant bacterial strains (clinical isolates). Despite the fact that both compounds were active against all test species, compound 2 was more effective overall than compound 1. In a dose of 500 g disc -1, the antibacterial activity of chloroform and ethanolic extracts of leaf, bark, and seed was tested. It was discovered that chloroform extract of leaf and bark showed action against majority of the test microorganisms. Only bacillus magaterium, salmonella paratyphi, and shigella dysenteriae are active against chloroform extract of seed. In the case of seed against S. paratyphi, the highest activity of chloroform extract was reported (Amarasuriyan *et al.*, 2014) mm dics -1. Bark ethyl extract is effective against all microorganisms tested.

***II. Antimicrobial Activity***

The antibacterial activity of the entire methanolic extract of Swietenia mahagoni seed against Gram-positive, Gram-negative, yeast, and fungal strains was assessed using disc diffusion assay, minimal inhibitory concentration (MIC), and minimal bactericidal concentration (MBC) values. The crude extract was tested for a variety of phytochemicals. As primary active ingredients, it contains alkaloids, terpenoids, antraquinones, cardiac glycosides, saponins, and volatile oils.

***III. Antioxidant activity***

Swietenia mahagoni seed methanolic extract contains phenol and flavonoid, which have antioxidant action in vitro. In free radical scavenging activity (DPPH), xanthine oxidase inhibition (XOI), hydrogen peroxide scavenging activity (HPSA), and ferric-reducing antioxidant power (FRAP) experiments, the extract displays significant antioxidant activity. The fractionation of the acetone extract of S. macrophylla bark with n-hexane, diethyl ether, and ethyl acetate, followed by chromatographic separation of the fractions, yielded three compounds: catechin, epicatechin, and swietemacrophyllanin. Spectroscopic data and comparison of NMR data with that of catiguanins A and B, phenylpropanoid-substituted epicatechins, revealed the structure of the compounds. These compounds from the polyphenols or flavan-3-ols class exhibited antioxidant activity using the DPPH [1, 1-diphenyl-2- picrylhydrazyl] free radical scavenging assay. When compared to Trolox, which was employed as a control, swietemacrophyllanin demonstrated the greatest antioxidant activity, with an IC50 value of 56 g/mL. In the streptozotocin-induced diabetic rat, an ethanol extract of S. macrophylla seeds showed antioxidant action.

***Cytotoxic activity***

Crude ethanolic extracts of seed, bark and leaf of *Swietenia mahagoni* and their various fractions gives significant cytotoxic effect by using brine shrimp lethality bioassay.

***IV. Anti-ulcer activity***

Long-chain unsaturated fatty acids are abundant in Mahagony seed extract. Anti-ulcer qualities have been discovered in long chain fatty acids, with the mechanism being linked to the prevention of gastric bacterial metabolism. In rats, mahogany seed extract was discovered to have a possible influence on gastric ulcer healing.

***V. Antifungal activity***

Antifungal activity of limonoids from S. mahogany against Puccinia arachidis, a groundnut rust. Mexicanolide, 3B-acetoxy-mexicanolide, 3Bhydroxymexicanolide, 2A, 3B-dihydroxymexicanolide, and 6-acetyl- 3-tigloylswietenolide from K. senegalensis, as well as 6-acetylswietenine and 6-acetyl- 3-tigloylswietenolide from S. mahogani, all effectively.

***VI. Antiviral Activity***

A bioactive compound, 3-hydroxycaruilignan C (3-HCL-C) was isolated from the most active ethyl acetate fraction of *S. macrophylla* stems and the chemical structure was identified using 1D and 2D nuclear magnetic resonance spectroscopy and confirmed using mass spectrometry. 3-HCL-C showed anti-HCV (Hepatitis C virus) activity.

***VII. Anti – HIV activity***

Methanolic extract of *Swietenia mahogany* bark contains chlorogenic acid, metylesters, catechin, gallocatechin, which shows significant HIV-1 protease inhibition action.

***VIII. Platelet Aggregation Inhibitors activity***

The ether extract from the seeds of *Swietenia mahogany* Jacq. (Meliaceae) was found to inhibit platelet activating factor (PAF)-induced platelet

aggregation. Systematic separation of the extract afforded twenty eight tetranortriterpenoids related to swietenine and swietenolide showed a strong inhibition against PAF-induced aggregation *in vitro* and *in vivo* assays.

### *IX. Anti-Infective Activity*

Because of the extensive antibiotic resistance documented for this disease, controlling infections caused by Pseudomonas aeruginosa is critical and significant. The presence of anti-infective compounds in S. macrophylla seeds was demonstrated using a host-pathogen screening assay on Caenorhabditis elegans infected with Pseudomonas aeruginosa, a common cause of nosocomial contamination in medical care facilities that leads to unwanted secondary infections in patients. Although the ethyl acetate extract had little antibiotic effect in vitro, it did improve the survival rate of P. aeruginosa-infected worms. The extract increased the expression of genes important for C. elegans innate immunity, such as defence gene lys-7, which codes for a lysozyme-like antimicrobial component.

### *X. Anticancer and Antitumor Activity*

Using the Epstein-Barr virus early-antigen (EBV EA) activation and 12-0-tetradecanoylphorbol-13-acetate (TPA) as the tumor promoter, the anticancer efficacy of the ethanol extract of S. macrophylla seeds, as well as its hexane and methanol fractions, was examined. The findings demonstrated significant inhibitory action against EBV EA activation, implying an anticancer impact. Using the MTT method, the cytotoxic activity of the crude ethanol extract of S. macrophylla seeds and its fractions was examined against HCT116, KB, Ca Ski, and MCF-7 human cancer cell lines. S. macrophylla ethyl acetate fraction (SMEAF) had the best anti-HCT116 activity (IC50 = 35.35 0.50 g/mL). DNA fragmentation using the TUNEL assay and the externalization of phosphatidylserine using annexin V/PI labelling both verified the induction of apoptosis. At doses of 0.05 mg/mL and above, cell cycle analysis revealed a significant increase in the sub-G1 population. After 24 hours, SMEAF caused a collapse of the mitochondrial membrane potential and a decrease of total intracellular glutathione, according to the findings.

### *XI. Antimutagenic Activity*

The antimutagenicity of the ethanol extract of S. macrophylla seeds was investigated using a micronucleus test. The number of micro-nucleated polychromatic erythrocytes generated by mitomycin C, a recognized mutagen, was reduced by nearly half in mice treated with S. macrophylla ethanol seed extract (20 mg/kg body weight). The crude extract of S. macrophylla was found to be significantly antimutagenic.

### *XII. Anti-Nociceptive Activity*

The number of writhing, tail immersion, and hot plate responses were reduced in mice treated with ethanol and aqueous extracts of S. macrophylla fruits (200 mg/kg body weight), indicating a potent anti-nociceptive effect. Analgesia is produced in thermal and chemical pain models via a mechanism that is partially linked to either lipoxygenase and/or cyclooxygenase via the arachidonic acid cascade and/or opioid receptors. The overall findings supported S. microphyll's traditional use as a pain reliever by confirming its anti-nociceptive activity.

### *XIII. Hypolipidemic Activity*

The treatment with the methanol extract of *S. macrophylla* (300 mg/kg body weight) in streptozotocin- and nicotinamide-induced type 2 diabetic rats for 12 consecutive days caused reduction in the elevated level of serum total cholesterol (18.56%) and triglyceride (10.41%), respectively. Under the same experimental condition the extract showed 45.41% and 37.78% reduction in cholesterol and triglyceride levels in streptozotocin-induced diabetic rats, respectively.

### *XIV. Antidiarrheal Activity*

The antidiarrheal effect of a petroleum ether extract of S. macrophylla seeds in Wister albino rats was investigated, and the results showed a significant antidiarrheal activity, as evidenced by a reduction in the rate of defecation and consistency of feces in castor oil induced diarrhea rats at various extract doses of 25, 50, and 100 mg/kg body weight.

### *XV. Antimalarial Activity*

Antimalarial properties of a decoction of S. macrophylla seeds have been reported. The antimalarial efficacy of S. macrophylla seed methanol extract against Plasmodium falciparum was examined. On chloroquine-resistant P. falciparum strains, the bark extract of S. macrophylla demonstrated high antimalarial efficacy (78 percent inhibition at 100 g/mL) (Indo). The bark extract inhibited the rat malaria P. vinckeipetteri 279BY by 73 percent in an in vivo investigation at 250 mg/kg body weight. In addition to antimalarial action against P. falciparum, the aqueous extract of *S. macrophylla* seeds showed antibabesial activity.

### *XVI. Antifeedant Activity*

Four out of fifteen limonoids extracted from the acetone extract of *S. macrophylla* fruits and triturated with ethyl acetate for silica gel column chromatography using CHCl3 with increasing amounts of ethyl acetate exhibited good antifeedant action against Spodoptera frugiperda in an antifeedant assay. At a concentration of 1,000 ppm, swietenolide, 6-O-acetylswietenolide, 3,6-O,Odiacetylswietenolide, and swietemahonin F were tested in a bioassay on S. frugiperda final instar larvae. Swietenolide had the highest antifeedant activity (antifeedant index of 94.1

2.90), according to the findings. The antifeedant indices of 6-O-acetylswietenolide, 3,6-O,O-diacetylswietenolide, and swietemahonin F, respectively, were 72.2 19.60, 72.0 9.38, and 70.2 8.90 for the other compounds. The compounds were identified after a thorough examination of their high-resolution 1H- and 13C-NMR spectra, which included COSY, HETCOR, and HMBC correlations.

### *XVII. Acaricidal Activity*

Varroatosis is a disease spread by Varroa destructor mites (Acari: Varroidae) that has become a major pest concern for honeybees, Apis mellifera and Apis cerana (Hymenoptera: Apidae), all over the world. By feeding on hemolymph, the mites inflict damage to immature and adult bees, weakening or killing them. In honeybee colonies infested with V. destructor mites, an ethanol extract of the stem bark and leaves of *S. macrophylla* displayed acaricidal activity.

### *XVIII. Heavy Metal Phytoremediation Activity*

Hydroponic experiments with cadmium concentration gradients at concentrations of 0, 7.5, 15, and 30 mg/L were used to identify cadmium accumulation and tolerance of *S. macrophylla* seedlings, as well as their potential for phytoextraction, in the study on the phytoremediation potential of *S. macrophylla*. Because of its cadmium absorbing capacity and high biomass production of mahogany shoots, these findings imply that *S. macrophylla* could be a good choice for remediating cadmium contaminated sites in tropical areas.

### *XIX. Renal Protective Activity*

The ethanolic extract of mahogany seed (*S. macrophylla* King) can reverse renal impairment in streptozotocin-induced diabetic mice, as evidenced by lower serum creatinine and urine protein levels following administration. The ethanolic extract of mahogany seed's kidney protective effect could be attributed to its anti-diabetic and antioxidant properties (Mayur *et al.*, 2011).

## 6. CONCLUSIONS

In India, *Swietenia macrophylla* research has failed to gain traction. It's vital that the nutrients from the miracle tree are used to a variety of uses. *Swietenia macrophylla* has anti-diabetic and anti-cancer properties. In order to better verify the benefits of *Swietenia macrophylla*, double-blind studies are less usual. The mechanism behind this irony has yet to be found. Environmental variables affecting the nutritional values of *Swietenia macrophylla* leaves and other parts grown around the world need to be looked into more thoroughly. *Swietenia macrophylla* fundamental mechanisms as an anti-diabetic and anti-cancer medication require more research. A lot of vexing questions have yet to be answered. There is a need for more research into the antioxidant activities of aqueous extracts on cancer cells. The tree, a native of India, has the potential to become a large source of money for the country if the potential for exceptionally healthy food is exploited by the industries.

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