

# Evaluation of Antibacterial and Antioxidant Properties of Swietenia Macrophylla Using In vitro Models

<sup>1</sup>S. Sangeetha, <sup>2</sup>Pitchiah Sivaperumal\*

<sup>1</sup>Assistant Professor,  
Department of Anatomy,

Saveetha Dental College and Hospital,  
Saveetha Institute of Medical and Technical Sciences,

Saveetha University, Chennai- 77

Mail ID- [sangeethas.sdc@saveetha.com](mailto:sangeethas.sdc@saveetha.com)

<sup>2</sup>Professor,

Centre for Marine and Aquatic Research (CMAR)

Saveetha Institute of Medical and Technical Sciences,

Saveetha University, Chennai -77

**\* Corresponding Author**

Dr. Sivaperumal Pitchiah , Professor,  
Centre for Marine and Aquatic Research (CMAR)

Saveetha Institute of Medical and Technical Sciences,

Saveetha University, Chennai -77

Mail ID- [sangeethas.sdc@saveetha.com](mailto:sangeethas.sdc@saveetha.com)

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## ABSTRACT:

Swietenia macrophylla is a medicinally important plant known for its rich phytochemical composition and diverse pharmacological activities. The present study aimed to evaluate the antibacterial and antioxidant properties of Swietenia macrophylla seed extract using in vitro models. The seeds were subjected to ethanolic extraction and screened for bioactive constituents responsible for therapeutic activity like cardiovascular diseases, diabetes etc. Antibacterial activity was assessed against *Staphylococcus aureus* and *Klebsiella pneumoniae* using the agar well diffusion method at different concentrations (50, 100, 150 µg/ml). The extract demonstrated significant antibacterial activity, with the highest zone of inhibition observed against *S. aureus* at lower concentrations, indicating the presence of potent antimicrobial compounds. Antioxidant activity was evaluated using DPPH radical scavenging assay and hydrogen peroxide scavenging assay at concentrations ranging from 25 - 100 µg/ml. The results revealed a concentration - dependent increase in free radical scavenging activity, suggesting strong antioxidant potential of the seed extract. The findings of this study support therapeutic significance of Swietenia macrophylla as a potential natural source of

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antibacterial and antioxidant agents for pharmaceutical and biomedical applications.

**Keywords:** antimicrobial, antioxidant, therapeutic, phytochemical, hydrogen peroxide, biomedical, Cardiovascular disease, Diabetes

## 1. INTRODUCTION

In addition to their vital role in photosynthesis, plants serve as an abundant source of diverse phytochemicals that are utilized in herbal medicine and functional foods for their therapeutic benefits in maintaining human health(1). Therefore, the development of pharmaceutical products requires extensive investigation of medicinal plants to improve our understanding of their biological activities and bioactive phytoconstituents responsible for these effects (2). *Swietenia macrophylla*, commonly called “big - leaf mahogany” or “sky fruit” belongs to the family Meliaceae (3). The species is predominantly distributed in open rainforests, semi - deciduous forests and deciduous forests, where trees partially or completely shed their leaves during dry season. The species name “macrophylla” is derived from the Greek word *makros* meaning “large” and *phylon* meaning “leaf”, referring to its broad leaves. Its fruit is commonly known as “sky fruit” because of its upward - pointing appearance toward the sky. (4) .

*Swietenia macrophylla* has been widely used in Asia and several other countries for the treatment of various ailments due to its antimicrobial, anti inflammatory, antioxidant, antimutagenic, anticancer, antitumor and antidiabetic properties( 5,8). Nearly all parts of the plant are employed in traditional medicine for managing different human diseases. The fruit of *S. macrophylla* are commercially incorporated into healthcare products aimed at improving blood

circulation and skin health(6). Among the various plant parts, the seeds are especially recognised for their significant medicinal properties (4,7) The fruit is a woody, ovoid - shaped capsule that is light brown in colour and dehisces into five segments, containing approximately 10 - 14 winged seeds (8).

*Swietenia macrophylla* seeds are rich in diverse bioactive phytochemicals, including limonoids, alkaloids, flavonoids, saponins, and tannins, which contribute to their potent antioxidant, anti-inflammatory, and antimicrobial activities(4,7). These phytoconstituents possess considerable therapeutic potential, particularly in the management of hypertension and diabetes mellitus (10). Major Chemical Constituents are Limonoids are the principal bioactive compounds present in the seeds, among which swietenine has been widely reported for its notable antidiabetic activity(7,10). The seeds contain a high oil content, with a predominance of unsaturated fatty acids such as linoleic acid, oleic acid, and palmitic acid (7,9,10). Phenolic acids and flavonoids present in the seeds exhibit strong antioxidant properties through effective free radical scavenging activity. In addition to the above compounds, the seeds also contain steroids and triterpenoids, which may further contribute to their pharmacological properties (9).

The physical and chemical composition of seeds contain various bioactive compounds that appear as pale red or brown amorphous solids, characterized by the presence of hydroxyl and carboxyl functional groups in

their chemical structures. Studies have reported the presence of several essential trace elements and minerals in the seeds, which may contribute to their nutritional and therapeutic value. (8)

This economically significant timber tree has traditionally been used in the management of various diseases, including hypertension, cardiovascular diseases, diabetes, elevated blood pressure (10). Crude seed extracts of *swietenia macrophylla* have demonstrated a wide range of biological activities, including antimalarial, antihepatitic, antidiarrheal, antidiabetic, anti inflammatory, antimutagenic, antinociceptive and anticancer properties (9,10).

The growing crisis of antimicrobial resistance has renewed scientific interest in medicinal plants as sources of novel bioactive compounds. *S. macrophylla* is a priming one because its extracts are rich in structurally diverse secondary metabolites that exhibit multiple biological activities including antibacterial, antifungal, antioxidant, antidiabetic and anti-inflammatory effects (10). So the aim of the present study is to evaluate the in vitro antibacterial and antimicrobial properties of ethanolic solvent extract of *Swietenia macrophylla*.

## 2.AIM

To evaluate the in vitro antibacterial and antimicrobial properties of ethanolic solvent seed extract of *Swietenia macrophylla*.

## 3.MATERIALS AND METHODS

Matured seeds of *Swietenia macrophylla* were bought commercially from local herbal medicine store. The seeds were cleaned devoid of dust and shade dried at room temperature for 10- 14 days. The dried seeds were manually dehulled and the kernels were powdered using electric grinder. The powdered material was sieved through a fine

mesh to obtain uniform particle size and the extract was obtained using soxhlet apparatus.

### 3.1 Evaluation of Antibacterial Activity

The antibacterial activity of the extract was evaluated against selected human pathogenic bacterial strains such as *Staphylococcus aureus* and *Klebsiella pneumoniae*. Bacterial cultures were inoculated into nutrient broth and incubated at 37 C for 18 - 24 hours. The turbidity of the bacterial suspension was adjusted to match 0.5 McFarland standard. The activity was assessed using the agar well diffusion technique. The agar plates were prepared and sterilised. Sterile cotton swabs were used to spread bacterial inoculum uniformly on agar plates. Wells of 6mm diameter were made. Different concentrations of the plant extract ( 50, 100, 150 µg/ml) were introduced into the wells. Standard antibiotics were used as positive controls. Plates were incubated at 37 C for 24 hours. The antibacterial activity was determined by measuring the zone of inhibition around the wells in mm.

### 3.2 Evaluation of antioxidant activity

#### 3.3 DPPH Radical Scavenging Assay

The antioxidant activity of the extract was evaluated using DPPH free radical scavenging assay. 0.1 mM DPPH solution was prepared in methanol and protected from light. Different concentrations of the extract (24,50,75,100 µg/ml) were prepared. 1 ml of each concentration was mixed with 1 ml of DPPH solution. The reaction mixture was incubated in the dark for 30 minutes at room temperature. Absorbance was measured using a UV- Visible spectrophotometer. Ascorbic acid was used as a standard antioxidant.

### 3.4 Hydrogen Peroxide Assay

To 1 ml of plant extract at various concentrations, 0.6 ml of hydrogen peroxide solution was added. The reaction mixture was mixed thoroughly and incubated for 10

minutes at room temperature. After incubation, the absorbance of the reaction mixture was measured. Ascorbic acid was prepared at concentrations similar to the sample and used as the reference standard.

## 4. RESULTS

### Antibacterial activity

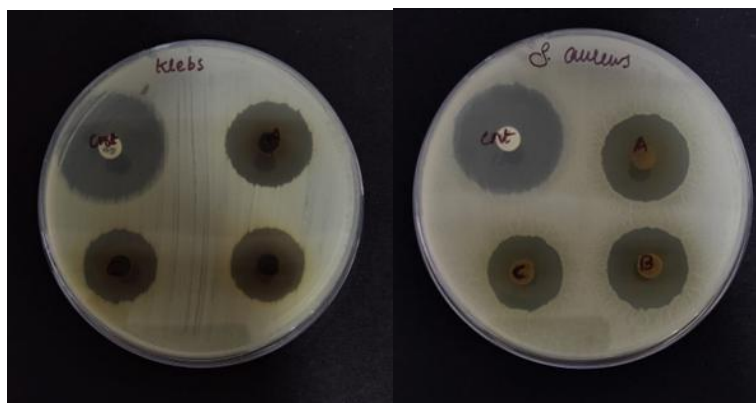


Plate 1: Klebsiella

Plate 2: Staphylococcus aureus

Cnt: Control; A: 50µg/ml; B: 100 µg/ml;  
C: 150µg/ml

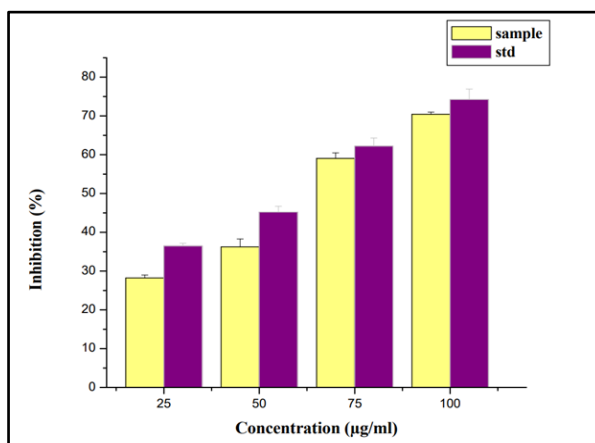
#### *Klebsiella pneumoniae*

**Zone of inhibition:** Cnt: Control=18mm;  
A: 50µg/ml=12mm; B: 100 µg/ml=14mm;  
C: 150µg/ml=12mm

#### *Staphylococcus aureus*

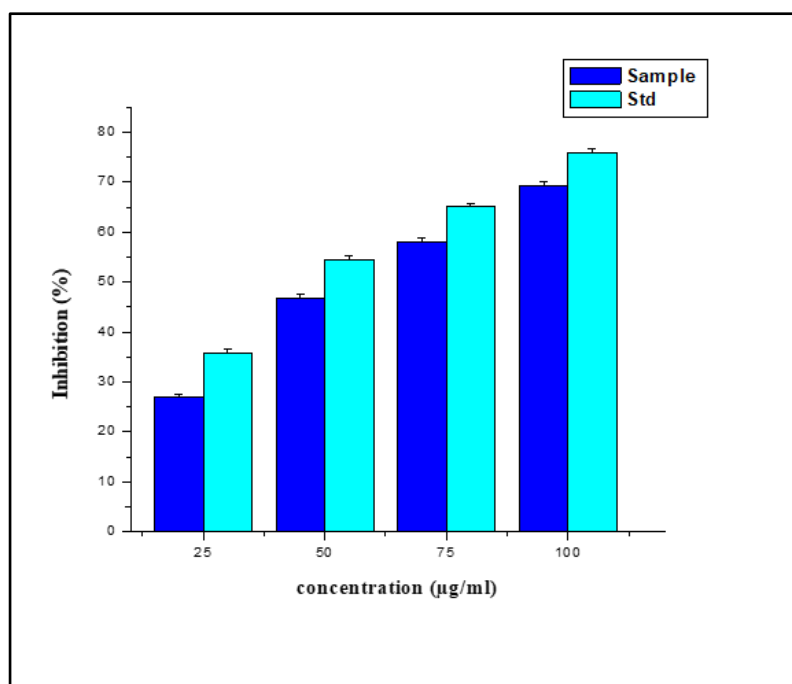
**Zone of inhibition:** Cnt: Control=19mm;  
A: 50µg/ml=14mm; B: 100 µg/ml=12mm;  
C: 150µg/ml=10mm

### Antioxidant - DPPH



**Graph 1:** represents the DPPH assay. X axis represents the concentration of seed extract and the Y axis represents the percentage of inhibition. As concentration of extract increases, the percentage of zone of inhibition also increases.

## Hydrogen peroxide assay



**Graph 2 :** represents Hydrogen peroxide assay , X axis represents concentration of seed extract and Y axis represents percentage of inhibition. As concentration of extract increases, the percentage of zone of inhibition also increases.

## 5. DISCUSSION

The antibacterial activity was studied against *S aureus* and *K pneumoniae* with seed extract of *Swietenia macrophylla* with different concentrations of 50, 100, 150 µg/ml .The present study demonstrated that the seed extract of *Swietenia macrophylla* possesses notable antibacterial activity against both Gram - positive *Staphylococcus aureus* and Gram- negative *Klebsiella pneumoniae*. The antimicrobial activity against *S aureus* exhibited the highest susceptibility at 50 µg/ml concentration producing a maximum zone of inhibition of 14 mm. Moderate inhibition of 12 mm was observed at 100 µg/ml , while weaker inhibition of 10 mm was recorded at 150µg/ml.The higher antibacterial activity at lower concentration may be due to the optimal diffusion of bioactive compounds through the agar medium. At higher concentrations, aggregation or reduced diffusion of

phytochemicals may have limited the antimicrobial effect, resulting in comparatively smaller inhibition zones.

The antibacterial activity against *K pneumoniae* showed a different pattern. The maximum inhibition of 14 mm was observed in 100 µg/ml, whereas both 50 and 150 µg/ml produced moderate inhibition zones of 12mm. This variation suggests that the antibacterial compounds present in the extract exhibit concentration - dependent activity specific to the bacterial species. *K pneumoniae*, being a Gram - negative bacterium, possesses an outer lipopolysaccharide membrane that usually provides greater resistance to antimicrobial agents (11). However, ethanolic seed extract was able to effectively inhibit its growth, indicating the presence of potent bioactive constituents capable of penetrating the bacterial cell wall.The ethanolic seed extract of *S mahagoni* exhibited broad spectrum

antibacterial activity consistent with findings reported in other studies (12). The strong antibacterial activity of the alcoholic extracts may be attributed to the high extraction efficiency of ethanol, which enables the isolation of numerous bioactive compounds responsible for antibacterial effects(13).

The present study evaluated the antioxidant potential of *Swietenia macrophylla* seed extract using DPPH free radical scavenging assay and hydrogen peroxide scavenging assay. In Graph - 1 The X axis represents the seed extract in different concentrations of 25,50,75,100 µg/ml. The Y axis represents the percentage of inhibition in mm. As the concentration of extract increases, the percentage of inhibition also increases. In Graph -2 The X axis represents the seed extract in different concentrations of 25,50,75,100 µg/ml. The Y axis represents the percentage of inhibition in mm. As the concentration of extract increases, the percentage of inhibition also increases.

The results obtained from both assays demonstrated that the seed extract possesses significant antioxidant activity, which increased progressively with increase in concentration of extract

(25,50,75 and 100 µg/ml). The concentration dependent increase in percentage inhibition indicates the strong free radical scavenging ability of the phytochemical constituents present in the extract.

The antioxidant evaluated by DPPH and hydrogen peroxide scavenging assays demonstrated a concentration- dependent increase in free radical scavenging activity. As the concentration of the extract increased from 25µg /ml to 100 µg/ml, the percentage inhibition also increased significantly. This indicates that the seed extract has the ability to donate electrons or hydrogen atoms to neutralize free radicals, thereby reducing

oxidative stress (14). Oxidative stress plays a major role in the pathogenesis of several chronic diseases including cancer, diabetes mellitus, cardiovascular diseases, neurodegenerative diseases and aging (7). Therefore, natural antioxidants from medicinal plants are increasingly being explored as safer alternatives to synthetic antioxidants.

The DPPH radical scavenging assay is widely used to evaluate the hydrogen - donating capacity of plant extracts. The significant scavenging activity observed in the present study suggests the presence of phenolic constituents capable of stabilizing free radicals by electron transfer mechanisms. Similarly, the hydrogen peroxide scavenging activity indicates that the extract can neutralize reactive oxygen species before they generate highly toxic hydroxyl radicals. Previous investigations on *S. macrophylla* have reported that catechin, spicatechin and swietemacrophyllanin isolated from the plant exhibit potent antioxidant properties (14).

The strong antioxidant activity observed in this study may be associated with the high phenolic and flavonoid content of the seed extract. Phenolic compounds are capable of chelating metal ions and scavenging free radicals, while flavonoids inhibit lipid peroxidation and stabilize reactive oxygen species (15,17). The ethanolic solvent used for extraction may also have contributed to the enhanced activity, as ethanol is efficient in extracting polar bioactive compounds including polyphenols and flavonoids. Similar studies have shown that ethanolic extracts possess greater antioxidant and antimicrobial activity compared to aqueous or non - polar solvent extracts due to better extraction efficiency of bioactive constituents (16).

The findings of the present study are in agreement with earlier reports demonstrating that *S macrophylla* possesses diverse pharmacological properties including antioxidant, antimicrobial, anti-inflammatory and antidiabetic activities. The result further validate the therapeutic importance of the seeds, which are often considered underutilized plant materials. Since oxidative stress and microbial infections are closely associated with several human diseases, the dual antioxidant and antibacterial properties of *S macrophylla* seed extract highlights its potential application in the development of natural therapeutic agents and pharmaceutical formulations.

Overall, the present investigation demonstrates that the ethanolic seed extract of *Swietenia macrophylla* exhibits promising antibacterial and antioxidant activities. The result support the medicinal value of the plant and suggest that it may serve as a potential natural source for the development of novel antimicrobial and antioxidant agents for pharmaceutical and biomedical applications.

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## CONCLUSION

The present study successfully demonstrated the antibacterial and antioxidant potential of the ethanolic seed extract of *S macrophylla* through various in vitro assays. The findings revealed that the seed extract exhibited significant antibacterial activity against both *S aureus* and *K pneumoniae*, with comparatively greater inhibition observed against the Gram-positive organism. The observed antimicrobial activity confirms the presence of biologically active phytoconstituents capable of suppressing bacterial growth and supports the traditional medicinal use of the plant in the treatment of infectious diseases. The study establishes that *S macrophylla* seed extract possesses significant antibacterial and antioxidant activities, thereby emphasizing its potential role in the development of novel phytopharmaceutical formulations and natural therapeutic agents for biomedical and pharmaceutical applications.

## CONFLICT OF INTEREST

There is no conflict of Interest

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