

Ayurveda and environmental network: Antimicrobial, pharmacological and ecological potential of *Swietenia macrophylla* Meliaceae (L.) Jacq.

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Abstract

To encapsulate the research reports on *Swietenia macrophylla* compounds to explore their medicinal and ecological importance. The plants of *Swietenia* genus may be used to recover ecological aspects and importantly to develop drugs to cure many diseases. Many research articles reported through the work that *S. macrophylla* possesses antidiabetic, antioxidative and antihyperlipidemic activity, antimicrobial and pharmacology potential to ecological recovery property. Herbal drugs prepared from plant extracts have an enormous range of medicinal properties. *S. macrophylla* species ascertained to have a broad range of medicinal properties and ecological potential to reap up beneficial things. *Swietenia macrophylla* Meliaceae (L.) Jacq. have immune-modulatory, anticancer, anti-diabetic, antiviral, anti-hypertension and many other curative properties. *S. macrophylla* gorgeous in flavonoids, tannins, alkaloids, sugars and terpenoids and limonoids, is believed to have vast therapeutic potential. Mahogany can grow in perennial and seasonally dry areas and even flourish in various types of soils. Encapsulation of the research reports on *Swietenia macrophylla* compounds is essential to explore their medicinal and ecological importance. The plants of *Swietenia* genus may be used to recover ecological aspects and importantly to develop drugs to cure many diseases. However, more study is needed to categorize, describe and systematize the vital metabolites and plant extracts used in disease treatment. Abundance of limonoids and many other compounds in *Swietenia* genus brand this plant more noteworthy for in-depth molecular level studies to discover additional potential about its pharmacological, ecological and other possible possessions.

Keywords: *Herbal drug; antimicrobial; Swietenia; ecology; chemical biology.*

1. Introduction

Natural drug, compounds and or herbal extract are practicing from long ago for medicinal purposes. Herbal extracts of single or multiple plants use in diverse combinations and prepare by various methods like boiling or tinctures made from various solvents including water. Distillates are sometimes dried to make capsules or tablets or may be in liquid form usually decoctions, oil-based and aqueous. Natural drugs are most preferred by the peoples as they are more safe, inexpensive and without side effects than allopathic drugs (Lin et al., 2011; Shirzad et al., 2013). In COVID-19 pandemic also herbal medicines showed its potential to cure many positive patients and grabbed worldwide market in therapeutics. Thus herbal drugs as an immunomodulator and anti-microbial offer sustainable and medicinal option to allopathic remedy (Demicheli et al., 2003; Burch et al., 2009; Nahas and Balla 2011).

Many vital phytochemicals are present in bark, seeds and leaves of *Swietenia macrophylla* Meliaceae (L.) Jacq. The plant name has been checked with "World Flora Online" (www.worldfloraonline.org). Alike *Azadirachta indica*, many limonoids and its derivatives are present in this plant and their structures allotted on the basis of analytical analysis (Chen et al., 2010). Catechin and epicatechin compounds and some fatty acids were also isolated from this tree and reported to be very essential for antioxidant activity (Falah et al., 2008). Among fatty acids, linoleic and linolenic acid are abundantly present in mahogany plant which are beneficial for human health (Moumita et al., 2011). Further, this tree has remarkable price and benefits in traditional medicine due to many therapeutic activities it possesses. Mainly, sky fruit and seeds present in them is reported to make healthcare or beauty products. It is known to be beneficial for better skin and blood circulation. Diseases like diabetes and diarrhea significantly managed by Ayurveda practitioner since long ago by extract of Mahogany plant parts (Goh and Kadir 2011).

S. macrophylla is a fast developing, long-lived, deciduous plant and reach up to 45-50 m height along big trunk (2.5 to 3 m) in diameter (Pennington 2002). This royal tree can survive for more than 350 years; is fundamental part ecosystem and an important sustainable source for indigenous people. The tree has small white flowers and bears fruit, brown bark with sweetened aroma. The Mahogany requires bright light for better growth however not usually for survival (Grogan and Barreto 2005; Whitmore 2012; Mayhew and Newton 1998; Grogan and Loveless 2013). Its fruit generally well-known as sky fruit, as it appear to grow aloft to the sky (Lourmas 2007). These trees found or grow around in 50 nations such as India, America, Mexico, Peru and some other countries (Blundell and Gullison 2003). The *S. macrophylla* big-leaved tree (Mahogany), legendary in the wood trade for its excellence. The diminution of Mahogany populations has led to alarm for the upcoming days to its commercial trade. *S. macrophylla* was listed in Appendix II (endangered species) by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Grogan and Barreto 2005). In many countries, *S. macrophylla* uses for many purposes by common peoples such as soil improvement or for human beings as remedy and additional routine practices.

Mahogany can grow in perennial and seasonally dry areas and even flourish in various types of soils (Grogan and Schulze 2008). Soil's nutrient cycle is intensely prejudiced by rain, fresh water transports the minerals for fertility of the soil, this is nothing but stem flow and throughfall (Fadhilah et al., 2021). To improve the soil fertility and to reduce the rainwater surface runoff, it is important to know the trees that can intercept rainwater nicely. Mahogany trees are well-known to have role in governing the amount and excellence of rainwater that falls to the earth. Rain water contains nutrients, however, natural forests or plants adds value to the fresh water and augment the nutrients present in rainwater, ultimately get to the soil. Its timber is one of the most loved hardwoods in the world due to its sturdiness, comfort during working

and amusing red colour. Due to Mahogany's importance, this species has been worryingly exploited in a large part of its natural range. It is claimed that, reaping of Mahogany causes restoration and fertility of the soil (Kumar et al., 2016; Foster et al., 1986; Kalliola et al., 1988; Kalliola et al., 1991; Salo and Kalliola 1991; Kalliola et al., 1992).

In this review paper highlighted the importance of Mahogany through all the glances viz. ecological significance, soil regeneration, rain water improvement, phytochemical and medicinal values and traditional uses. Mahogany plantation is deeply discussed to boost natural regeneration of the soil. In vivo and In vitro studies of the plant extracts and metabolites reported for their medicinal properties and proved based on traditional uses. Finally, emphasized the importance of *Swietenia* genus and made recommendation on the plantation of the Mahogany species. In sight of the ecological and remedial significance of *S. macrophylla* more consideration is necessary in the direction of the innovation of their potential natural therapeutic practices.

2. Methodology

Very recent and old reference papers including, books, book chapters and review articles for information regarding the medicinal and ecological uses are used in this review article. Some of the books are directly used from the website and library. Scientific websites viz. MEDLINE, Scopus, Springer and PubMed referred for the referencing purposes. Many research articles reported through the work that *S. microphylla* possesses antidiabetic, antioxidative and antihyperlipidemic activity, antimicrobial and pharmacology potential to ecological recovery property. 126 studies were included, majority of them are related to medicinal property and few of studies related to the ecological importance of *Swietenia*.

3. Metabolites of *Swietenia*

Plants are rich source for varied diversity of secondary metabolites such as flavonoids, tannins, alkaloids, sugars and terpenoids. In developing as well as in some developed countries, peoples believe in traditional medicines to combat the diseases (WHO 2002). Plant extracts contain numerous phytochemical compounds and are safer and more inexpensive. The plants which have antimicrobial power and other beneficial properties are always remain of people's interest. *Swietenia* is one of among them. Phenols, alkaloids, anthraquinones, flavonoids, volatile oils, long chain unsaturated acids, saponins, terpenoids, cardiac glycoside, phospholipids are identified in the plant, genus *Swietenia* (Arumugasamy et al., 2004). Analytical analysis showed that *S. macrophylla* mainly contains limonoids and their derivatives (Connolly and Labbé 1980). Alike Indian neem plant, Mahogany also contains many

tetranortriterpenoids and so increasing research trend and awareness in *S. macrophylla* reached to significant level. An extensive collection of purified compounds with pharmacological activities are reported from different parts of *S. macrophylla*. Organic structures of some Swietenia metabolites are showed in Fig. 1.

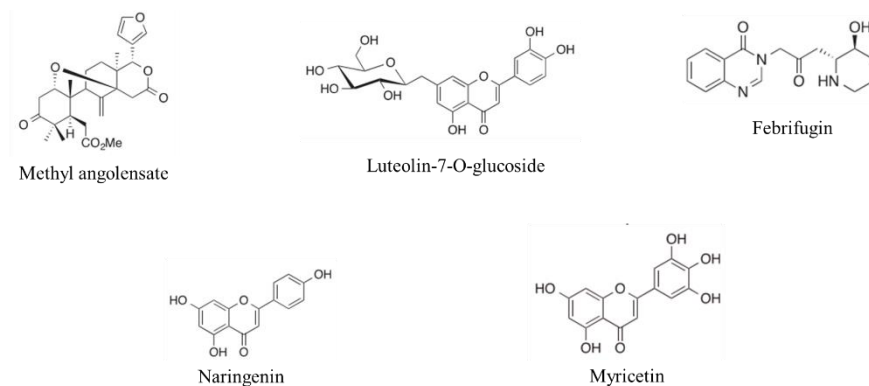


Fig. 1 Structure of *S. macrophylla* metabolites isolated from different parts.

3-hydroxycaruilignan C was isolated from the *S. macrophylla* stems and the chemical structure was confirmed by nuclear magnetic resonance spectroscopy and mass spectrometry. In *S. macrophylla*, gallic acid, protocatechuic acid and catechin phenolics were identified and their structures confirmed by mass spectroscopic instruments (Proestos and Komaitis 2013). Among more potent phenols, flavonoids has great potential as a free radical scavengers and antimicrobial and other bio-powers. The flavonoids are abundantly present in Mahogany which lead to more antioxidant power (Middleton et al., 2000). Plants of Meliaceae family is assorted with many limonoids, technically known as triterpenoids. To the record, >300 limonoids have been isolated and identified in Swietenia which is very big number than in any other plant families (Nakatani et al., 2001). However, extraction of metabolites is totally depend on the extraction solvent and method used for the isolation of metabolites. The list of few metabolites identified in Swietenia genus is listed in Table 1.

Table 1. Phytochemicals present in *S. macrophylla* species seeds and bark and BVOC released by the plant.

Plant part	Compound	Reference
Biogenic Volatile Organic Compounds	Dimethyl sulphide	Vettikkat et al. 2020
	Monoterpenes	
	Isoprene	

Seeds	Augustineolide	Chan et al. 1976
	9-Hexadecenoic acid	Mursiti et al 2019
	Palmitic acid	Ibrahim et al. 2018
	Holotoxinogenin 3 Beta-Acetate	Sri Mursiti et al 2019
	Capsanthin	
	Tigloildisoxilin	
	Olealdehyde	
	Holotoxinogenin 3 Beta-acetate	
	Swietenine	Solomon et al. 2003
	8,30-Epoxy swietenine Acetate	Connolly et al. 1980
	3 β ,6-Dihydroxydihydrocarapin	Taylor and Taylor 1983
	7-Deacetoxy-7-Oxogedunin	
	Proceranolide	Mootoo et al. 1999
	Swietemahonin E	Kadota et al. 1990a
	Swietemahonin F	Kadota et al. 1990b
	Swietemahonin A	Ekimoto et al. (1991)
	3-O-Tigloyl-6-O-Acetylswietenolide	Chen et al. 2010
	Scopoletin	
	B-Sitostenone	
	Secomahoganin	Kadota et al. (1990)
	6-acetoxygedunin	Kadota et al. (1990)
	Methyl angolensate	Kadota et al. (1990)
	7-deacetoxy-7-oxogedunin	Kadota et al. (1990)
	3-O-acetylswietenolide	Ekimoto et al. (1991)
Leaves	Germacrene A	Soares et al. 2003
	Hexadecanoic Acid	
	Swietenine J	Soloman et al. 2003b
	Methyl-6-B-Hydroxyangolensate	Liu et al. 2012
	Khayanolide E	Olmo et al. 2003
	1-O-Acetylkhayanolide B	Liu et al. 2012
	12 α -Acetoxyswietephragmin C	
	Scopoletin	Chen et al. 2010
	Melianone	Chakraborty 1970

	Cyclomehogenol	
	Stigmasterol glucose	Rastogi and Mehrotra 1993
	Siderin	Liu et al. 2011
	Dimethyl phthmalate	Prabavathy D and Valli Nachiyar 2013
	Diisobutyl phthmalate	
	Dibutyl phthmalate	
	Syringic acid	Shalini et al. 2010
Bark	catechin	Preciado et al. 2016
	Maxicanolide	Saad et al. 2003
	epicatechin	Preciado et al. 2016
	swietemacrophyllanin	Falah et al. 2008

4. Mahogany reconnoiter for medicinal purposes

Mahogany is in use as traditional medicine from long ago (Sukardiman and Ervina 2020). Limonoids and triterpenoids are abundantly present in mahogany and broadly explored for traditional medicinal purposes in the common peoples community round the globe (Telrandhe et al., 2022; Lu et al., 2016). Skin treatment, blood parameters and to treat health complications, Mahogany fruits are reported to be useful (Patel et al., 2012). Metabolites of Mahogany play important role as hypoglycemic agents, hence use to manage diabetes, even they are superior to currently using drugs. Due to side effects of allopathic medicines, now majority of the peoples around the world look for a plant based drugs. However, there is need to search for molecular mechanism of plant metabolites in the human body, safety concern and concentration to optimize its impact. It is known that seeds or seed powder of *S. macrophylla* cure hypertension and high blood pressure (Chan et al., 1976; Kojima et al., 1998; Chen et al., 2010). Moreover, Mahogany's boiled seed extract found to be useful on injuries and skin infections (Tan et al., 2009). *S. macrophylla* is used for the management of diarrhea, hypertension and diabetes mellitus (Purnobasuki 2004). Leishmaniasis is a parasitic disease, caused by infection with *Leishmania* parasites and phlebotomine sand flies bite spread this disease. This disease may be cure by seeds of Mahogany and their seed extract is used for abortion purposes (Bourdy et al., 2000) Low blood glucose is observed with Mahogany seed oil and leaves extract (Moumita et al., 2011). Like Indian Indian neem tree, Mahogany extracts of different plant parts have potential to cure many diseases viz. dysentery, hypertension, intestinal infection, malaria, diarrhea, anaemia, cancer and fever (Raja 1990; Al-Radahe et al., 2012). Mahogany's plant parts effective against severe wounds (Suzuki et al., 2008). Mahogany use for various purposes as shown in the Fig. 2.

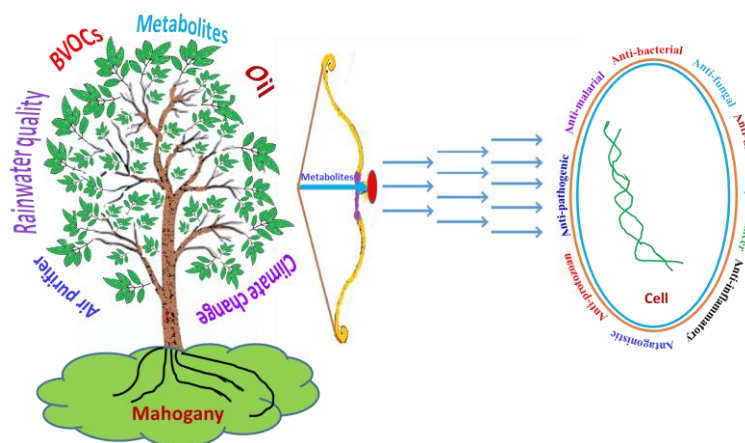


Figure 2. Schematic representation of *S. macrophylla* applications in medicinal, biological, physical, and varied climatic conditions. Applications in healthcare and ecological are of great importance because of their innate miraculous nature.

5. Mahogany shield to crisscross pathogenic attacks and manage diseases

5.1. Check to bacterial attack

In Mahogany plant, more than 300 limonoids have been isolated to date and all the limonoids are very varied and plentiful in this specific plant clan than in other trees. Abundant presence of varied limonoids provide a characteristics that have created curiosity in this Mahogany's herbal metabolites for the scientific community. 3-6 dihydroxy dihydrocarpin, augustineolide, 6-acetoxy humilinolide, swiemahogins A and B and phragmalin-type limonoid, 6-O-acetyl-3-demethylswietephragmin E tetranortriterpenoids and many more limonoids are found in *S. macrophylla* (Table 1). Triterpenoids reported to show noteworthy bactericidal action against multi-drug resistant (MDR) microbial species (Sahgal et al., 2009). Seed, stem, bark and leaves extract of *S. macrophylla* showed varied potential against bacterial species. Even use of various solvents also played important role in extraction of metabolites as anti-microbial agent. MDR *Staphylococcus aureus* and *Escherichia coli* can be checked by Mahogany extract. Ethanolic extracts of fruit cover displayed overall more effective activity than methanolic extract against pathogenic bacteria (Cowan 1999). At the same time, acetone was less effective than other alcohols. It does mean, solvents used for the extraction for the metabolites played important role in medicinal properties. Broad spectrum antimicrobial activity against *Saccharomyces*, *Micrococcus* and *Bacillus* species, *Aspergillus*, *Ustilago* and *E. coli* observed with dichloromethane, methanol and n-hexane extracts of stem, leaves and bark (Jayasinghe et al., 2002). Many reports and articles published so for showing that *S. macrophylla* is gifted plant as accepted ecological anti-bacterial compound. Limonoids and other metabolites present in the various plants parts can be a potent bio-drugs in future.

Infectious diseases provoked by humankind are aggravated by climatic damages and ultimately headed to pathogenic diseases (Mora 2022). Multidrug resistant (MDR) bacteria are one of the utmost central present intimidations to community health. Nosocomial infections usually caused by MDR bacteria. Now prevalent reasons of community-acquired infections are some MDR bacteria. In fact, MDR spread is due to increased healthcare costs, antibiotic use, morbidity, and mortality. Community spread of MDR bacteria is one of the important task, which will demand novel drugs and multi-disciplinary methodology. Plant based drugs can be one of the greatest strategy to overcome this issue. Because Ayurveda drugs does not have any side effects and have potential to eradicate the diseases. *S. macrophylla* plant genus contains many phytochemicals and proved to be able to cure many health issues. *S. macrophylla* species have potential to treat diarrhea and pathogenic attack and showed antioxidant power, also have anticancer, antinociceptive and antidiabetic activities (Moghadamtousi et al., 2013). Triterpenoids or limonoids present in the Mahogany mostly responsible for their medicinal properties like antimalarial, antifungal; mahogany extract can be used to control insect pest (Govindachari et al., 1999; Sahgal et al., 2010).

5.2. *Metabolites of S. macrophylla* exhibited anti-fungal activity

Triterpenoids are important defense ingredients present at adequate amounts to kill pathogenic fungi (Grayer and Harborne 1994). It is proved that, more the presence of triterpenoids that specifically ward off the more species of fungi like *Candida tropicalis*, *Neisseria gonorrhoeae*, and *C. albicans* (Trusheva et al., 2013). Meliacins from *Chisocheton paniculatus* is antifungal triterpenoids present in Mahogany is known for its antifungal activity (Bordoloi et al., 1993). Pathogenic fungi present in plants also killed by the limonoids of the *S. macrophylla*. Groundnut rust *Puccinia arachidis* can be easily eradicated by the limonoids content in *S. macrophylla*. *S. mahogani* extracted B,D-seco limonoid was assessed for its antifungal activity (Govindachari et al., 1999). Fungus like *C. albicans* and *Pseudomonas aeruginosa* and *Bacillus subtilis* can be inhibited by Mahogany metabolites (Tan et al., 2009). Ethyl acetate extracts containing methyl luteolin-7-O-glucoside and angolensate exhibited anti-fungal activity against *A. niger* and significantly inhibited *Alternaria alternate* growth (Chiruvella et al., 2007).

5.3. *S. macrophylla* potential as anti-inflammatory and antagonistic role

Metabolites present in the *S. macrophylla* have painkiller and anti-inflammatory potential. *S. macrophylla* has potential to inhibit neutrophil which are responsible for pro-inflammatory activity; ultimately may be used to stop inflammations in humans. The isolated compounds including the compounds which responsible to the anti-inflammatory effects abundantly remain present in mahogany plants. The highly diversified compounds including triterpenoids present in the *S. macrophylla*, reported to be the insect growth regulating and anti-feedant metabolites (Champagne et al., 1992).

Striped cucumber beetle and *Spodoptera frugiperda* were tested to see the anti-feedant potential of mahogany metabolites. However, ability to manage insect pest was totally depend on the solvent used for the extraction of metabolites. Mahogany extract fed larvae could not reached to the pupation and even their growth was stunted (Mikolajczak and Reed 1987).

5.4. Anti-cancerous power of *S. macrophylla*

From centuries, the anticancer potential of plants based metabolites have been documented (Amara et al., 2008; Guevera et al., 1996). Isolation of several compounds from the known medicinally important plants eventually steered to the discovery of medicines used to treat various cancer (Dawurung et al. 2021). As the time goes, structural analysis of Mahogany metabolites and their molecular mechanism in humans is at the central dogma of scientific community. It is already proved mahogany metabolites played big role in cancer treatment and remain to clench great potential as significant resource of drugs for various diseases and cancer remedy. Mahogany's assorted medicinal power like cancer chemo-preventive effects and cytotoxicity established that led to substantial attention from last few decades (Wadsworth and González 2008; Gonzales and Valerio 2006; Daniel 2012). Mahogany based anticancer drugs activate the apoptosis in cancer cells and stop cytotoxicity (Goh and Kadir 2011). The versatile potential acquired by the Mahogany metabolites is due to their massive structural diversity which paved a way for the development of novel drugs (Shoeb et al., 2006; Cragg and Newman 2005). Many limonoids present in Mahogany and pharmacological effects of limonoids can inhibit the growth of breast cancer cells by programmed cell death (Poulose et al., 2006).

Development of anticancer drug from *S. macrophylla* has increased interest due to their natural curative impact ultimately received the attention in medicinal era (Conforti et al., 2008; Tan et al., 2009). Some of the reports did cytotoxic study by using *S. macrophylla* ethanolic seeds extract. The crude extract was assessed by using MTT assay against breast carcinoma, cervical carcinoma, nasopharyngeal and epidermoid carcinoma. *S. macrophylla* extracts exhibited significant potential to stop the cancerous cells and help to induce apoptosis (Tohir et al., 2020). The study also supported by the DNA fragmentation data. *S. macrophylla* leaf and bark extracts showed anticancerous activity against KB cells (Camacho et al., 2003). Alkaloids from the plants such as vincristine and vinblastin reported to be have cytotoxic effects on cancerous cells. Further these alkaloids showed capacity to halt cell partition at specific phase, ultimately help in apoptosis (Nogrody 1992). Limonoids from other plants are also capable to prevent the spread of human choriocarcinoma cells by prompting apoptosis (Kumar et al., 2016). It is very clear that from the above points, more limonoids containing plants like Mahogany are very much potent to cure many types of diseases and can be remedy to treat various cancers and for inducing apoptosis mechanism.

5.5. Anti-diabetic possession of *S. macrophylla*

Diabetes is endocrine long-lasting metabolic malady that relates with the insulin production or insulin resistance. Blood glucose level is control or maintained by insulin hormones. Its remedy is to maintain normal blood glucose level by medication, exercise and diet. Though the allopathic drugs give better results, these drugs have drawbacks and sometimes antagonistic effects. Certain allopathic drugs could fail its effectiveness in substantial percentage of peoples (Pandey et al., 2011). Irrespective of the effectiveness of synthetic drugs to regulate blood glucose there is universal demand to find complementary diabetes treatment. Variety of flora present on the earth that offers countless options to cope up diabetes disorder (Perumal et al., 2015; Meles et al., 2019; Ansori et al., 2019; Husen et al., 2017; Amelia et al., 2018). Natural drugs do not have side effects, preclude complications and importantly never lead to low sugar level. There are many plants which showed anti-diabetic activity, however, *S. macrophylla* is the best amongst due to its significant hypoglycemic effect (Sukardiman and Ervina 2020; Suryani et al., 2013; Wresdiyati et al., 2015; Zapata-Sudo et al., 2012; Yadav et al., 2008; Singh and Gupta 2001).

Seeds and bark of *Swietenia* mainly used to treat diabetes. It is reported that ethanolic extract of *S. mahagoni* seed inhibited α -amylase activity (Hajra et al., 2011). Its water and alcohol based extracts have showed inhibition of α -glucosidase and In vivo hypoglycemic activity (Wresdiyati et al., 2015). In vivo treatment of ethanolic extract of Mahagony seed reduced blood glucose level of the rat (Raja 1990). Peroxisome proliferator-activated receptor observed to bind by *S. mahagoni* extract in diabetic mice (Li et al., 2005). This further supported by observing the increased absorption and the use of glucose in the peripheral cell membrane of insulin. Hypoglycemic activity of *S. macrophylla* seeds and their metabolites have confirmed by In vitro studies. *S. macrophylla* seed metabolites viz. swietenine, 6-O-acetylswietenolide and diacetyl swietenolide led to hypoglycemic activity in cell line. Streptozotocin-induced diabetic rats treated with methanolic extract of the *S. macrophylla* seeds to see the anti-diabetic effect of the extract. Treated mice showed significant reduction in blood glucose level and serum lipids in induced rats (Maiti et al., 2008; Maiti et al., 2008). Glibenclamide and extract of *S. mahagoni* bark was tested against anti-diabetic activity in rats. At the same time, antioxidant potential of the same extract was taken into consideration. It was observed that, in seed extract treated mice there was significant reduction in blood glucose level and even restored the body weight. Antioxidant activity was also noteworthy induced than normal rats (Panda et al., 2010).

Induced activity of catalase and peroxidase enzymes in kidney, skeletal muscles and liver were obtained in three weeks extract treated mice. In the same experimental animals reduced glucose level and normal levels of the cholesterol and lipoproteins with other contents were observed (De et al., 2011; Dutta et al., 2014). Wardani (2016) tested

the anti-diabetic potential of *Swietenia mahagoni* extract in alloxan-induced mice. In vivo investigational data showed that, mahogany extract reduced blood glucose level and further regenerated the β -cells of the islets of Langerhans (Szkdeliski 2001; Yadav 2001; Singh and Gupta 2008). There are many other articles which reported the power of Mahogany extract in regeneration of β -cells and improved secretion of insulin (Szkdeliski 2001; Falah et al., 2008). Various solvents like chloroform methanol and petroleum ether based extract significantly reduced glucose in blood of diabetic rats (Hashim et al., 2013)[94]. Naveen and Urooj (2015) anticipated that metabolites of mahogany work synergistically and work to control blood glucose level and other parameters like serum lipid management, antioxidant power and improved inclusive fitness.

In vivo molecular studies on metabolite's targets of mahogany showed antimicrobial potential (Mendes and Bogle 2015; Vigneshwaran and Lalitha 2016; Ponnusamy 2010). α -amylase inhibitor and peroxisome proliferator-activated receptor gamma were the targets for such study (Jian et al., 2018; Zapata-Sudo et al., 2012). Seed metabolites of *S. mahagoni* viz. swietenollide, swietemahonin, secomahoganin and few other metabolites tested against SGLT2 to check antagonistic effect (Vigneshwaran and Lalitha 2016). Medicine based research approach may floor approach to develop natural substance centered drug discovery.

5.6. *Plasmodium falciparum* and *Babesia gibsoni* squared by *S. mahogany*

Plasmodium falciparum and *Babesia gibsoni* are pathogenic protozoan which upon infection lead to malaria and anaemia, respectively (Nicholls et al., 2003). Globally, malaria is the utmost central parasitic illness of human beings with countless infection rate and yearly fatal rate is so high. It is expected that the world's major population is at threat and among young children mortality is significant (Dumic et al., 2018; Saxena et al., 2003). *B. gibsoni* infection usually lyses the erythrocytes eventually infected person become anemic. Further, it lead to hemoglobinuria, hyperbilirubinuria and sometimes organ failure (Onishi et al., 2022). Pentamidine isethionate, diminazene, parvaquone and diaceturate drug administration drops the protozoan pathogenic severity in dogs, nevertheless, these drugs persuade side effects (Morita et al., 2007; Murase et al., 1990; Wulansari et al., 2003). There are allopathic drugs to cure malaria, however, that drugs have side effects. Safe, promising and inexpensive remedy may be in the medicinal plant extracts (Bagavan et al., 2011). Sometimes immune-compromised patients in *B. microti* infection may remain for long time after various drug treatments, this scenario demands effective drugs without side effects (Gray et al., 2010). *S. macrophylla* plant extract tested against both of these protozoans and reported to be useful to inhibit the growth (Homer et al., 2000; Rajasekaran et al., 2010]. *S. macrophylla* showed strong activity against both the parasites (Murnigsih et al., 2005).

6. Ecological importance of the *S. macrophylla*

S. macrophylla helps in accumulation of groundwater altitudes, stops the soil destruction eventually increases the fertility. Inclusively mahogany recompenses to great extent to the complete ecology. Eventually assists new plants and harvests budding in and everywhere at the neighboring zone. Mahogany has a very huge monetary importance, woody excellence and valuable influence in environmental carbon sequestration through tree planting (Dixon et al., 1994). Increased industrialization, natural forests are decreasing and to cope up this situation, tree plantation via agroforestry may be helpful to mitigate climate change (Dhyani et al., 2021). This approach is the solitary presently appropriate to stop pollution and lead to the clean environment. Natural forests and plantation of beneficial trees like Mahogany also help for ecological soil recovery and offer many other countless environmental benefits viz. improve in soil fertility, easing of weather change, carbon sequestration, aid in raining and water quality, pest management and biodiversity preservation (Kumar et al., 2021).



Figure. 3 Representative picture of *S. macrophylla* plantations by MITCON at various parts of the India.

The seasons are getting erratic due to global warming, CO₂ and methane release. In this scenario, mahogany trees turn as a rescuer by reducing the hazard to the climate and help to decrease universal warming and its adverse impact. Sulphur compound discharge by Mahogany trees help to reduce the environmental warming and also play role in increasing groundwater levels and protect soil from attrition. Largely, Mahogany gives plenty things to the intact ecosystem including human beings. Mahogany tree is a blessing to the world as it purifies air and reduces air pollution, generates healthy, eco-friendly and harmless environment. We, the MITCON, due to ecological and medicinal importance of *Swietenia* species, have started plantation in various places in the India (Fig. 3).

6.1. Role of Mahogany in ozone formation, cloud materialization and climate change

It was assumed that dimethyl sulfide (DMS) emission in nature is significantly released by oceans which is known natural sulphur origin; considerably impact universal weather. Biogenic volatile organic compounds (BVOCs), show a durable effect on quality of air and weather due their organic potential in the ozone materialization. Marine phytoplankton are the major biogenic source of DMS in the nature (Lovelock et al., 1972; Charlson et al., 1987; Watts 2000; Stefels 2000). DMS may influence on cloud formation and sulphur aerosols. Now, it is proved that BVOCs help ecosystem to adapt to ecological stress, mainly biotic stress allied to climate change. Big-leaf mahogany trees recently reported to be accountable for emissions of DMS, monoterpenes, isoprene and periodic assimilation of carbon around their surroundings (Vettikkat et al., 2020). In atmospheric chemistry, DMS shows important role in contributing for the sulfate aerosol particles formation. This particle formation directly or indirectly contribute in materializing cloud condensation nuclei (Andreae and Crutzen 1997). The reports now concluded high DMS is found from the Amazon rainforest which is clear natural basis for DMS (Jardine et al., 2015). Earlier few studies recorded that, DMS can be released by trees through absorption of carbonyl sulfide or from sulfur sources within the tree (Yonemura et al., 2005; Geng and Mu 2006; Kesselmeier et al., 1993). In chemical ecology, plant based terpenoids also play key functional role to face climate change. BVOCs released by mahogany when mixed with polluted air, reactive BVOCs can influence local air quality considerably and improve regional climate (Goldstein et al., 2009). Big-leaf Mahogany emit monoterpenes, isoprene and DMS. It is reported that, mahogany alone globally emits 370-550 mg DMS yearly (Vettikkat et al., 2020). As this tree play part in many ways; cultivation of Mahogany is gaining popularity in the world; further warrants the impact on climate and air quality through BVOCs.

7. Conclusion

The genus *Swietenia* is astonishing tree of plenty and can be broadly used for numerous practices. It is used to regain the fertility of the soil and improve the quality of fresh water. Moreover, the extracts of Mahogany been reported for its remedial purposes. Antidiabetic, antifungal, antifungal, anticancerous, antimalarial and many other beneficial properties are reported in the species. Despite the requirement of more detailed research on it, few components have been isolated from *S. macrophylla*. These compounds are reported to be very useful for routine practices, ecological aspects and medicinal purposes. BVOCs released by Mahogany when mixed with polluted air, reactive BVOCs can influence local air quality considerably and improve regional climate. Though, *Swietenia* is miraculous tree and beneficial for human beings and environment, recorded under endangered species. Hence there is need to plant *Swietenia* more and more to save the earth and ecology.

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