Review Article

The Chemical Constituents and Diverse Pharmacological Importance of *Simarouba glauca* DC.

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ABSTRACT

The evergreen flowering tree *Simarouba glauca* is indigenous to Florida, the Lesser Antilles, South America, and the United States. Common names for this plant include bitterwood, dysentery barks, Laxmi Taru, and paradise tree. Comestible canvases and top-quality vegetable oils can be produced from seeds. According to the pharmacological review, *S. glauca* possesses a variety of therapeutic properties, including analgesic, antimalarial, antibacterial, antitumor, antiulcer, and antioxidant properties. The tree has been shown to have a number of chemicals with therapeutic activity. There have been reports that the tree contains numerous significant phyto ingredients with various medicinal use. Hepatoprotective conditioning was seen in the leaves, and the seeds are applied to snake bite injuries. These leaves of the tree have been reported with various pharmacological activities. The present study highlights the numerous properties of the tree parts and clearly defines the research gap that helps the future researchers to conduct various research activities in the tree.

Keywords: *Simarouba glauca*, Vegetable oil, Pharmacological activities, Hepatoprotective, Comestible canvases, Snake bites.

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INTRODUCTION

Simarouba glauca, also abbreviated as SG, is a member of the Simaroubaceae family and is commonly referred to as "Laxmi taru" or "Paradise tree." *S. glauca* have synonyms like Quassia simarouba, Zwingera amara, Simarouba medicinalis, Gavilan, Negrito maruba, etc.,[1] SG has been employed in traditional system of drug as anticancer, antimicrobial, antiviral and anthelminthic agent, especially in regions covering Southern Florida, the West Indies and Brazil.[2] This is indigenous to Brazil and Guiana. It was first introduced in India by National Bureau of Plant Genetic Resources (NBPGR) in the Research Station at Amravati, Maharashtra in 1966 and at University of Agricultural sciences, Bangalore in 1986 for its beautiful flowers.[3]

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Plants serve as comparatively good models for various bioactive compounds that are applied either specifically or sporadically to treat a range of fatal illnesses. Human societies have explored and employed medicinal constituents in the treatment of fatal conditions since time long past.[4] In India, medicinal herbs are widely employed as a folk medicine, in a variety of indigenous medical systems, or inadvertently in contemporary pharmaceuticals.[5] Herbal drugs are classified as indigenous health-care drug that identifies, inhibits, and manages internal and physical conditions else from allopathic propositions, views, and generalities.[6] People appreciate plants because they adhere to a traditional idea that they can supply humans with nutrition, medical treatment, and other benefits.[7]

A good supply of lipids, proteins, fats, and carbohydrates is *S. glauca*. Edible fat based of stearic, palmitic, and oleic acids makes up the kernels. Although the seeds

do contain oil, the three essential amino acids leucin, lysine, and valine are especially abundant in the kernels. Additionally, there are 51.8 g of protein per 100 g on average. Foods made from this plant contain alkaloids, calcium, sodium, triterpenoid, glycogen, phenolics, and saponins.[8] All of the plant parts from this species are used to make food, fuel, medicine, manure, building materials, lumber, etc.

The seeds of *S. glauca* DC. are an eco-friendly, evergreen, polygamodioecious tree that contains 60-70% oil that can be used for both edible and non-edible purposes, producing vegetable butter (vanaspati), margarine, pharmaceuticals, and other edible products are examples of edible usage.[9] Other non-edible products include soap, detergents, surfactants, cosmetics, paints, lubricants, candles, and substitutes for diesel engines. Its fruit pulp is used by the beverage and fermentation industries to produce jams, squashes, and other edible products. In addition, fruit pulp can be utilized for producing biogas and ethanol. Semi sweet fruit pulp, containing 11-12% sugars is eaten.[10] *S. glauca's* leaf and bark extracts provide therapeutic benefits such as anti-cancerous, hemostatic, anti-dysenteric, anthelmintic, antiparasitic, and antipyretic characteristics.[11] *S. glauca* is an evergreen multipurpose medicinal plant that contains vital compounds that have been treated to fight infections. It boosts our life span and speeds up our body's immune system. It has more than 10 medicinally important quassinoids, which stimulate the tree's energizing characteristics.[12] Chemicals that are innately built into plants are known as phytoconstituents. Due to their therapeutic effects, phytochemicals are become more prevalent. These phytochemicals are crucial in combating against a number of respiratory illnesses, arthritis, tumors, and other ailments due to the fact that they are free of any negative side effects like synthetic drugs have. Plant parts like leaves, buds, stems, pulp, seeds, and others produce phytochemicals.[13]

Plant Profile

Common name:	Aceituno, Paradise tree, Simaba, and Bitter wood tree.
Malayalam:	Lakshmi taru,
Tamil:	Shorgum Maram,
Hindi:	Laxmitaru,
Kingdom:	Plantae,
Order:	Sapindales,
Family:	Simaroubaceae,
Genus:	Simarouba,
Species:	*Simarouba glauca*.

TREE

BARK

LEAVES

SEED COAT

SEED

Parts of *Simarouba glauca* Tree.

S. glauca is commercially cultivated in the states like Gujarat, Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, West Bengal and also in Maharashtra and Orissa Seeds and other vegetative techniques of propagation, such as grafting, air layering, cutting, and tissue culture, are utilized for propagation.[14] Its tough seed coat imposes physical dormancy, which leads to decreased emergence and germination of the seed. Scarification, soaking the seeds in 100 ppm Plant Growth Regulators (PGRs), GA (Gibberellic acid), CCC (Chlormequat chloride), SA (Salicylic acid), 6-BA (6-Benzylaminopurine), and the use of various priming techniques are just a few mechanical and chemical treatments used to break the dormancy of its seed.[15]

Physical Characteristics

It's a medium-sized, evergreen tree (7-15 m). Since it is dry and semiarid, it can be widely cultivated in areas where no other economically viable plants can be grown. It has been formed in areas with periodic downfall of 250 mm to 2500 mm and temperatures as high as 45°C. It grows well up to 1000 m above ocean position in all kinds of well-drained soils. The tree starts to flower in December and produces fruit in January and February. The fruit is ready to be harvested in May.[16] The kernel had 8.51 w.b. It is a mid-sized branch that grows about seven times in its lifetime, usually to a height of 20 measurements and a periphery of 50-80 cm. It was predicted that the optimal soil pH and temperature ranges for a wide range of agroclimatic conditions, including somewhat sticky and tropical regions, were 5.5-8.[17]

The root system for mountainous soil is weak. The stem has a height of 9 m and a periphery of 40-50 cm. It has a thin, gray outer bark while the inner bark is delicate.[18] The leaves are uniformly blue-green and oily, with 3-21 alternating leaflets. They are oblong and occasionally indented or smooth. Bisexual blooms have bright green calyxes, differing pate forms from sepals, and are unseen. There are single-whorl delicate creamy greenish or yellowish petals available. The staminated flowers have gynophores, but no single ovule carpel.[19]

Stem is over to 9 m height with 40-50 cm in periphery. It produces bright green leaves 20 to 50 cm in length, small white flowers, and small red fruits. The drupelets are blackish purple in Kaali genotypes and yellowish green in Gauri genotypes and they're ready for harvesting by April/May.[20] Since growing, the seeds are 1.5 to 2 cm long pinkish or yellowish. There are two kinds one produces a greenish fruit and the other distinct violet or nearly black fruit depending on fruit colour.[21]

Chemical constitutions

S. glauca contains 11 quassinoids, the active ingredients in the tree, which are significant in medicine. There have been reports of alkaloids, flavanoids, cardinolides, glycosides, phenolic compounds, saponins, and fixed canvases in *S. glauca* extract. The main active ingredients in *Simarouba glauca* include ailanthinone, benzoquinone, canthin, dehydroglaucarubinone, glaucarubine, glaucarubolone, glaucarubinone, holacanthone, melianone, simaroubidin, simarolide, simarubin, simarubolide, sitosterol, and tirucallaetc.[22] Basically, these plants were used to extract a variety of alkaloids with high cytotoxicity and quassinoids with potent antifungal effects. The bark and leaves of SG contain triterpenes, which are beneficial in treating amoebiasis, diarrhea, and malaria. Quassinoids have demonstrated positive anti-tumor conditioning, the bitter values of the plant family of Simaroubaceae.[23] Normal SG qualitative studies have had positive goods on alkaloids, carbohydrates, flavonoids, and triterpenoids.[24]

GC-MS chromatogram of water extract *Simarouba glauca* representing some medicinal compounds like *Simarouba glauca* has medicinally important Flavone, thujopsene, oleic acid, phytol, and methylreserpate.[25-27] Phytoconstituents present in ethanolic leaf extract of *Simarouba glauca* as reported by Ramesh *et al.*, 2019 are Benzenamine, N-ethyl Aniline, 2,2-Bis(4-trimethysiloxy) phenylpropane],2,2-Bis[4-trimethylsilyloxy) phenyl] propane, 4-(3-pentyl)pyridine,pyridine,4-(1-ethylpropyl),5Alpha-androatane-3,17-dione17 monoxime,Androstane-3,17-dione 17-oxime.[28]

Nutritive value of *Simarouba glauca*

S. glauca is a rich source of nutrients that include lipids, adipose acids, carbohydrates and proteins.[29] Kernal proteins are rich in essential amino acids videlicet leucine (7.76 g/100g protein), lysine (5.62 g/100 g protein) and valine (6.12 g/100 g protein). The factory mess contain calcium (143 mg/100 g), sodium (79 mg/100 g), saponins with triterpenoid aglycone (3.7 g/100 g), alkaloids (1.01 g/100 g), phenolics (0.95 g/100 g) and phytic acid (0.73 g/100 g). The leaves contain flavonoids (0.14 to 0.18), phenolics (250- 400 µg/mg) and tannin substances (67-200 µg/mg), which help in combating critical conditions such as cancer and diabetes.[30] There is edible fat in the kernels composed of stearic, palmitic, and oleic acids; the seeds contain oil. The kernel is high in lysine, valine, and videlicet leucine, three important amino acids. Moreover, 51.8 g/100 g of protein is the average.[31] The seed's major fatty acid composition is

52-54% oleic acid, 27-33% stearic acid and 11-12% palmitic acid.[32]

Pharmacological properties

Antioxidant activity

It has been reported that *S. glauca* leaf extract has antioxidant properties.[33] *S. glauca* chloroform extract had the ability to scavenge H_2O_2 in an attention-dependent way. Similar to DPPH, extracts were mostly successful in scavenging free revolutionaries and chelating ferrous iron. Additionally, the extracts demonstrated indirect antioxidant activity.[34]

Antiamoebic activity

In vitro studies showed that *S. glauca* was active against *Entamobea histolytica* due to presence of crystalline glycosides glaucarubin insulated from *S. glauca* and displayed amoebicidal parcels in *in vitro* studies.[35]

Antibacterial activity

S. glauca leaves extract has implied antibacterial exertion against both Gram positive and Gram-negative bacteria. Fresh and dried leaves of *S. glauca* extract inhibits the microorganisms similar as *Bacillus subtilis, Escherchiacoli, Pseudomonas aeruginosa* and *Staphylococcus aureus.*[36] Soxhlet extraction was used to obtain the ethanol and the methanol extracts of dried and fresh SG leaves. Extracts of SG were shown averagely successful in inhibiting BS, EC, PA, and SA.[37] Numerous studies have proved the antimicrobial exertion of numerous shops. Studies of Laxmi Taru's antimicrobial exertion thus was confined to antimicrobial conditioning of many bacterias.[38] Ganesh *et al.* showed that the crude methanol and ethanol extracts made from dried and fresh SG leaves have inhibited BS, SA, PA, and EC progress.[39] Kalaiyan *et al.* 2020 reported the antibacterial activity of copper oxide nanostructure from *S. glauca* leaf extract and the best activity was observed against *K. pneumonia,* followed by *S. aureus.*[40]

Antimalarial activity

Research showed that *S. glauca* contains three strong quassinoids that effectively prevented malaria both *in vivo* and *in vitro*. Some quassinoids present in *S. glauca* have shown potent inhibitory activity of a chloroquine resistant Plasmodium falciparum strain.[41] 6α tigloyloxychaparrinone, ailanthone, eurycomanone, isobrucein B, orinocinolid, neosergeolide, pasakbumin B and C, and simalikalactone D have been identified to be major antimalarial production Quassinoids.[42-47]

Antifungal activity

Methanol and ethanol extract of *S. glauca* exihibited antifungal exertion against *Fusarium oxysporum* and *Aspergillus parasiticus.* Ethanolic extracts of fresh leaves were set up to be more effective as compared to the methanolic extracts of the fresh leaves against the growth of the fungi by agar well prolixity system.[48]

Antiulcer activity

Chloroform extract of *S. glauca* showed cure dependent on inhibition of ethanol convinced gastric lesions in albino rats, causing 82.63 protection at 400 mg/kg, and 53.48 protection at 200 mg/kg, Chloroform extract of *S. glauca* also showed cure dependent inhibition of indomethacin convinced gastric lesions in albino rats, causing 62.65 protection at 400 mg/kg and 54.86 protection at 200 mg/kg, Chloroform Extract of the leaves of *S. glauca* dropped the acidity and increased the mucosal concealment. Therefore *S. glauca* flaunting antiulcer exertion.[49]

Hepatoprotective Activity

The hepatoprotective properties of *S. glauca* leaf extracts are retained in ethanolic and chloroform extracts. Some studies reveal that *S. glauca* silver extract can be used for the development of a new remedy of hepatoprotective exertion.[50]

Anticancer Activity

S. glauca contain chemicals having cancer killing parcels. Four quassinoids videlicet ailanthinone, glaucarubinone, dehydroglaucarubinone and holacanthone attributed to the anti-luekemic and anticancer exertion of this condiment. Leaves of *S. glauca* are thought to aid in the fight against cancer. Traditional medical interpreters use of leaf decoction as a cancer cure. The anticancer property of the extract can cure cancer of first and alternate stages, whereas the quality of life improves a lot, in case of cases with third and fourth stages.[51] Another study demonstrated that anti-tumorous exertion of glaucarubinone which is an active constituent present in *S. glauca* is active against solid excrescences (mortal and mouse cell lines), multi-drug-resistant mammary excrescences in mice, and anti-leukemic exertion against leukemia in mice.[52] Bioassay of *S. glauca* redounded in the insulation of one new canthine glucopyranoside, seven known canthine alkaloids (2-8), two known quassinoids (9-10) and a neo lignin.[53] Most of the compounds inhibited the proliferation of an Nf1 and p53 deficient mouse glioma cell line at non cytotoxic attention.[54] There's a notable anticancer exertion in several species within the family of the Simaroubaceae. SG contains compound with properties that suppress excrescences. The condiment's antileukemic and antitumor part has been linked to four Quassinoids videlicet Ailanthinone, Glaucarubinone, Dehydroglaucarubinone, and Holacanthone.[55]

Glaucarubinone has been reported to inhibit pancreatic cancer cell proliferation and migration synergestically with gemcitabine via down regulation of P21 activated kinases.[56] *In vitro* cytotoxicity has been shown against KB cells, similar as glaucarubin, glaucarubinone, glaucarubol, and glaucarubolone by several factors in Quassinoids SG seeds.[57] Quassinoids SG seed ingredients Bruceantin, bruceantinol, glacarubinone and simalikalctone D are among the strongest Quassinoids with this form of antitumor action.[58] Tricaproin isolated from *S. glauca* inhibit colorectal cancer cell growth.[59]

Other uses

SG leaves and bark have long acted in tropical areas as a natural remedy. SG bark for successful malaria and dysentery treatment.[60] Bark is used by another indigenous lineage in the South as an alcohol to treat fever, diarrhea, and malaria, as well as a hemostatic agent to prevent bleeding. It is applied externally to wounds and cuts.[61] The bark is boiled in water and is sometimes used to give a strong tangy and alcohol to cleanse your skin and cure dysentery, diarrhoea, bowel, blood bleeding, and internal bleeding.[62]

SG is a versatile, significant, erratic, and dioecious oil painting crop factory that can produce 2000-2500 kg of oil painting ha/time, piecemeal from being medicinal. About 75% of oil paintings are made from SG kernels, which also include an abundance of logged and stripped fats suitable for both artificial and home use.[63] SG seeds are rich in comestible fat (nearly 60 w/w) used in tropical countries for cuisine. The cutlet from the oil painting birth contains proteins that are used in cattle feed after toxic and bitter compounds have been uprooted.[64] Oleic acid, a important and protean unsaturated adipose acid, used for the manufacture of detergents, cleansers, and lubricants, etc., is set up in SG seed oil painting for 59-65%.[65] Given the reporting of the acute cytotoxicity, phytotoxicity, and sweats to large scale SG propagation of the *Simarouba* quassinoids as an indispensable oil seed crop, it's also justified that the oil painting is routinely tested for mortal consumption.[66] A few studies exist on the use of transesterified paradise oil as a fuel for diesel engine.[67,68]

CONCLUSION

In conclusion, *S. glauca* has remarkable pharmacological qualities, including antioxidant, antibacterial, antipyretic, anti-inflammatory, and antimalarial effects. It has these characteristics because of the high concentration of bioactive compounds such alkaloids, flavonoids, and terpenoids. Despite the fact that *S. glauca* has been utilized for a long time in traditional medical systems, further investigation is required to fully comprehend its modes of action and therapeutic potential. Further research on *S. glauca* may lead to the development of novel medications for the treatment of inflammatory disorders, oxidative stress, and infections.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

SG & *S. glauca*: *Simarouba glauca.*

SUMMARY

Simarouba glauca, often known as the "bitter tree," has shown significant pharmacological importance due to its diverse bioactive compounds. The review paper summarizes its various medicinal properties, including anti-microbial, anti-cancer, and anti-diabetic effects. The plant's active compounds, such as quassinoids and saponins, contribute to its therapeutic potential. Research highlights its promise as a source of natural remedies, emphasizing the need for further studies to fully understand its mechanisms and clinical applications.

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