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THERAPEUTIC POTENTIAL AND DOCUMENTED PHARMACOLOGICAL ACTIVITIES OF SIMAROUBA GLAUCA: A COMPREHENSIVE REVIEW

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Keywords: Simarouba glauca, pharmacological activities, Lakmitaru.

ABSTRACT

Simarouba glauca, commonly known as Lakmitaru or paradise tree, belongs to the family Simaroubaceae. It is traditionally referred to as dysentery Bark due to its well-known use against dysentery. The plant is native to Southern Florida, the West indies and Brazil. In India, Simarouba *glauca* is traditionally used for the treatment of Helminthic infection, dysentery, hypotension, cancer and diabetes. The plant has demonstrated various pharmacological activities, including antibacterial, antifungal, antioxidant, anticancer, anti-proliferation and pro-apoptotic activity, anti- inflammation, antimicrobial, antimalarial, anti-amoebic, antiulcer, hepatoprotective, reducing patchy skin saturation, haemolytic, acaricidal, hypertensive, antidysentery, analgesic and anti-leukemic activities. This review aims to highlight the pharmacological activities of various parts of *Simarouba glauca* and to serve as a valuable foundation for future research endeavours.

1. INTRODUCTION

Simarouba glauca, commonly known as '**Lakmitaru**' or '**Paradise tree'** belongs to family Simaroubaceae. It is indigenous to Southern Florida, the West Indies and Brazil, and is considered exotic in countries like India, Sri Lanka, the Philippines, and Myanmar. It was first introduced by National Bureau of Plant Genetic Resources in the research station at Amravati in Maharashtra in 1966 and later to the university of Agricultural Sciences, Bangalore in 1986. Ethnomedicinal claim of *Simarouba glauca* include the use of a decoction of leaf powder to treat cancer by the Paniyas Tribes of Wayanad district, Kerala and by communities in Shimoha, Karnataka. In Cuban folk medicine, the leaves are used for helminthic infection, dysentery and to exert hypotensive action. Phytochemical survey reported the presence of alkaloid, flavonoid, terpenoid, anthraquinone, steroids, phenol, saponin, tannin, carbohydrate and oil. It exhibited antibacterial, antifungal, antioxidant, anticancer, anti-proliferation and pro-apoptotic avtivity, anti-inflammation, antimicrobial, antimalarial, antiamoebic,

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antiulcer, hepatoprotective, reducing patchy skin saturation, haemolytic, acaricidal, hypertensive, antidysenteric, analgesic and anti-leukemic activities. This review aims to highlight the pharmacological activities of various parts of *Simarouba glauca* and to serve as a valuable foundation for future research endeavours.

2. PLANT PROFILE



COMMON NAME: Paradise tree, Dysentery bark, Bitter ash, bitter damson princess tree, Bitter wood.

FAMILY: Simaroubaceae

SYNONYMS: *Quassia glauca, Simarouba medicinalis, Simarouba officinalis.*

VERNAKULAR NAME

Hindi : Lakmitaru
Malayalam: Lakshmi tharu
Tamil : Shorgum maram

TAXONAMICAL CLASSIFICATION

Kingdom : Plantae
Order : Sapindales
Family : Simaroubaceae
Genus : Simarouba
Species : glauca

3.PHARMACOLOGICAL ACTIVITIES LEAF

- **Alpha-Glucosidase Inhibitory Activity**

Kiran P. et al. (2020) studied the alpha-glucosidase inhibitory activity of *Simarouba glauca* fraction in vitro, in silico, and through kinetic studies. The purified fraction, named Fraction-14, exhibited significant inhibition of yeast alpha-glucosidase enzyme (IC_{50} = 2.4 µg/mL) compared to the anti-diabetic drug acarbose (IC_{50} = 2450 ± 24 µg/mL). The kinetic study of Fraction-14 indicated a mixed-type inhibition of alpha-glucosidase with K_m = 6.2 µg/mL. Molecular docking revealed stronger binding energy for the active compounds (-7.769 kJ/mol, -7.04 kJ/mol, and -7.127 kJ/mol) compared to acarbose (-6.867 kJ/mol).

Anu Paul and Newly Joseph (2022) conducted Phytochemical screening of aqueous and chloroform extracts of Lakshmi taru *(Simarouba glauca)* leaves was conducted. Anti-cancer potential was evaluated through molecular docking using software tools like Autodock, PyMOL, and Open Babel. The anti-diabetic activity was assessed via alpha-amylase inhibition assay using ethanol extracts at various concentrations. The highest inhibition (83%) was observed at 150 µL of ethanol extract, indicating significant anti-diabetic potential.

- **Antidiabetic and Antioxidant Activity**

Abdullah N. T. et al. (2019) screened *Simarouba glauca* extracts for antidiabetic

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and antioxidant activities in STZ-induced diabetic rats. The methanolic leaf extract significantly reduced blood glucose levels and improved lipid profiles, SGOT, and SGPT levels in diabetic rats. Histopathological studies of the pancreas and liver showed improved β-cell mass and reduced damage. In diabetic rats treated with *S. glauca*, HbA1c levels were reduced from 6.2% to 2.6%, and the diabetic control group showed an increase of 14.83%. The pre-treated group showed only a 10.42% increase, indicating preventive effects. The extract significantly improved antioxidant activity, reducing oxidative stress-related damage.

➢ **Nephroprotective Activity**

Abdullah N. T. et al. (2018) studied the nephrotoxicity effects of *Simarouba glauca* in rats, evaluating serum urea, creatinine, BUN, total protein, phosphorus, and glucose levels. Histopathological studies showed that in diabetic rats treated with *S. glauca*, there was a significant reduction in elevated serum urea, creatinine, and kidney damage compared to untreated rats. The study concluded that *simarouba glauca* administration significantly prevented renal damage and had a protective effect against nephrotoxicity related complications.

➢ **Anti-inflammatory Activity**

Nawres Taha Abdullah et al., (2018) screened the methanolic extract of *Simarouba glauca* was evaluated for anti-inflammatory activity using a formaldehyde-induced paw edema model in Wistar rats. Leaves were shade-dried, powdered, and extracted with 90% methanol via reflux. Preliminary phytochemical and acute toxicity studies were conducted. Inflammation was induced with 4% formaldehyde. Group 1 was the control, Group 2 was disease control, Group 3 received Diclofenac (10 mg/kg), and Groups 4 and 5 received Simarouba glauca extract (250 mg/kg and 500 mg/kg, respectively). Using a plethysmometer, results showed that the extract significantly reduced paw edema, indicating strong anti-inflammatory effects.

Svenia Periyapurath Jose et al., (2023) isolated and characterized squalene (SQ), a triterpenoid from *Simarouba glauca*, using FT-IR and NMR. In an anti-inflammatory study, rats were divided into five groups, including a control, carrageenan-only, SQ + carrageenan, and diclofenac + carrageenan groups. SQ (5.0 mg/kg) was identified as the minimum effective dose for maximum edema inhibition. Three hours after carrageenan injection, significant reductions ($p < 0.05$) were observed in inflammatory markers (TNF-α, IL-6, PGE-2, NO, COX-2, TBARS, MPO), while antioxidant enzymes (SOD, catalase, GPx) significantly increased, indicating strong anti-inflammatory and antioxidant activity of SQ.

Antony J et al. (2017) investigated the in vivo anti-inflammatory activity of the ethanolic extract of *Simarouba glauca* leaves using the croton oil-induced ear edema model in mice. Topical application of croton oil caused significant ear swelling, which was reduced upon treatment with the extract at concentrations

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of 1%, 3%, and 5%, showing inhibition of 23.53%, 45.92%, and 59.79%, respectively. The standard drug, dexamethasone cream, showed 72.64% inhibition. The study concluded that the ethanolic extract exhibited significant anti-inflammatory activity, with the highest dose (5%) demonstrating effects comparable to the standard treatment.

➢ **Anti-inflammatory bowel disease**

G. Ariharasivakumar et al. (2020) evaluated the anti-inflammatory and antioxidant effects of *Simarouba glauca* leaf extracts, EASG and CHSG, on experimentally induced Inflammatory Bowel Disease (IBD) in Wistar rats. The extracts were analysed for phytochemicals, including flavonoids, phenols, and β-sitosterol, and their antioxidant potential was assessed using DPPH and ABTS assays. In vivo, rats were treated with indomethacin to induce IBD and pretreated with the extracts or standard drug (prednisolone). Results showed that both EASG and CHSG extracts, at 400mg/kg, significantly reduced inflammation, as indicated by improved macroscopic scoring and reduced myeloperoxidase (MPO) levels. Histopathological studies further confirmed reduced tissue damage. The extracts also enhanced antioxidant activities in intestinal tissue, increasing Superoxide Dismutase (SOD), Catalase (CAT), and Glutathione Peroxidase (GPx) levels while reducing lipid peroxidation and increasing reduced Glutathione (GSH) levels. In vitro, both extracts showed significant cytoprotective effects against cell damage in Caco-2 cells. The study concluded that EASG and CHSG have significant anti-inflammatory activity, likely due to the presence of β-sitosterol and potent antioxidants like phenols and flavonoids.

➢ **Anthelmintic Activity**

Fahmida Jabi et al., (2023) evaluated the anthelmintic activity of *Simarouba glauca* was evaluated using petroleum ether, ethanol, ethyl acetate, and water extracts against Pheretima posthuma worms. Activity was measured based on the time taken for paralysis and death. The ethanolic extract showed the most potent effect, with paralysis at 22.33 minutes and death at 31.56 minutes, compared to the standard drug Albendazole (15 mg/ml), which showed paralysis and death at 38.28 and 46.21 minutes, respectively. This indicates significant anthelmintic potential of the ethanolic extract.

➢ **Anti-nematodal Activity**

P. G. Kavitha et al., (2023) investigated the methanolic leaf extract of *Simarouba glauca* demonstrated significant nematocidal activity against Meloidogyne incognita (root-knot nematode) in vitro at concentrations of 100%, 50%, and 25%. At 100% concentration, it showed the lowest egg hatching rates and highest juvenile mortality-up to 92.58% after 72 hours. GC-MS analysis identified active phytochemicals like hexadecanoic acid-methyl ester and methyl stearate responsible for the effect. Pot and field studies confirmed that soil application of S.

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glauca leaf powder (10 g/plant or 5 kg/ha) effectively reduced nematode infestation in vegetables.

➢ **Anti-protozoal activity**

Marley Garcia et al. (2012) conducted a study to evaluate the antileishmanial activity of Cuban plant extracts against Leishmania amazonensis, targeting both promastigote and intracellular amastigote forms. In the antipromastigote screening, 20 plant extracts were tested using an MTT-based colorimetric assay at concentrations ranging from 6.25 to 100 µg/mL. All extracts showed activity with IC_{50} values ≤ 100 µg/mL. Among them, only four extracts- Bambusa vulgaris, Hura crepitans, Mangifera indica, and *Simarouba glauca*- demonstrated selective activity and were evaluated further against intracellular amastigotes. Of these, three extracts showed significant inhibition with IC_{50} values ≤ 50 µg/mL. Hura crepitans exhibited the most potent activity (IC_{50} = 27.7 ± 0.6 µg/mL), followed by Bambusa vulgaris (IC_{50} = 41.5 ± 0.6 µg/mL) and Simarouba glauca (IC_{50} = 47.5 ± 0.0 µg/mL). The extract of Mangifera indica showed lower potency (IC_{50} = 60.1 ± 3.3 µg/mL). Additionally, Simarouba glauca showed a cytotoxic concentration (CC_{50}) of 228.7 ± 8.0 µg/mL against BALB/c mice peritoneal macrophages, resulting in a selectivity index (SI) of 5.

➢ **Antimicrobial Activity**

Aymé Fernández-Calienes Valdés et al. (2008) conducted an in vitro antimicrobial study on ethanol extracts of *Simarouba glauca*, Melaleuca leucadendron, and Artemisia absinthium. Simarouba glauca showed strong, broad-spectrum antiprotozoal activity against Trypanosoma b. brucei, T. cruzi, Leishmania infantum, and Plasmodium falciparum, with IC_{50} values below 3 µg/mL, though its activity was considered non-specific. Among antifungal tests, *S. glauca* also showed the highest inhibitory effect against Microsporum canis (IC_{50} = 2 µg/mL). While M. leucadendron exhibited selective antimicrobial activity, S. glauca stood out for its potent, albeit non-specific, antimicrobial and antifungal properties.

Soumya KK and Padma Nambisan et al., (2018) conducted a scanning electron microscopic evaluation to assess the in vitro antimicrobial activity of *Simarouba glauca* leaf extract. The dried leaves of the plant were extracted using solvents of varying polarity (hexane, chloroform, ethyl acetate, 70% acetone, methanol, and water). Antibacterial activity was assessed via disc diffusion and MIC methods against pathogens including Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumoniae, Salmonella typhimurium, Escherichia coli, and Proteus vulgaris. The methanol extract showed the highest phenolic content (95.32 ± 1.6 mg/g) and potent antioxidant activity with an IC_{50} of 10 µg. Scanning electron microscopy at MIC levels confirmed cell damage or reduction in bacterial count.

KS Ramya et al. (2019) investigated the antimicrobial activity of various solvent extracts of *Simarouba glauca* leaves against three clinically important bacterial

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strains—Pseudomonas aeruginosa, Salmonella typhi, and Salmonella paratyphi—as well as two fungal strains, Fusarium oxysporum and Sclerotium rolfsii. The microbial cultures were obtained from Tamil Nadu Agricultural University, Coimbatore. The antibacterial activity was assessed using the well diffusion method with ampicillin (5 mg/mL) as the positive control. Among the tested extracts, the methanol extract showed the highest antibacterial activity, with zones of inhibition at 250 µL measuring 22 ± 2.1 mm for P. aeruginosa, 19 ± 1.5 mm for S. typhi, and 16 ± 3.7 mm for S. paratyphi, all exceeding or comparable to the standard drug. The chloroform extract also demonstrated notable activity, recording inhibition zones of 18 ± 2.1 mm for P. aeruginosa, 18 ± 2 mm for S. typhi, and 19 ± 0.5 mm for S. paratyphi. Ethyl acetate extract exhibited moderate activity, with inhibition zones of 17 ± 1.5 mm, 18 ± 2 mm, and 14 ± 1.5 mm against the same bacteria, respectively.

B. Karthikeyan, et, al., (2019) study evaluated the antimicrobial activity of *Simarouba glauca* leaf extracts (cold water, hot water, ethanol, and methanol) against three bacterial species: Bacillus subtilis, Staphylococcus aureus, and Streptococcus species at concentrations of 250, 500, and 1000 ppm. Cold water extracts showed moderate activity, with the highest inhibition (17 mm) observed in cold water fresh leaf extract against B. subtilis at 1000 ppm. Hot water extracts exhibited slightly lower activity, with maximum inhibition of 6.50 mm for S. aureus. Ethanol extracts demonstrated significant antibacterial activity, especially the ethanol fresh leaves extract showing 18 mm inhibition against B. subtilis at 1000 ppm. Methanol extracts also exhibited potent antibacterial activity, with methanol fresh leaves extract showing 15.50 mm inhibition against B. subtilis and 8.20 mm against S. aureus at 1000 ppm. Overall, ethanol and methanol extracts, particularly from fresh leaves, were more effective compared to aqueous extracts, indicating that organic solvents enhance the extraction of bioactive antimicrobial compounds from S. glauca.

Sushma Rudraswamy et al., (2023) investigated the antimicrobial potential of *Simarouba glauca* (SG) leaf extracts against oral biofilm-causing pathogens. Ethanolic (ESG) and aqueous (ASG) extracts were prepared and tested against Streptococcus mutans, Lactobacillus acidophilus, Staphylococcus aureus, Escherichia coli, and Porphyromonas gingivalis using agar well diffusion and broth dilution methods. ESG showed significant inhibition zones for S. mutans (25 mm) and L. acidophilus (23 mm) at 1 mg/mL, while ASG showed moderate activity against E. coli (14 mm) and S. aureus (15 mm) at 1.5 mg/mL. Neither extract was effective against P. gingivalis. MIC values ranged from 0.312 to 1.25 mg/mL for the sensitive bacteria.

Adithya S.B. et al. (2023) investigated the antimicrobial potential of *Simarouba glauca* leaf methanolic extract against antibiotic-resistant Escherichia coli isolated from environmental sources. The E. coli strains were confirmed through

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biochemical and molecular analysis. The extract was prepared and its phytochemical composition confirmed by TLC. Using the agar diffusion method, the study demonstrated that the methanolic extract of S. glauca exhibited strong antimicrobial activity against antibiotic-resistant E. coli, suggesting its potential as a natural alternative for combating resistant bacterial strains.

- **Antimicrobial, Antioxidant, and Anticancer Activity**

Shanmuga Priya Ramasamy et al., (2022) conducted broad-spectrum antimicrobial, antioxidant, and anticancer studies on *Simarouba glauca* leaf extract. The antimicrobial activity and minimum inhibitory concentration (MIC) were evaluated against 14 bacterial and 16 fungal strains. The ethanolic and methanolic extracts exhibited exclusive activity against Staphylococcus aureus and showed significant inhibition against Escherichia coli and Serratia marcescens. The methanolic extract displayed the highest antioxidant potential compared to the ethanolic extract. Additionally, the methanolic extract of S. glauca exhibited significant cytotoxicity against the MCF-7 breast cancer cell line, with an IC_{50} value of 16.12 µg/mL.

- **Antibacterial activity**

Armando Caceres et al. (1990) conducted an in vitro screening of 84 medicinal plants used in Guatemala for gastrointestinal disorders against five pathogenic enterobacteria: Escherichia coli, Salmonella enteritidis, Salmonella typhi, Shigella dysenteriae, and Shigella flexneri. Results showed that 34 plants (40.48%) inhibited one or more bacteria, with Salmonella typhi being the most frequently inhibited (33.73%) and E. coli the most resistant (7.35%).

B. L. Jangale et al. (2012) investigated the antibacterial activity of *Simarouba glauca* leaf extracts (ethanol and methanol) from both fresh and dried leaves against foodborne pathogens (Staphylococcus aureus, Escherichia coli) and spoilage organisms (Bacillus subtilis, Pseudomonas aeruginosa). Using the well diffusion assay, all extracts showed inhibitory activity against the tested bacteria, with the highest zone of inhibition (11 mm) observed for the fresh leaves methanol (FLM) extract against E. coli, and the lowest (2 mm) for FLM against B. subtilis. MIC values were determined by agar dilution, with FLM extract showing the most potent activity—B. subtilis was inhibited at just 160 ppm, followed by S. aureus at 640 ppm, and P. aeruginosa at 2560 ppm. In contrast, other extracts like dried leaf methanol (DLM), dried leaf ethanol (DLE), and fresh leaf ethanol (FLE) showed antimicrobial activity only at higher concentrations, with MICs of 2560 ppm or more. Overall, the FLM extract exhibited the strongest antibacterial potential, particularly against B. subtilis.

Sneha Kochath Santhosh et al. (2016) evaluated the antibacterial activity of *Simarouba glauca* extracts using the disc diffusion method against Staphylococcus, Salmonella, Bacillus, Klebsiella,

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Pseudomonas species, and Escherichia coli. Discs infused with varying concentrations (250, 500, 750, 1000 µg/mL) of ethyl acetate and petroleum ether extracts were placed on Muller Hinton agar plates inoculated with bacterial cultures. After incubation at 37°C for 16–18 hours, no antibacterial activity (i.e., no zone of inhibition) was observed for either extract against any of the tested bacteria.

- **Antibacterial, Antioxidant, Haemolytic, and Thrombolytic Activity**

K. Santhana Lakshmi et al., (2014) investigated the in vitro antibacterial, antioxidant, haemolytic, and thrombolytic activities of *Simarouba glauca* leaf extract. Three extracts (chloroform, methanol, and ethyl acetate) were screened for antibacterial activity against five pathogenic microorganisms using the well-diffusion method. The antioxidant activity of the extracts was assessed using an H_2O_2 radical scavenging assay. Haemolytic activity was determined through agar diffusion techniques, while thrombolytic activity was evaluated via clot disruption and phytochemical profiling. The methanolic extract exhibited significant antimicrobial activity, with an IC_{50} value of 6.72 ± 0.1 µg/mL. Haemolytic activity was highest in the ethyl acetate extract, while thrombolytic activity was strongest in the chloroform extract, showing 34.86% clot lysis, comparable to streptokinase.

- **Antifungal Activity**

Khaling Mikawlrawng et al. (2014) studied the comparative in vitro antifungal activities of *Simarouba glauca* against Fusarium oxysporum and Aspergillus parasiticus. Methanolic and ethanolic extracts from both fresh and dried leaves were tested for antifungal activity using the well diffusion assay. The results showed strong inhibition of both fungal species, with ethanolic extracts being more effective than methanolic extracts. Additionally, the study revealed that *Simarouba glauca* leaf extracts were more effective against Aspergillus parasiticus than Fusarium oxysporum. The zone of inhibition (in millimeters) for each extract was as follows: ethanolic extracts of fresh leaves (EF) showed 6.24 mm against Fusarium oxysporum and 11.60 mm against Aspergillus parasiticus; ethanolic extracts of dried leaves (ED) showed 2.52 mm against Fusarium oxysporum and 9.10 mm against Aspergillus parasiticus; methanolic extracts of fresh leaves (MF) showed 11.10 mm against Fusarium oxysporum and 5.50 mm against Aspergillus parasiticus; and methanolic extracts of dried leaves (MD) showed 1.50 mm against Fusarium oxysporum and 11.30 mm against Aspergillus parasiticus.

Sandeep Kaushik et al. (2014) investigated the in vitro antifungal activity of *Simarouba glauca* leaf extracts against Aspergillus parasiticus, a known aflatoxin-producing fungus. Using the well diffusion assay, both methanolic and ethanolic extracts from fresh and dried leaves were tested. The results showed that ethanolic

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extracts exhibited greater antifungal efficacy than methanolic extracts. Among all samples, the ethanolic extract of fresh leaves showed the highest zone of inhibition (12.10±1.00 mm), followed closely by the methanolic extract of dried leaves (11.40±0.10 mm), indicating promising antifungal potential of *Simarouba glauca* leaf extracts.

- **Anti-Ulcer Activity**

Dr. Shankara Sharma et al. (2014) investigated the acute toxicity and anti-ulcer activity of chloroform extract of *Simarouba glauca* in rats, revealing no signs of toxicity up to 2000 mg/kg body weight as per OECD guidelines, indicating its safety for therapeutic use. The study demonstrated that the chloroform extract exhibited significant dose-dependent anti-ulcer activity in both ethanol- and indomethacin-induced ulcer models. In the ethanol-induced model, the extract showed 53.48% and 82.63% protection at doses of 200 and 400 mg/kg, respectively, while in the indomethacin-induced model, it showed 54.86% and 62.65% protection at the same doses. These effects were comparable to the standard drug Omeprazole, which provided 83.85% and 75.79% protection in ethanol- and indomethacin-induced ulcers, respectively, at a dose of 20 mg/kg.

Ridahunlang N. (2016), in a doctoral dissertation at KMCH College of Pharmacy, evaluated the therapeutic potential of *Simarouba glauca* leaf extracts on experimentally induced inflammatory bowel diseases (IBD) in Wistar rats using two models: indomethacin-induced and acetic acid-induced enterocolitis. Indomethacin, a non-selective COX inhibitor, induces enterocolitis resembling Crohn's disease, characterized by ulcers, wall thickening, inflammation, and oxidative stress. Acetic acid causes non-transmural inflammation mimicking human colitis, leading to mucosal necrosis and ulceration due to intracellular acidification. In the indomethacin model, rats treated with ethanolic (EASG) and chloroform (CHSG) extracts of *Simarouba glauca* showed improved body weight recovery compared to the control group, indicating a protective effect. Similarly, in the acetic acid model, both EASG and CHSG treated groups showed significant weight gain and mucosal protection, with better outcomes than untreated controls.

- **Cardioprotective Activity**

Lolita Prima Fernandes et al. (2016) demonstrated the cardioprotective effects of *Simarouba glauca* leaf extract in cyclophosphamide (CYP)-induced cardiotoxicity in rats. CYP administration significantly altered ECG parameters, increased cardiac injury markers (CK-MB, CK-NAC, LDH), and impaired antioxidant status (reduced SOD and catalase, increased lipid peroxidation). Treatment with S. glauca, especially at 400 mg/kg, significantly improved ECG values, reduced cardiac biomarkers, and enhanced antioxidant enzyme levels, indicating its strong cardioprotective and antioxidant potential.

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➢ **Antihypertensive Activity**

Sammy Devies F et al., (2023) conducted a preliminary investigation into the blood pressure-lowering potential of the aqueous leaf extract of *Simarouba glauca* (AESG) in normotensive adult Wistar rats.Under anesthesia, rats were administered AESG intravenously at doses of 2.5 and 5.0 mg/kg, and changes in blood pressure were recorded. The extract produced a dose-dependent reduction in blood pressure. At 2.5 mg/kg, there was a moderate decrease in systolic (122.00 ± 1.15 mmHg), diastolic (84.67 ± 2.40 mmHg), and mean arterial pressure (97.10 ± 1.99 mmHg). A more pronounced reduction was observed at 5.0 mg/kg, with systolic, diastolic, and mean arterial pressures significantly dropping to 84.00 ± 2.31 mmHg, 62.67 ± 1.45 mmHg, and 69.80 ± 1.73 mmHg, respectively.

Sammy Davies Edoho Osagie-Eweka et al., (2024) studied the prophylactic antihypertensive effects of *Simarouba glauca* extracts on salt-load-induced hypertension in normotensive male Wistar rats. Body weight and relevant hemodynamic parameters were obtained weekly for four weeks using the non-invasive (tail-cuff) MRBP system, as described by Bunag and Butterfield. The results indicated that salt-loading elicited significant weight loss and altered hemodynamics, particularly systolic and diastolic blood pressure, affecting relevant biochemical indicators of hepatic and renal functions. However, groups pre-treated with respective doses of AESG exponentially gained weight, significantly preventing alterations in hemodynamics and mitigating relevant biochemical indicators and pathological changes in relevant organs. Pre-treatment with AESG, particularly at 50 mg/kg², remarkably demonstrated significant antihypertensive potential.

➢ **Dyslipidaemia and Oxidative Stress**

Osagie-Eweka et al., (2021) studied the effects of ethanol leaf extract of *Simarouba glauca* on induced dyslipidaemia and oxidative stress. The data show a marked reduction in HDL cholesterol and triglyceride (TG) levels at all doses ($P<0.05$). A significant increase ($P<0.05$) in HDL cholesterol was observed at EESG 500 and 1000 mg/kg. Furthermore, the data indicated a significant ($P<0.05$) elevation in heart MDA levels at 500 mg/kg. The liver and kidney CAT activities were elevated ($P<0.05$) at EESG 1000 mg/kg, 500 mg/kg, and 2000 mg/kg, respectively. Liver and kidney SOD activity increased ($P<0.05$) at 2000 mg/kg, 500 mg/kg, and 1000 mg/kg. The liver GSH-Px was elevated ($P<0.05$) at 2000 mg/kg. The increased activity of endogenous defence enzyme systems may have resulted from cytochrome P-450/NADPH oxidase-induced oxidative stress linked to xenobiotic metabolism.

➢ **Anti-Arthritic Activity**

Dr. Hannah Elizabeth et al. (2023) investigated the anti-arthritic activity of ethanolic extract of *Simarouba glauca* leaves using the Bovine Serum Protein (BSP) denaturation method. The extract was prepared from 1 kg of dry leaf powder using a Soxhlet apparatus. The in-vitro

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study tested concentrations ranging from 10 to 1000 µg/ml, showing a dose-dependent inhibition of protein denaturation, with a maximum inhibition of 73.84% at 1000 µg/ml. This was compared to the standard drug Diclofenac sodium, which showed 84.95% inhibition at the same concentration.

➢ **Anti-Obesity Activity**

Sweta Gupta et al. (2023) evaluated the anti-obesity potential of *Simarouba glauca* leaf extract using in-vitro assays on the 3T3-L1 cell line. Extracts were prepared using ethanol, methanol, and hydro alcohol via Soxhlet extraction, followed by Rota evaporation. Anti-obesity activity was assessed through lipase inhibition, amylase inhibition, Oil Red O staining, and MTT cytotoxicity assays. Among the three, the ethanol extract showed the most promising anti-obesity effects, comparable to the standard drug orlistat, particularly in lipase and amylase inhibition as well as lipid accumulation reduction in adipocytes.

➢ **Hepatoprotective Activity**

Preethu P et al. (2016) investigated the hepatoprotective activity of ethanolic and chloroform extracts of *Simarouba glauca* leaves against paracetamol-induced liver damage in rats. The study measured liver function markers such as SGPT, SGOT, and ALP. Paracetamol significantly elevated these enzymes, indicating liver injury. However, pre-treatment with both extracts at 200 mg/kg and 400 mg/kg doses significantly reduced enzyme levels, showing dose-dependent hepatoprotection. The 400 mg/kg ethanol extract was especially effective, with SGPT, SGOT, and ALP levels reduced to 53.23±1.11, 94.40±0.942, and 55.46±1.06, respectively, closely approaching the standard silymarin-treated group. Histological analysis also confirmed reduced liver damage, highlighting the hepatoprotective potential of *Simarouba glauca* extracts.

➢ **Antioxidant Activity**

Sneha Kochath Santhosh et al. (2016) evaluated the antioxidant activity of *Simarouba glauca* using total antioxidant, hydroxyl radical scavenging, and DPPH assays. Both ethyl acetate and petroleum ether extracts exhibited dose-dependent antioxidant effects. The ethyl acetate extracts consistently showed stronger activity with lower IC_{50} values (1000 µg, 1120 µg, and 1200 µg across the three assays) compared to petroleum ether extract (2000 µg, 1320 µg, and 1280 µg). However, Vitamin C demonstrated the highest antioxidant potency with the lowest IC_{50} (700 µg) in all assays.

Anu Gopalakrishnan et al. (2016) evaluated the in vitro antioxidant activity of the chloroform soluble fraction (CSF) of *Simarouba glauca* leaf extract using superoxide and nitric oxide radical scavenging assays. The CSF exhibited dose-dependent free radical scavenging activity, comparable to vitamin C. At 500 µg/mL, CSF inhibited 95.30% of superoxide and 82.56% of nitric oxide radicals, while vitamin C showed 97.03% and 79.08% inhibition, respectively. The EC_{50} values for CSF were 35.12 ± 4.02

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µg/mL for superoxide and 46.05 ± 7.09 µg/mL for nitric oxide scavenging, demonstrating significant antioxidant potential.

Ramesh J et al. (2017) conducted a GC-MS analysis and antioxidant activity study of *Simarouba glauca* leaf ethanolic extract. Quantitative analysis revealed the presence of vitamins A, B1, B2, B3, and C. The extract exhibited notable DPPH free radical scavenging activity, with increasing inhibition from 21.37% at 20 µg/mL to 87.28% at 100 µg/mL, and an IC_{50} value of 51.50 µg/mL. Compared to the standard ascorbic acid (IC_{50} = 46.0 µg/mL), the extract showed good antioxidant potential, indicating its efficacy as a natural source of antioxidants.

- **Antioxidant and Antiproliferative and Anti-haemolytic Activity**

Amulya Giridasappa et al. (2021) investigated the antioxidant, antiproliferative, antibacterial, and anti-hemolytic properties of silver nanoparticles (AgNPs) synthesized using *Simarouba glauca* (Ag-SG) and Celastrus paniculatus (Ag-CP) extracts. The AgNPs, confirmed to be spherical (~40 nm) through FTIR, XRD, SEM-EDX, and TEM analyses, exhibited strong antioxidant activity (notably Ag-SG with DPPH IC_{50} of 34.01 ± 0.64 µg/mL), antibacterial effects against gram-positive and gram-negative bacteria, and selective cytotoxicity against cancer cells (MCF-7 and HT-29) without harming normal breast epithelial cells (MCF-10A). Ag-SG showed a higher inhibitory effect on MCF-7 cells (IC_{50} = 70.84 ± 0.67 µg/mL). Apoptotic features such as nuclear fragmentation were validated by AO-EB dual staining.

- **Antioxidant and Anticancer Activity**

T.G. Umesh (2015) conducted a comprehensive study on the in vitro antioxidant potential, free radical scavenging, and cytotoxic activity of *Simarouba glauca* leaf extracts using methanol, ethanol, and water as solvents. The phytochemical analysis revealed the presence of 0.14–0.18% flavonoids, 250–400 µg/mg phenolics, and 67–200 µg/mg tannins. Antioxidant properties were assessed using FRAP, phosphomolybdenum, ferric ferrozine, DPPH, reducing power, and iron chelation assays. The extracts demonstrated strong reducing power (EC50: 57–61 µg/ml), significant DPPH radical scavenging activity (IC50: 9–13 µg/ml), and iron chelation activity, especially in the aqueous extract (IC50: 332 µg/ml). Methanolic extracts showed high antioxidant potential in FRAP and phosphomolybdenum assays, while the aqueous extract exhibited superior activity in the ferric ferrozine assay (580 µg AAE/mg extract). Cytotoxic studies using the MTT assay revealed that the methanolic extract had strong cytotoxicity against the SCC9 cancer cell line and moderate activity against HCT116 cells.

Sridevi I et al. (2017) evaluated the in vitro antioxidant and anticancer activity of *Simarouba glauca* leaf extracts against T-24 bladder cancer cell lines. Various extracts (chloroform, ethyl acetate, methanol, ethanol, aqueous, and hydroalcoholic) were

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prepared using Soxhlet extraction. Antioxidant potential was assessed using DPPH, FRAP, and ABTS assays, with hydroalcoholic extract showing high phenolic content (92.38 ± 0.29 mg/g GAE) and significant radical scavenging activity. The methanol and ethanol extracts exhibited the highest antioxidant activities, comparable to ascorbic acid. Among all extracts, the ethanol extract showed the strongest anticancer effect on T-24 cell lines with an IC_{50} of 533.55 ± 25.02 µg/mL, whereas the standard drug doxorubicin had an IC_{50} of 0.16 µM/mL.

- **Toxicity Assessment Study**

Sammy Davies E et al. (2019) conducted a toxicity assessment of methanolic leaf extract of *Simarouba glauca* (MESG) on kidney function in Wistar rats over a 30-day period. The study involved oral administration of MESG at doses of 500, 1000, and 2000 mg/kg. Results showed a significant elevation ($P < 0.05$) in plasma urea levels only at 1000 mg/kg, while creatinine levels remained unchanged across all doses. Plasma sodium levels significantly decreased at 500 and 2000 mg/kg, but not at 1000 mg/kg, and chloride levels were significantly reduced only at 500 mg/kg. No significant differences were observed in potassium ion levels across all groups. Unbound calcium levels significantly increased at 500 and 2000 mg/kg but showed no significant change at 1000 mg/kg. Although plasma bicarbonate (HCO_3^-) levels decreased across all treated groups, the reductions were not statistically significant. Overall, the findings suggest that while MESG did not cause major toxicity, certain doses may affect kidney function parameters and electrolyte balance, indicating a need for cautious dose consideration.

- **Oral Acute and Sub-Chronic Toxicity Study**

Sammy Davies E. et al. (2020) evaluated the oral acute and sub-chronic toxicity of ethanol leaf extract of inhibition. Key compounds include canthine-6-one, 9-hydroxy canthin-6-one, and glaucarubinone. Canthine-6-one suppresses cell proliferation by reducing BrdU incorporation, causes G2/M cell cycle arrest, and inhibits AKT phosphorylation, reducing cancer cell survival. 9-hydroxy canthin-6-one disrupts the Wnt signaling pathway by inhibiting GSK3β and β-catenin, which are associated with tumor development. Glaucarubinone downregulates PAKs and HIF-1α, inhibits drug efflux by targeting ABC transporters, and induces apoptosis through the activation of Bax, caspase-9, and p53.

Shaji E. Mathew et al. (2019) evaluated the cytotoxic and antitumor efficacy of the methanolic leaf extract (ME) of *Simarouba glauca*. The extract showed low cytotoxicity towards both cancer and normal cells ($IC_{50} > 100$ µg/mL), with high cell viability in HepG2 (79.78%), HeLa (81.42%), HCT15 (89.61%), and Vero (81.63%) cell lines at 100 µg/mL. Acute toxicity studies in female Wistar rats indicated that the extract was safe at doses above 2 mg/kg. In an ascites tumor model, the extract moderately increased mean

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survival days and lifespan percentage in mice treated with 200 mg/kg (20.17 days, 11.01%) and 400 mg/kg (19.83 days, 9.17%) compared to the control (18.17 days). Pre-treatment groups showed a greater increase in lifespan—13.76% and 19.27% for 200 mg/kg and 400 mg/kg doses, respectively.

Biba Vikas, et al., (2021) studied the apoptotic properties of the leaf extract of *Simarouba glauca* against human leukemia cancer cells using an MTT assay. The study revealed that petroleum ether extract exhibited the highest in vitro anticancer activity. The petroleum ether extracts strongly inhibited the proliferation of K562 cells, with an IC50 value of 186 µg/mL. Dual acridine orange/ethidium bromide fluorescence staining and Hoechst staining revealed apoptotic features. Annexin V confirmed early and late-stage apoptosis, while Caspase-3 analysis indicated that cell death occurred due to mitochondrial or death receptor activation in the mitochondrial pathway.

Mahesh CD, et al., (2021) investigated the in vitro anticancer activities *of Simarouba glauca* aqueous extract leaves in an Ehrlich Ascites Carcinoma (EAC) model in mice. The study showed that an aqueous extract of *S. glauca* DC leaves (500 mg/kg, p.o.) significantly increased lifespan compared to the control group. 5-Fluorouracil (20 mg/kg, p.o.) was used as a positive control. The extract altered hematological parameters, increasing hemoglobin content while decreasing RBC and WBC counts relative to the cancer control group. In conclusion, *S. glauca* DC leaves (500 mg/kg, p.o.) demonstrated anticancer activity against EAC-induced carcinoma in mice.

Omar Sadik Shalal and Sajjad Mohsin Irayyif (2022) evaluated the cytotoxic and apoptotic effects of *Simarouba glauca* methanol extract on PC-3 prostate cancer cell lines in a cross-sectional study conducted at the Iraqi Centre for Genetic and Cancer Research. Using concentrations of 0.29, 29, and 290 µg/mL, the extract induced significant cytotoxicity, with an IC_{50} of 35.24 ± 0.23 µg/mL compared to 15.31 ± 1.83 µg/mL for the positive control (rifampicin). The extract significantly promoted early apoptosis and mitochondrial membrane depolarization in PC-3 cells ($p < 0.05$). Additionally, it downregulated the expression of VEGF-A and ALOX5 genes by 5-fold and 4-fold, respectively, indicating its potential anti-cancer properties.

Santhosh Mallikarjun Bhavi, et al., (2024) studied biogenic silver nanoparticles from *Simarouba glauca* DC leaf extract, focusing on their synthesis, characterization, and anticancer effects in lung cancer cells, particularly C. elegans. The biogenic AgNPs were characterized using UV-visible spectroscopy, X-ray diffraction (XRD), particle size analysis, zeta potential analysis, energy dispersive X-ray spectroscopy (EDX), Fourier-transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). Cytotoxic potential was assessed using an MTT assay. The anticancer potential of biosynthesized AgNPs was tested on L-132 and A549 cell lines. The results showed

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dose-dependent cytotoxicity, with significant effects observed at higher concentrations, particularly against A549 cells. The nanoparticles significantly improved survival rates and reduced paralysis in worms infected with Pseudomonas aeruginosa PAO1 and Staphylococcus aureus.

➢ **Acaricidal activity**

Ajai Mansingh and Lawrence A. D. Williams (1998) investigated the acaricidal potential of crude extracts (CEs) from various Jamaican plants against engorged Boophilus microplus ticks. Among the plants tested, *Simarouba glauca* exhibited the highest acaricidal activity with an Acaricidal Index (AI) of 100. Although the extract showed low direct toxicity (less than 20% mortality), it significantly inhibited tick reproduction, with oviposition inhibition reaching up to 62.7% and complete inhibition of embryogenesis (100%). The Relative Reproductive Success (RRS) was recorded as zero, indicating a total suppression of the reproductive cycle in treated ticks.

CORTEX

➢ **Antimalarial activity**

Frits F. J. Franssen et al. (1997) evaluated the in vivo and in vitro anti-plasmodial activity of *Simarouba glauca* bark extracts, traditionally used in Guatemala for malaria treatment. After 7 days of oral treatment with 750 mg/kg aqueous extract, parasitemia reduced significantly (mean 9.5 ± 7.1% and 8.1 ± 5.4%). The dichloromethane extracts showed notable in vitro cytotoxicity against Artemia salina with an LC_{50} of 51.2 ± 13.8 mg/mL. Additionally, IC_{50} values against Plasmodium falciparum strains NF54 and K1 were 0.195 ± 0.04 mg/mL and 0.184 ± 0.024 mg/mL, respectively, indicating promising antimalarial potential.

ROOT

➢ **Larvicidal activity**

Sanju Singh et al. (2024) investigated the mosquito larvicidal potential of glaucarubinone, a bioactive compound isolated from the root extract of *Simarouba glauca* DC., through bioactivity-guided chemical analysis. Using a modified WHO 2005 protocol, glaucarubinone was tested against larvae of three mosquito vector species: Anopheles stephensi, Aedes aegypti, and Culex quinquefasciatus. Among them, Culex quinquefasciatus was the most susceptible, with an LC_{50} of 13.88 ppm and LC_{90} of 70.01 ppm at 24 hours of exposure, followed by Aedes aegypti and Anopheles stephensi. Microscopic observations revealed that the mode of action involved the lysis of midgut and thorax cells in third instar larvae. Additionally, the crystal structure of glaucarubinone was elucidated for the first time using X-ray crystallography.

➢ **Antioxidant and Anticancer activity**

Bhavisha Hingu et al. (2023) investigated the phytochemical, antioxidant, and in vitro anticancer activities of *Simarouba glauca* root extract. For antioxidant analysis, different volumes of the extract (2, 5, 10, and 15 µl at 100 µg/ml) were applied on

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silica gel TLC plates and developed using a mobile phase of toluene, methanol, and ethyl acetate (4:1:4 v/v/v). After derivatization with DPPH reagent and visualization under white light, 254 nm, and 366 nm, white fluorescent bands were observed at Rf values of 0.29, 0.47, and 0.82. This indicated the presence of antioxidant compounds, likely phenolics, capable of scavenging free radicals. The in vitro anticancer activity of the methanolic root extract against A549 human lung adenocarcinoma cells. Treatment with varying concentrations (5%, 10%, 15%, and 20%) for 48 hours resulted in a dose-dependent increase in apoptosis and necrosis, as determined by FITC Annexin V staining and flow cytometry. Cell cycle analysis revealed S-phase arrest, with a significant reduction in viable cells compared to control ($p < 0.05$), highlighting the extract's potent antiproliferative and apoptosis-inducing effects.

AERIAL PARTS

➢ Anticancer activity

Alaina Pupulin et al. (2023) investigated the anticancer potential of Paradise Tree Extract (PTE) derived from *Simarouba glauca* in both triple-negative and ER-positive breast cancer cell lines. The study demonstrated that PTE selectively induces apoptosis in cancer cells, sparing normal cells. Mechanistic studies revealed that PTE causes reactive oxygen species (ROS) generation and destabilizes mitochondrial membrane potential, triggering programmed cell death. Importantly, PTE enhanced the efficacy of common chemotherapeutics (cisplatin and Taxol) while reducing their toxicity in noncancerous cells. In vivo studies using human tumor xenografts in immunocompromised mice confirmed significant tumor growth inhibition, with the combination of PTE and chemotherapeutics showing the strongest anti-tumor effects. PTE displayed a dose- and time-dependent reduction in cancer cell viability ($IC_{50} \approx 0.4$ mg/mL) and showed no toxicity to normal human cells even at the highest tested dose.

LEAF AND STEM BARK

➢ Antibacterial activity

Navya Nagaraj et al. (2021) investigated the antibacterial activity of *Simarouba glauca* (SGL – leaf and SGB – stem bark) aqueous extracts against multidrug-resistant (MDR) Salmonella enterica serovar Typhi and Enterotoxigenic Escherichia coli (ETEC) using the agar well diffusion method. The study showed a dose-dependent increase in antibacterial activity. SGL extract demonstrated significant zones of inhibition (ZI), with ~21 mm against S. Typhi and ~28 mm against E. coli at 500 mg/mL, indicating strong antibacterial effects. SGB extract showed moderate activity with ZIs of ~18 mm (S. Typhi) and ~21 mm (E. coli) at 500 mg/mL. Comparisons with standard antibiotics (Ampicillin and Bacterin) confirmed the extracts' efficacy in reducing bacterial load at higher concentrations. MIC and MBC were determined using broth microdilution. SGL extract showed both MIC and MBC at 10 mg/mL with an

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MBC/MIC ratio of 1, and SGB extract showed MIC and MBC at 5 mg/mL with a ratio of 1, indicating bactericidal activity for both extracts.

LEAF AND BARK

- **Anticancer Activity**

K. Gurudatham, et al., (2023) explored the anticancer potential of the methanolic extract of *Simarouba glauca*, evaluating its ability to induce apoptosis and inhibit tumour growth in lung adenocarcinoma (A549) and normal lung (L132) cell lines using four different solvents. The methanolic extract of bark and leaves exhibited the highest concentration yield using Soxhlet extraction. Comparative cytotoxicity studies showed that bark extracts had an IC50 of 350 µg/mL and an LD50 of 300 µg/mL on A549 cancer cell lines. Cell cycle analysis of methanolic bark extracts, compared to leaf extracts, indicated that bark extracts arrested A549 cell proliferation at the G0/G1 phase, with significant increases in G0/G1 cells (42.33%, 23.93%, 23.47%, and 17.96%, respectively). Increased reactive oxygen species (ROS) levels were observed in A549 cells treated with bark and leaf extracts compared to untreated cells. The methanolic extract from both bark and leaves exhibited the highest anticancer potential via cell cycle arrest, ROS generation, and apoptosis induction.

LEAF, BARK AND FLOWER

- **Antioxidant Activity**

Sajeeda N. et al. (2019) conducted a comparative study on the phytochemical profile and antioxidant properties of bark, flowers, and leaves extracts of *Simarouba glauca* using various solvents—ethanol, chloroform, methanol, and water—via Soxhlet extraction. Qualitative and quantitative analysis revealed that the chloroform extract of the flower had the highest alkaloid (2.1% w/w) and flavonoid content (3.9% w/w). The methanol extract of leaves contained the highest phenol (2.5% w/w) and carbohydrate (2.2% w/w) content. Among all tested parts and solvents, the water extract of bark demonstrated the highest antioxidant activity, showing 90.92% inhibition in H_2O_2 assay with an IC_{50} of 39.63 µg/ml, and also performed best in DPPH (80.39% inhibition, IC_{50} 38.21 µg/ml), reducing power (79.25%, IC_{50} 39.76 µg/ml), and nitric oxide scavenging (79.08%, IC_{50} 49.12 µg/ml). In contrast, the methanol extract of leaves showed the least antioxidant activity with only 56% inhibition in nitric oxide assay (IC_{50} 62.96 µg/ml).

BARK

- **Anti-Inflammatory and Antidiabetic Activity**

Aleesha R, et al., (2020) evaluated the anti-inflammatory and antidiabetic activity of *Simarouba glauca* bark extract in an in vitro study. The extract effectively inhibited heat-induced albumin denaturation, with an IC50 value of 46.42 µg/mL, compared to the standard (24.09 µg/mL). Heat-induced hemolysis tests were also conducted, with IC50 values of 42.51 µg/mL and 21.41 µg/mL for the test sample and standard, respectively. The percentage inhibition

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varied across concentrations of 75–100 µg/mL. The IC50 values of the test and standard were 19.08 µg/mL and 9.08 µg/mL, respectively.

STEM BARK

➢ **Antioxidant activity**

Osagie-Eweka et al. (2018) conducted a comparative in vitro antioxidant study on aqueous, methanol, and ethanol stem bark extracts of *Simarouba glauca* DC using various assays such as DPPH, reducing power, FRAP, hydroxyl radical, ABTS+, and nitric oxide scavenging activities. All tests were dose-dependent, with BHT, ascorbate, and Trolox as standard antioxidants. The extracts did not show significant DPPH scavenging activity at 50% inhibition but exhibited moderate activity below that threshold. Notably, the methanol extract showed the highest reducing power (EC50 = 3.5 µg/ml), followed by aqueous (3.7 µg/ml) and ethanol (4.0 µg/ml). FRAP results indicated significant total antioxidant activity, slightly better than BHT. Hydroxyl radical scavenging was substantial in all extracts, close to Trolox activity. ABTS+ radical scavenging was moderate, with the aqueous extract (22.5 µg/ml) performing better than methanol and ethanol. Remarkably, nitric oxide radical scavenging activity was strong in the aqueous extract (IC50 = 10.0 µg/ml), surpassing methanol, ethanol, and even the standard Trolox (IC50 = 18.0 µg/ml).

SEED

➢ **Antimicrobial Activity**

Ramesh J, et al., (2018) studied the biosynthesis of silver nanoparticles using *Simarouba glauca* seed extract and their antimicrobial properties. The formation and stability of the reduced Ag-NPs in the colloidal solution were monitored via UV-vis spectrophotometry. SEM and FT-IR spectral analysis of the seed extract, before and after nanoparticle development, confirmed the presence of functional groups responsible for metal ion conversion into metal nanoparticles.

➢ **Antioxidant activity**

Haleshappa R et al. (2021) evaluated the in vitro antioxidant and free radical scavenging activity of *Simarouba glauca* seed petroleum ether extract using DPPH, ABTS, and FRAP assays. The extract showed significant antioxidant potential with a maximum DPPH scavenging activity of 74% (IC_{50} = 137.89 µg/mL), ABTS scavenging activity of 35% (IC_{50} = 337.29 µg/mL), and FRAP activity of 62.5 µg/mL as ascorbic acid equivalents.

WHOLE PLANT

➢ **Insecticidal Activity**

S.S. Bangar et al. (2017) investigated the bioefficacy of crude methanolic extracts of *Simarouba glauca* (leaf, seed, root, and bark) against two major agricultural pests: Plutella xylostella and Helicoverpa armigera, using the leaf dip bioassay method. The extracts showed significant insecticidal activity, with the highest mortality (80%) observed against Plutella

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xylostella, particularly with leaf and bark extracts. Additionally, strong antifeedant activity was recorded against Helicoverpa armigera. Among the tested plant parts, male leaf and bark extracts exhibited the most potent effects.

➢ **Anticancer activity**

Kurt A. Reynertson et al. (2011) investigated the ability of medicinal plant extracts to induce differentiation in murine embryonic stem (ES) cells. Plant parts were extracted in methanol and partitioned into hexane, ethyl acetate, butanol, and aqueous fractions. These fractions were screened using alkaline phosphatase (AP) activity and WST-1 cytotoxicity assays. AP activity indicates undifferentiated stem cells and is lost upon differentiation. The butanol fraction of wood extract from *Simarouba glauca* saplings significantly induced differentiation in ES cells, shown by reduced or absent AP staining, suggesting that the extract can promote stem cell differentiation.

4. CONCLUSION

Ongoing research into medicinal plants holds immerse potential to uncover novel remedies that can contribute significantly to the treatment and cure of various human ailments. The bark and leaf extracts of *Simarouba glauca* is well known for its different types of pharmacological properties such as anticancer, antibacterial, anti-inflammatory, antidiabetic, nephroprotective, anthelmintic, antimicrobial, haemolytic, antifungal, anti-ulcer, cardioprotective, anti-hypertensive, hepatoprotective and acaricidal activities. The leaf, fruit bulb, seeds, flower, bark as well as root and cortex are possessing medicinal properties such as insecticidal, antioxidant, antibacterial, anticancer, larvicidal and antimalarial properties. The crude drug is rich in active constituents, including glucarubim, quassinoids, ailanthinone, benzoquinone, halocanthone, melianone, simaroubidin, simarolide, simarubin, simarubolide and β-sitosterol. In conclusion, further studies on these plants could assist future researchers in the development of novel lead molecules.

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