

FROM ETHNOMEDICINE TO DRUG DISCOVERY: THE PHARMACOLOGICAL PROMISE OF *DALBERGIA SISSOO*

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ABSTRACT

Dalbergia sissoo, commonly known as Sheesham, is an important medicinal plant of the Fabaceae family, widely distributed across tropical and subtropical regions. It has long been recognized in traditional medicine systems for its therapeutic value. The plant contains a diverse spectrum of phytochemicals, including flavonoids, tannins, glycosides, quinones, phenolic acids and essential oils, which contribute to its broad pharmacological profile. Various plant parts such as leaves, bark, heartwood and seeds are known to possess significant medicinal properties. Traditionally, *D. sissoo* has been used for treating conditions like inflammation, skin disorders, fever, anemia, infections, and bone-related ailments. Decoctions and extracts from the plant have been applied in Ayurveda and folk medicine for their analgesic, antipyretic, and blood-purifying actions. Modern scientific investigations further support many of these uses, highlighting its anti-inflammatory, antioxidant, antimicrobial, antidiabetic, hepatoprotective and anti-osteoporotic activities. Despite its long history of ethnomedicinal use, the full therapeutic and pharmacological potential of *Dalbergia sissoo* remains underexplored. Many compounds reported from the plant have not yet been thoroughly evaluated for their mechanisms of action, toxicity profile or potential for drug development. With advances in phytochemical analysis and molecular pharmacology, *D. sissoo* emerges as a promising candidate for discovering novel therapeutic agents. This review aims to present a comprehensive and up-to-date overview of the phytochemistry, traditional medicinal applications, and pharmacological activities of *D. sissoo*, thereby encouraging further research and promoting its potential utilization in future drug discovery and development.

KEYWORDS: *Dalbergia sissoo*, Phytochemistry, Ethnomedicinal uses, Bioactive compounds, Fabaceae.

INTRODUCTION

➤ Background of *Dalbergia sissoo*

Dalbergia sissoo, commonly known as Sheesham or Indian Rosewood, is a fast-growing, deciduous tree belonging to the family Fabaceae. Native to the Indian subcontinent and widely distributed across tropical and subtropical regions, it is well known for its durable timber and ecological value. Beyond its commercial uses, *D. sissoo* has attracted increasing attention due to its rich phytochemical composition and diverse medicinal properties. Various parts of the plant including the bark, leaves, seeds, roots, and heartwood contain bioactive compounds such as flavonoids, tannins, glycosides, phenolic acids, quinones, and terpenoids,

which contribute to its broad pharmacological potential. Its long history of use in traditional medicine and emerging scientific evidence highlight *D. sissoo* as a promising natural resource for therapeutic applications.^[1]

➤ Ethnomedicinal Significance

In traditional systems such as Ayurveda, Unani, and folk medicine, *D. sissoo* has been used for centuries to treat a wide spectrum of ailments. The plant is reputed for its anti-inflammatory, antipyretic, analgesic, and wound-healing properties. Remedies prepared from its bark or leaves are commonly used for managing fever, skin diseases, anemia, infections, and digestive disorders.^[2] Heartwood preparations are traditionally administered to

strengthen bones, reduce joint pain, and support recovery from fractures. Its seeds and roots are used in various formulations for treating urinary problems and metabolic disorders. The long-standing therapeutic relevance across diverse cultural practices underscores the importance of this species as a traditional healing agent.^[1]

➤ Need for Scientific Exploration

Despite its strong ethnomedicinal foundation, the scientific understanding of *D. sissoo* remains incomplete. Although several studies have identified its phytochemical constituents and biological activities, comprehensive research on its pharmacodynamics, pharmacokinetics, molecular mechanisms, and safety profile is still limited. Many of its traditionally known therapeutic effects have not yet been validated through well-designed experimental or clinical studies. Furthermore, the isolation and characterization of novel bioactive compounds are in early stages. Given the global rise in demand for plant-based medicines and natural drug leads, there is a critical need to explore *D. sissoo* more rigorously using modern scientific methods.^[3]

➤ Objective and Scope of the Review

The present review aims to provide an in-depth and up-to-date understanding of the medicinal significance of *Dalbergia sissoo*. It summarizes current knowledge on its taxonomy, botanical characteristics, phytochemical composition, and traditional uses. Additionally, the review critically examines reported pharmacological activities, including anti-inflammatory, antioxidant, antimicrobial, antidiabetic, hepatoprotective, and anti-osteoporotic effects. The scope also includes an evaluation of toxicity data, research gaps, and future prospects for drug discovery. By integrating traditional knowledge with modern scientific findings, this review seeks to highlight the therapeutic potential of *D. sissoo* and encourage further studies for its clinical and pharmaceutical development.^[2]

Taxonomical Classification

➤ Complete Taxonomic Hierarchy

Dalbergia sissoo is a member of the Fabaceae family, one of the largest families of flowering plants known for its nitrogen-fixing ability and economic importance. The complete taxonomic hierarchy is as follows:^[4,5]

- Kingdom: Plantae
- Sub-kingdom: Tracheobionta (Vascular plants)
- Superdivision: Spermatophyta (Seed-producing plants)
- Division: Magnoliophyta (Angiosperms)
- Class: Magnoliopsida (Dicotyledons)
- Subclass: Rosidae
- Order: Fabales
- Family: Fabaceae (Leguminosae)
- Subfamily: Papilionoideae (Faboideae)
- Genus: *Dalbergia*
- Species: *Dalbergia sissoo* Roxb

➤ Botanical Identity and Nomenclature

Dalbergia sissoo is commonly known as Sheesham, Indian Rosewood, or Sissoo. The species was first described by William Roxburgh and later validated by Augustin Pyramus de Candolle, hence the scientific name *Dalbergia sissoo* RoxbDC. It is a deciduous tree that typically reaches a height of 10–20 meters, characterized by pinnate leaves, fragrant flowers, and elongated, flat pods containing several seeds.

The plant exhibits significant morphological variation due to environmental influences, but its heartwood is distinctly recognized by its dark brown color, fine grain, and durability. The species thrives in well-drained soils, particularly near riverbanks, and is widely cultivated for timber, shade, and medicinal applications.^[4]

➤ Related Species in the Genus *Dalbergia*

The genus *Dalbergia* includes over 250 species of trees, shrubs, and climbers distributed across Asia, Africa, and South America. Many species are valued for their timber, medicinal properties, and ecological significance. Important related species include:^[6]

- *Dalbergia latifolia* – East Indian Rosewood
- *Dalbergia melanoxylon* – African Blackwood
- *Dalbergia nigra* – Brazilian Rosewood
- *Dalbergia retusa* – Cocobolo
- *Dalbergia odorifera* – Chinese Rosewood
- *Dalbergia lanceolaria* – Lancewood
- *Dalbergia baronii* – Madagascar Rosewood
- *Dalbergia stevensonii* – Honduras Rosewood

Botanical Description

➤ Morphology of Plant Parts

- **Leaves:** *Dalbergia sissoo* has compound, imparipinnate leaves consisting of 3–5 broad, leathery leaflets. The leaflets are ovate to rhomboid, smooth, and glabrous with an entire margin and a pointed apex. They exhibit a characteristic light to dark green coloration, turning yellow before shedding. The petiole is short, and leaf arrangement is alternate.
- **Bark:** The bark is thick, rough and grey-brown in color with prominent vertical fissures. The inner bark is fibrous and pale, containing various bioactive compounds used in traditional medicine. Mature trees exhibit deeply furrowed bark, offering protective resilience against environmental stress.^[7]
- **Flowers:** The flowers are small, fragrant, and arranged in axillary or terminal panicles. They are pale white to light pink in color and possess the typical papilionaceous structure characteristic of the Fabaceae family. Flowering usually occurs between February and April, depending on climate.
- **Fruits:** The fruits are flat, oblong to lanceolate pods measuring 4–7 cm in length. They are thin, papery, and light brown when mature. The pods are indehiscent, meaning they do not split open upon maturity, and each pod typically contains 1–4 seeds.

- **Seeds:** The seeds are small, kidney-shaped, and yellowish-brown in color. They possess a smooth surface and are enclosed within the dry, membranous fruit pod. Seeds are lightweight and adapted for dispersal by wind and water.^[8]

➤ Distribution and Habitat

Dalbergia sissoo is native to the Indian subcontinent and widely distributed across India, Pakistan, Nepal, Bhutan, Bangladesh and Afghanistan. It commonly grows along riverbanks, forest edges, and plains, particularly in regions with well-drained alluvial soils. The species thrives in tropical and subtropical climates, tolerating temperatures ranging from 5°C to 45°C. It can grow at altitudes up to 1500 meters and is highly adaptive to diverse soil types, including sandy, loamy and rocky soils. Due to its resilience, *D. sissoo* is extensively planted in agroforestry systems, roadside plantations, and reforestation programs.^[9]

➤ Ecological Importance

Dalbergia sissoo plays a significant ecological role in maintaining soil fertility and stabilizing ecosystems. As a leguminous species, it forms symbiotic associations with nitrogen-fixing bacteria, enriching the soil with essential nutrients and improving soil health. Its deep and extensive root system helps prevent soil erosion, especially along riverbanks and degraded landscapes.^[10] The tree provides habitat and food for various bird species, insects, and microorganisms, contributing to biodiversity conservation. Additionally, its dense canopy offers shade and microclimatic regulation, enhancing local environmental quality. Due to its fast growth and adaptability, *D. sissoo* is widely used in afforestation, carbon sequestration and land rehabilitation programs.^[11]

Phytochemical Profile

- **Primary Metabolites:** Primary metabolites are essential compounds that support the basic growth and development of *Dalbergia sissoo*.
- **Carbohydrates:** Present in significant amounts across leaves, bark and seeds. They play a key role in

providing structural and metabolic energy. Simple sugars, polysaccharides, and starch reserves are commonly reported.

- **Proteins:** Seeds of *D. sissoo* contain notable protein levels, which support germination and metabolic activity. Enzymatic proteins participate in physiological processes such as nitrogen fixation and defense.
- **Lipids:** Found mainly in the seeds, consisting of fatty acids and sterols. Lipids contribute to membrane structure, energy storage, and stress adaptation.^[12]
- **Secondary Metabolites:** Secondary metabolites are responsible for the plant's medicinal properties and pharmacological activities.^[13]
- **Flavonoids:** Key flavonoids include biochanin A, isoliquiritigenin, quercetin, dalbergin and formononetin. These compounds exhibit antioxidant, anti-inflammatory, antimicrobial and anti-osteoporotic effects.
- **Tannins:** Rich in hydrolysable and condensed tannins, especially in bark and heartwood. They contribute to astringent, wound-healing, and antimicrobial activities.
- **Glycosides:** Presence of flavonoid glycosides and phenolic glycosides. These enhance bioavailability, antioxidant potential, and cytoprotective actions.
- **Phenolic Acids:** Gallic acid, ferulic acid, syringic acid, and caffeic acid have been reported. Phenolic acids are linked to free radical scavenging, hepatoprotective and anti-inflammatory effects.
- **Quinones:** Dalbergichromene, dalbergione, and related quinones are present primarily in heartwood. These are known for antibacterial, antifungal, and cytotoxic properties.
- **Terpenoids & Essential Oils:** Terpenes such as sesquiterpenes, triterpenoids, and volatile oils are detected in leaves and bark. They provide anti-inflammatory, analgesic and antimicrobial activities.^[13,14]

➤ Phytochemical Screening

Table 1: Qualitative phytochemical analysis of *D. sissoo* extracts.^[15]

Sr. No.	Phytochemical Test	Chemical Group Detected	Observation / Result
1.	Molisch's test	Carbohydrates	Purple/violet ring formed
2.	Biuret test	Proteins	Violet color develops
3.	Sudan III test	Lipids	Red-orange coloration
4.	Shinoda test	Flavonoids	Pink/red coloration
5.	Ferric chloride test	Phenolics & tannins	Blue-green/black coloration
6.	Bornträger's test	Quinones	Red/pink color in ammoniacal layer
7.	Keller–Killiani test	Cardiac glycosides	Brown ring at interface
8.	Salkowski test	Terpenoids	Reddish-brown coloration
9.	Lead acetate test	Tannins	White to yellow precipitate
10.	Liebermann–Burchard test	Steroids/triterpenoids	Green to blue coloration

Traditional and Ethnomedicinal Uses

➤ Ayurveda, Unani, and Siddha References:

Dalbergia sissoo (Sheesham) holds a significant place in traditional Indian medicine systems.^[16]

Ayurveda: Known as “Shisham,” “Shishava,” or “Pitashalaka”.

Classified under: Kashaya (astringent) dravyas. Used for:

- Jwara (fever)
 - Shotha (inflammation)
 - Krimi (infections/worm infestations)
 - Vranaropana (wound healing)
 - Rakta shodhana (blood purification)
 - Decoctions of bark and leaves are commonly prescribed in Ayurvedic formulations for skin disorders, dysentery, and bone strength.
- **Unani Medicine** Referred to as Tali.
- Used in *dawa-ul-misk, majoon, and arq preparations.
 - Recognized for anti-inflammatory, cooling, and diuretic properties.
 - Applied in the treatment of joint pain, fever, urinary disorders, and blood impurities.
- **Siddha System**
- Used for ulcers, skin infections, respiratory ailments, and anemia.
 - Paste of leaves and bark is applied for wound healing and inflammation.
- **Folk Medicine Practices**
- **Leaf paste:** Applied topically for boils, abscesses, wounds, and ringworm.
 - **Bark decoction:** Consumed for fever, digestive problems, and internal infections.
 - **Seed oil:** Used traditionally for joint pain, rheumatism, and skin dryness.
 - **Heartwood powder:** Given to enhance blood purification and treat skin rashes.
 - **Root preparations:** Used by tribal communities for bone fractures and muscular injuries.
- **Use in Treating Specific Ailments**
- **Inflammation:** Leaf, bark and heartwood extracts are used in pastes and decoctions to reduce swelling, pain and redness. Anti-inflammatory activity is widely acknowledged in traditional medicine.
 - **Fever:** Aqueous bark extracts are commonly administered to control acute and chronic fevers, often combined with ginger or black pepper in folk formulations.
 - **Skin Ailments:** Includes treatment of Eczema, Dermatitis, Scabies, Ringworm, Ulcers and wounds. The astringent and antimicrobial nature of tannins and flavonoids supports these uses. Bone Fractures & Musculoskeletal Disorders. The plant is valued for its role in bone healing, where bark paste is applied externally to reduce pain and support repair.

Tribal communities use Sheesham for fractures, sprains, and stiffness.

- **Infections:** Traditionally used for Bacterial and fungal infections, Diarrhea and dysentery, Urinary tract infections, Parasitic infestations.
- **Metabolic & Hematological Conditions:** Used as a blood purifier, especially in chronic skin diseases. Decoctions are consumed for anemia, general weakness and loss of appetite.^[17]

Pharmacological Activities of *Dalbergia sissoo*

➤ Anti-inflammatory Activity

Extracts of the bark, leaves, and heartwood exhibit strong anti-inflammatory effects by inhibiting prostaglandins, cytokines, and nitric oxide production. Flavonoids, tannins, and phenolic compounds contribute to suppressing edema, swelling, and tissue inflammation. Animal studies demonstrate significant reduction in carrageenan-induced paw edema, confirming its traditional use for inflammatory disorders.

➤ Antioxidant Activity

Phytochemicals such as flavonoids, phenolic acids, and tannins impart strong antioxidant potential. Extracts effectively scavenge free radicals (DPPH, ABTS) and enhance endogenous antioxidant enzymes such as SOD and catalase. This property supports protection against oxidative stress-related diseases.

➤ Antimicrobial and Antifungal Activity

D. sissoo shows broad-spectrum antimicrobial activity against Gram-positive, Gram-negative bacteria, and various fungal pathogens. Methanolic and aqueous extracts inhibit species like *E. coli*, *S. aureus*, *P. aeruginosa*, and *Candida albicans*. The antimicrobial action is attributed to phenolics, quinones, and essential oils.

➤ Antidiabetic Activity

Leaf and bark extracts exhibit hypoglycemic effects by improving insulin sensitivity, reducing blood glucose levels, and enhancing glucose uptake. Flavonoids and glycosides play key roles in regulating carbohydrate metabolism. Studies show inhibition of α -amylase and α -glucosidase enzymes.

➤ Hepatoprotective and Nephroprotective Effects

Ethanol extracts protect liver and kidney tissues from toxin-induced damage. They restore biochemical markers (ALT, AST, creatinine) and reduce oxidative stress. The hepatoprotective potential is linked to phenolic antioxidants and lignans, which prevent lipid peroxidation.

➤ Anti-osteoporotic Effect

D. sissoo is traditionally used for bone healing, and modern studies support its anti-osteoporotic properties. Heartwood and leaf extracts increase bone mineral density, enhance osteoblast function, and reduce

osteoclast activity. This is attributed to phytoestrogens and antioxidant compounds.

➤ Analgesic and Antipyretic Properties

Bark and leaf extracts demonstrate significant pain-relieving and fever-reducing effects. The analgesic action is mediated through modulation of central and peripheral pain pathways, while antipyretic effects are due to suppression of prostaglandin synthesis.

➤ Wound-Healing Activity

Topical application of leaf and bark extracts accelerates wound contraction, collagen synthesis, and

epithelialization. Antioxidant, antimicrobial, and anti-inflammatory mechanisms contribute to enhanced wound repair.

➤ Other Reported Biological Activities

In addition to the above, *Dalbergia sissoo* exhibits: Anticancer activity, Antiplasmodial effects, Antiulcer activity, Antihyperlipidemic effects, Immunomodulatory properties, Cardioprotective activity.^[18]

Bioactive Compounds Responsible for Therapeutic Effects

Key isolated phytochemicals

Table 2: Isolation of phytochemicals.^[19]

Sr.No.	Compound	Chemical class	Reported / putative activity
1.	Dalbergin	Isoflavonoid / lignan-type phenolic	Anti-inflammatory, antioxidant,
2.	Dalbergichromene/Dalbergione	Quinone / chromene derivatives	Antimicrobial,
3.	Formononetin	Isoflavone	Phytoestrogenic, anti-osteoporotic,
4.	Biochanin A	O-methylated isoflavone	Anti-inflammatory, antioxidant, potential anticancer effects
5.	Quercetin	Flavonol	Strong antioxidant, anti-inflammatory, antimicrobial
6.	Isoliquiritigenin	Chalcone	Antioxidant, anti-inflammatory, anticancer potential
7.	Gallic acid, Ferulic acid, Caffeic acid	Phenolic acids	Radical scavenging, synergize, hepatoprotective, with flavonoids
8.	Volatile terpenoids (leaf/bark oils)	Mono/sesquiterpenes	Antimicrobial, analgesic, anti-inflammatory

➤ Structure–Activity Relationship (SAR) — concise insights

- **Flavonoids / Isoflavones:** Number and position of hydroxyl groups strongly correlate with antioxidant capacity (ortho-dihydroxy motifs enhance radical scavenging).
- **O-methylation:** They can increase lipophilicity and membrane permeability but may reduce H-donor antioxidant capacity; methylated isoflavones often show improved metabolic stability. Glycosylation reduces acute activity in vitro but frequently improves water solubility and alters absorption kinetics in vivo.^[7]
- **Chalcones and prenylated flavonoids:** The α,β -unsaturated carbonyl in chalcones contributes to anti-inflammatory and anticancer actions via Michael acceptor chemistry (protein thiol modification). Prenylation increases lipophilicity and cell membrane affinity, often enhancing antimicrobial and cytotoxic potency.
- **Quinones and chromenes:** Redox-active quinone moieties mediate antimicrobial and cytotoxic effects

through ROS generation and enzyme inhibition; however, this can also underlie toxicity to host cells.

- **Phenolic acids:** Simple phenolics act as primary antioxidants and synergize with flavonoids to stabilize free radical intermediates.^[20]
- **Pharmacokinetic considerations (ADME/T)**
 - **Absorption:** Many polyphenols (flavonoid aglycones) are moderately absorbed; glycosides are less well absorbed until hydrolysed by intestinal enzymes/microbiota. Poor water solubility of aglycones can limit oral bioavailability.
 - **Distribution:** Lipophilic isoflavones and quinones bind plasma proteins and may distribute to tissues (including bone for phytoestrogens). BBB penetration is variable and generally low for polar tannins.
 - **Metabolism:** Extensive first-pass metabolism (phase I/II) — O-methylation, glucuronidation, sulfation — produces metabolites that may be active or inactive. Gut microbiota also generate bioactive metabolites from parent compounds.
 - **Elimination & Half-life:** Conjugated metabolites are excreted in urine/bile; half-lives vary widely

across classes. Repeated dosing or formulation can alter exposure.

- **Toxicity & Safety:** Redox-active quinones can cause cytotoxicity at higher concentrations; long-term safety, genotoxicity and herb-drug interactions (enzyme modulation) are inadequately studied for many isolates.^[4]

➤ Recommendations for further work

- Isolate and fully characterize major compounds from different plant parts with modern spectroscopic methods.
- Systematic SAR campaigns (semi-synthetic analogues) around isoflavone and quinone scaffolds.
- In vitro ADME and toxicity screens (microsomal stability, Caco-2 permeability, CYP inhibition, genotoxicity) before animal studies.
- Pharmacokinetic profiling of lead compounds (oral bioavailability, metabolite ID) and exploration of formulation strategies to enhance delivery.
- Mechanistic pharmacology (molecular targets, signaling pathways) to connect chemical structure with observed bioactivities.^[17]

Future Prospects

- *Dalbergia sissoo* holds strong potential for discovering new therapeutic compounds, as many of its phytochemicals remain insufficiently explored.
- Advanced analytical tools such as LC-MS, GC-MS and NMR can help identify novel bioactive molecules and clarify their mechanisms of action.
- Isolated compounds from *D. sissoo* may serve as lead structures for drug design, molecular docking and structure–activity relationship (SAR) studies.
- Synergistic effects among multiple plant constituents create opportunities for developing improved polyherbal formulations inspired by traditional medicine.
- Nanotechnology-based drug delivery systems—such as nanoparticles, liposomes, nanoemulsions, SLNs and phytosomes—can overcome issues of low solubility and poor bioavailability.
- Specialized nanoformulations targeting bone tissue may enhance its anti-osteoporotic potential, while nanofiber dressings and hydrogels can support wound-healing applications.
- Incorporation of *D. sissoo* phytochemicals into biomaterials and scaffolds offers new directions for tissue engineering and regenerative medicine.
- Sustainable cultivation practices, agroforestry and micropropagation are essential to protect the species from overharvesting and environmental stress.
- Establishing standard extraction protocols and quality control markers will ensure consistency, purity and reproducible therapeutic effects.
- More extensive preclinical and clinical studies are required to confirm its pharmacological activities and evaluate long-term safety.

- Toxicity evaluations, including chronic toxicity and herb–drug interactions, need to be thoroughly assessed before pharmaceutical commercialization.
- Standardized and validated formulations could bridge the gap between traditional uses and modern therapeutic applications, enhancing its relevance in future drug discovery.^[15]

CONCLUSION

Dalbergia sissoo demonstrates a remarkable therapeutic profile supported by its diverse phytochemical composition and long-standing use in traditional medicine systems. The plant exhibits a wide range of pharmacological properties including anti-inflammatory, antioxidant, antimicrobial, antidiabetic, hepatoprotective, nephroprotective, wound-healing, and bone-strengthening activities which highlight its potential as a source of future drug candidates. Despite promising evidence, scientific exploration of many of its bioactive molecules remains incomplete, especially concerning toxicity, mechanisms of action, and clinical validation. Given its strong medicinal relevance, *D. sissoo* represents an important resource for pharmaceutical, nutraceutical, and biomedical research. Advancing its therapeutic applications will require interdisciplinary efforts integrating phytochemistry, pharmacology, toxicology, nanotechnology, and conservation sciences. With systematic research and sustainable utilization, *D. sissoo* may significantly contribute to the development of novel, plant-based therapeutic solutions in the future.

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