Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
https://www.phytojournal.com
JPP 2023; 12(1): 52-57
Received: 17-10-2022
Accepted: 15-11-2022

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A phytochemical and pharmacological review on *Dalbergia sissoo*: A potential medicinal plant

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DOI: https://dx.doi.org/10.22271/phyto.2023.v12.i1a.14557

Abstract
Dalbergia sissoo plant, often known as the Bangladesh Shishu, is a member of the Fabaceae family. It widespread in Bangladesh, including Sylhet, Ranirhat, Isamoti, and Chittagong. It is also found in Afghanistan, Pakistan, India, and Nepal. This plant has been used to treat leukoderma, diarrhea, dyspepsia, ulcers, stomach disorders, itching, syphilis, scabies. This plant's extract comprised terpenoids, alkaloids, glycosides, flavanols, tannins, saponins, and glycosides. All segments of *Dalbergia sissoo* are analgesic, anti-inflammatory, anthelmintic, antidiarrheal, molluscicidal, antinociceptive, antioxidant, antiulcer, antimicrobial, antidiabetic, osteogenic, antispermatogenic, antitemite and neuroprotective activities. The accessible information was acquired from research articles using a keyword search in Google Scholar, Pub med, Science direct, Springer Link, Wiley and Sci-Hub. The foregoing criteria selected 35 suitable articles from 2000 to 2022 for this study. This research examines *Dalbergia sissoo's* botanical traits, therapeutic value, and bioactive compounds. This analysis will aid future scientific research as pharmacologists must gather and identify data.

Keywords: *Dalbergia sissoo*, traditional use, phytochemistry, pharmacology, marketed product in Bangladesh

Introduction
Plants, animals, bacteria, and marine organisms have been used in medicine since the beginning of time to relieve pain and treat illnesses. Fossils show that people have been using plants as medicines for at least 60,000 years [1]. Historically, medicinal plants have been an excellent source of chemicals that could be used to treat diseases, and they are still a major source of new drug leads. In the past, when making new medicines, the pharmaceutical industry relied mostly on libraries of synthetic chemicals. At the same time, the number of new drugs coming onto the market has been going down, which has made scientists more interested in making drugs from natural sources [2]. *Dalbergia* sissoo is a member of the Fabaceae family and has lovely flowers. It is also known as Indian Rose Wood. Three hundred of the twenty-five known *Dalbergia* species are found in India. The wood from a *Dalbergia* tree is highly demanded because of its aesthetic value, pleasant aroma, and high oil content. The 18th-century Swedish brothers Nils and Carl Dalberg influenced the plant's name [3]. According to reports, *Dalbergia sissoo* is a stimulant used in traditional medicine and traditional cures. Traditional medicine uses it to treat gonorrhea and skin problems. In Ayurveda, the paste prepared from the bark is used as an anthelmintic, antipyretic, and analgesic, while the juice from the leaves is used to cure eye issues. The wood is also used to heal boils, leprosy, and motion sickness in India [4]. *Dalbergia sissoo* leaves cure non-specific diarrhoea in animals in rural India and Nepal. Leaf extract treats sore throats, heart issues, diarrhea, syphilis, and gonorrhoea. Anthelmintic, eye, and nasal problems benefit from leaf juice. Scabies, syphilis, scorching urine, and digestive issues are treated with it. Leaf decoction treats gonorrhoea. Ayurveda recommends leaf juice for eye problems. The wood cooled, anthelmintic, and antileprotic. Arial components were spasmolytic, aphrodisiac, and expectorant. Leprosy, boils, and vomiting are all cured by wood. The Yunana used the wood to treat blood diseases, fever, itching, scabies, hot urine, stomach problems, syphilis, and a variety of other maladies. Curing herpes, vitiligo, and high temperatures with heartwood. Shimshapa Sara ksheerapaka treats fever. Roots alleviate diarrhea and dysentery. In addition to relieving nausea and vomiting, the roots may cure a hernia, relieve gonorrhea, and alleviate gastrointestinal discomfort. *Dalbergia sissoo* contains glycosides, flavanols, tannins, saponins, sterols, and terpenoids, according to phytochemical analysis [5]. D. Sissoo purifies blood and treats leprosy. The bark, leaves, and roots are usually utilized as stimulants and astringents. Traditional healers utilize bark the most. The roots' bark has antidiarrheal properties, and inhaling their smoke may cure both bronchitis and migraines [6].

Benefits for the skin, gastrointestinal tract, neurological system, heart, antioxidants, antiparasitic, anti-inflammatory, analgesic, osteogenic, and many more have been documented for Dalbergia sissoo [7]. It has also been used as a stimulant and astringent, and in the treatment of colorectal cancer and bacterial infections. The juice from the leaves is effective in treating ocular and nasopharyngeal disorders. In addition to relieving these symptoms, it is also used to treat scabies, a burning feeling, hot urine, and digestive issues. Coughs, nausea, leucoderma, ulcers, and gout-like symptoms are among things that it may help with. Dandruff sufferers with long hair often use a filtrate made from cooked leaves to cleanse their hair [8]. Flavones, isoflavones, flavonols, neoflavonols, and coumarins were extracted from *Dalbergia sissoo* and examined for their potential medical use. Among phytochemicals, isoflavones have a role in preventing bone loss and fractures. The leaves of *Dalbergia sissoo* contain a number of active compounds, such as genstein, biochanin A, pratensein, caviunin, quercetin 3-O-rutinoside, caviunin 7-O—D-glucopyranoside, biochanin 7-O-glucoside, kampferol-3-O-rutinoside, and others [9].

Taxonomical Classification of *Dalbergia sissoo*
Kingdom: Plantae
Division: Magnoliophyta
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Fabales
Family: Fabaceae
Genus: *Dalbergia*
Species: *Dalbergia sissoo* [10].

Synonyms
Amerimnon sissoo (Roxb.)
Kuntze Amerimnon P. Browne
Coroya Pierre Ecastaphyllum P. Browne
Miscolobium Vogel
Triptolemea Mart [10].

Common Names
Sanskrit: Shinshapa, aguru
English: Indian Rosewood, Bombay Blackwood Hindi: Shisham, sissu, sissai, sisam
Tamil: Sisso, gette
Kannada: Beeti, shista baage, agaru, bindi
Bengali: Shishu French: Ébénier juane Arabic: Arabic [10].

Description
In its natural habitat, *Dalbergia sissoo* may grow to a height of 30 meters (98 feet) and a diameter of 80 centimeters (31 inches), making it a large deciduous tree. The thin top of the crown spreads widely outward bark that is longitudinally wrinkled, and grey and peeling. Both a taproot and lateral ramifying roots may be seen in their early stages. Three to five alternate, elliptical, acuminate, glabrous, and imparipinate leaflets measure 2.5 to 3.6 centimeters in diameter. Small axillary panicles host racemes 2.5–3.7 cm in length, with 5-8 mm long, white to pale yellow flowers. Pods are 5-7.5 cm long and 8-13 mm wide, indehiscent, glabrous, and contain 1-4 seeds. Seeds that resemble kidneys and are flat and pale brown *Dalbergia sissoo* may grow to be 30 meters tall and 80 centimeters in diameter at the base under optimal conditions broad, low, and thin at the top. Bark that is longitudinally wrinkled, gray, and peeling. A mature taproot with branching side roots. Petiolules are 3-3.5 mm long and imparipinate; leaflets are 2.5-3.6 cm in diameter and are broadly ovate with acute apexes and glabrous margins. White to pale yellow flowers, ranging in size from 5-8 mm, are arranged in racemes. Axillary panicles that are just 2.5–3.7 centimeters long. Pods are 5–7.5 cm in length by 8–13 mm in width and contain anywhere from one to four seeds. They are indehiscent and glabrous [11]. In addition to its deep taproot, this plant also has several surface roots that produce numerous new growths known as suckers. Hairy, drooping young shoots. The stems have bark that varies in color from pale to dark brown to grey and may be up to 2.5 cm (0.98 in) thick. Thin sections of it peel off. Superior limbs support a wide crown [12].

Fig 1: Bark

Fig 2: Leaves

Fig 3: Seed

Fig 4: Whole Plant

6. Phenology

In November, its leaves turn brown and fall. The tree may lose its leaves by December or January in cold climates. In particularly wet and warmer regions, some leaves may survive, while new leaves start sprouting in the first half of February and flushing completes by the first week of March. New leaves and flower buds open in March-April. D. sissoo may be wind-pollinated, insect-pollinated, or both. Its pollination and fertilization timing, self-pollination, and outcrossing status are unknown. The pods appear in April and mature in July. By December or January, they darken and the seed ripens [13].

7. Geographical Distribution

Native: *Dalbergia sissoo* has a wide distribution in Afghanistan and Bangladesh, where it thrives in natural and artificial forests in tropical and subtropical climates. Bhutan, India, Iraq, and Pakistan [3].

Exotic: Kenya, Mauritius, Nigeria, Sudan, Tanzania, Thailand, Togo, the USA, and Zimbabwe are included [5].

Bangladesh: Rangpur, Nilphamari, Dinajpur, Chua-danga, and Khulna are all cities in Bangladesh [14].

8. Traditional Uses

Dalbergia sissoo plant components have been used as an abortifacient, anthelmintic, antipyretic, aperitif, aphrodisiac, expectorant, refrigerant, anal difficulties, diarrhea, dyspepsia, leukoderma, and skin disorders. It treats Vata illnesses including sciatica and hemiplegia. *Dalbergia sissoo* seed oil treats skin burning, and scabies. Leaf extract treats sore throats, heart problems, diarrhea, syphilis, and gonorrhea. Anthelmintic leaf juice treats eye and sinus problems. It treats scabies, body blistering, scalding urine, syphilis, and digestion. The wood was antileprotic, anthelmintic, and cooling. Spasms, aphrodisiacs, and expectorants were treated using arial parts. Wood treats leprosy, sores, and vomiting. Roots treat diarrhoea and dysentery [15].

9. Chemical Constituents

Phytochemical analysis of an ethanolic extract of the bark of the *Dalbergia sissoo* plant revealed the presence of carbohydrates, proteins, amino acids, phenolic compounds, and flavonoids [16]. When analyzing the leaves and pods of the plant, a phytochemical screen may reveal the presence of flavonoids, tannic carbohydrate, reducing sugars, antroquinones, steroids and phenoids, saponins, glycosides, alkaloids, proteins, free amino acids, oils, and lipids [17]. *Dalbergia sissoo* pod oil was evaluated by gas chromatography with flame ionization detection (GC-FID) and gas chromatography with mass spectrometry (GC-MS) to determine its constituent chemicals (Gas Chromatography Mass Spectroscopy). The GC-FID technique identified the following fatty acids: capric acid (1.496%), lauric acid (5.695%), myristic acid (4.925%), palmitic acid (10.130%), palmitoleic acid (2.166%), palmitoleic acid (2.862%), stearic acid (2.862%), oleic acid (10.232%), and linoleic acid (22.35%) [18]. *Dalbergia sissoo* leaves may contain beneficial chemicals such as genstein, biochanin A, pratensein, caviunin, quercetin 3-O-rutinoside, caviunin 7-O—D- glucopyranoside, biochanin 7-O-glucoside, kampferol-3-O-rutinoside, and more [9].

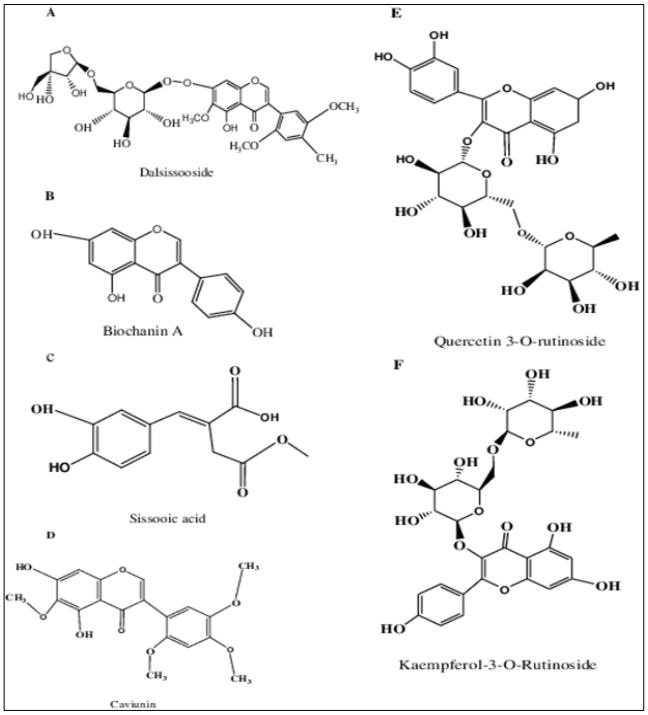

Fig 5: Chemical Structure of Important Constituents in *Dalbergia sissoo* Leaves [9].

10. Pharmacological Activity Analgesic Activity

Three doses (100, 300, and 1000 mg/kg) of an alcohol extract of Dalbergia sissoo were tested for their analgesic properties. The hot-plate method and a tail-clip test in mice were used to evaluate leaf extract. The flavonoids in *Dalbergia sissoo* leaf extract may be responsible for its analgesic effects by inhibiting prostaglandin production [19]. *Dalbergia sissoo* bark extract's analgesic impact on peripheral activity was investigated (Non norcotic). The fact that it took the pain stimulus much longer to impact the response time after taking *Dalbergia sissoo* indicates that it has potent analgesic efficacy. The pain sensitivity was not affected by extract dosages of 300 mg/kg or 500 mg/kg, but a dose of 1000 mg/kg administered 30 minutes later seems to have had this effect [20].

Anti-inflammatory activity

The anti-inflammatory effects of an oral dosage range of 100, 300, and 1000 mg/kg of an ethanolic extract of *Dalbergia sissoo* leaves were investigated in several rat models of inflammation. Anti- inflammatory effects were studied using a nystatin-induced paw oedema model. Despite supporting data, flavonoids often credited with anti-inflammatory effects remain elusive [21]. Using a right hind paw oedema model of inflammation, a 90% ethanolic extract of *Dalbergia sissoo* bark was examined for its anti-inflammatory properties in Wistar rats. The right hind paw edema resolved after oral administration of ethanolic extract at doses of 300, 500, and 1000 mg/kg. The ethanolic extract of *Dalbergia sissoo* bark at 1000 mg/kg demonstrated the greatest anti- inflammatory effect compared to the other groups (300 and 500 mg/kg) [22]. The ethanolic leaf extract of *Dalbergia sissoo* was evaluated utilizing the human red blood cell (HRBC) membrane stabilization in vitro assay and the cotton pellet granuloma test in mice. The findings showed that *Dalbergia sissoo* leaf extract in ethanol was able to stabilize the HRBC membrane. 47.622.25, 55.152.04, 56.410.51, 77.662.88 and 78.393.39 percent protein denaturation was inhibited at 100, 200, 400, 800, and 1000 g/ml, respectively [23].

Antinociceptive Activity

The antinociceptive properties of the methanol extract of *D. sissoo* leaves were studied in mice. Methods including: 100, 200, and 400 mg/kg (P.O.) of formalin, glutamate, and cinnamaldehyde in mice; hot plate and tail immersion in mice to mimic heat pain; acetic acid to mimic writhing in mice. Despite the fact that certain flavonoids have shown antinociceptive activity [8]. Using the tail flick method, we examined the analgesic effects of an ethanolic extract of *D. sissoo* plant bark in Wistar rats. Oral administrations of 300, 500, and 1000 mg/kg of 0.5% carboxyl methyl cellulose (CMC) were performed. Antinociception was tested against asprin at a range of doses. *D. sissoo* bark extract may have antinociceptive effects due to phytochemicals such flavanoids [16].

Antiulcer activity

The leaves of the *Dalbergia sissoo* plant were used to cure experimental ulcers. Induced gastric ligation and Indomethacin-induced ulcers at 250 mg/kg and 500 mg/kg are used to assess the plant's antiulcer effects. Even though saponins have been found to have antiulcer activity [24]. The protective effects of a methanol extract of the stem bark of *D. sissoo* on ulcers caused by diclofenac sodium in rats. In rats with gastric ulcers, a methanol extract of D. sissoo stem bark decreased the ulcer index, TBARSs, H2O2, and MPO activity. Diclofenac-treated rats had their CAT, SOD, GSH-Px, GST, GSH, and NP-SH activities increased by a methanol extract of the stem bark of D. sissoo. Diclofenac increased the alkalinity of stomach juice and decreased its total, free, and volumetric acidity [25].

Antimicrobial Activity

The in vitro antibacterial activity of *Dalbergia sissoo* was tested against *Staphylococcus aureus* and *Pseudomonas aeruginosa*, and both aqueous and methanolic extracts demonstrated antibacterial activity with a Zone of Inhibition (ZOI) of 14 mm at doses of 0.386 mg/ml and 0.005 mg/ml, respectively. The dilution technique was used to establish the minimum inhibitory concentration (MIC) [26]. Leaf, pod, and bark methanolic extracts from the *D. sissoo* plant were effective against most bacterial and fungal strains. *M. luteus*, *B. cereus*, *S. saprophyticus*, *Proteus sp*., *Citrobactor*, *K. pneumoniae*, and *salmonella typhi* were all suppressed by the methanolic extract of *D. sissoo* leaves. The bacterial species *M. luteus*, *B. cereus*, *S. saprophyticus*, *Proteus sp*., *Citrobactor sp*., and *K. pneumoniae* were all inhibited by a methanolic extract of *D. sissoo* pods. Significant antibacterial activity was shown by a methanolic extract of *D. sissoo* bark against *B. cereus*, *S. saprophyticus*, *Proteus* sp., and *Citrobacter sp*. [27].

Antidiabetic Activity

Dalbergia sissoo DC stem bark extract exhibits anti-diabetic effects when taken orally in either ethanol or water. *Dalbergia sissoo* is efficacious when given orally at doses of 250 and 500 mg/kg in settings where streptozotocin is used to trigger the disease [28].

Anthelmintic Activity

The anthelmintic properties of the *Dalbergia sissoo* plant bark have been the subject of much research. Three different concentrations of *Dalbergia sissoo* extracts (25mg/ml, 50mg/ml, and 75mg/ml) were evaluated for their potential anthelmintic effects. The use of earthworms in the study of anthelmintic effectiveness. Tannins have been shown to have anthelmintic properties, and it is thought that they do so via binding to and disrupting free proteins in the host animal's digestive system or glycoprotein on the parasite's cuticle [29]. The efficacy of an anthelmintic was evaluated by measuring the amount of time it took for worms to become paralyzed and die when treated with 10, 25, 50, and 100 mg/ml of *Dalbergia sissoo* petroleum ether, carbon tetrachloride, benzene, and ethanol. Citrate of piperazine, the standard form. *Dalbergia sissoo* was shown to be toxic to earthworms, rendering them unable to move before ultimately killing them. Both 19 minutes and 48 minutes and fifteen seconds of paralysis were recorded with 100 milligrams per milliliter of *Dalbergia sissoo* carbon tetrachloride extract [30].

Antioxidant Activity

Extracts of *Dalbergia sissoo* leaves were tested for their antioxidant activity against ascorbic acid using the DPPH method. Both the ethanolic and the methanolic extracts demonstrated the ability to eliminate DPPH. Extracts of *D. sissoo* leaves demonstrated that the DPPH activity was dose-dependently slowed. The ethanol extracts were more effective than the methanol ones. Methanolic extract had an EC50 of 815.53 g/ml, whereas ethanolic extract had an EC50 of 106.32 g/ml [31].

Neuroprotective Activity
Neuroprotective properties of 300 and 600 mg/kg of oral ethanol extracts of *Dalbergia sissoo* leaves were investigated. The passive avoidance (PA) method was utilized in this assessment. The leaves of *Dalbergia sissoo* have shown promise as a therapy for a variety of neurological disorders [32].

Antidiarroheal activity
Compared to controls, *D. sissoo* leaf ethanol extract significantly reduced both stool production and episodes of castor oil- and MgSO4-induced diarrhoea. *D. sissoo* was just as effective as the usual antidiarrheal medicine loperamide at reducing diarrhoea brought on by castor oil and MgSO4. Milk peristalsis induced by charcoal meal and barium sulfate when administered by *D. sissoo* with atropine sulfate was significantly reduced in mice [33].

Molluscicidal activity
D. sissoo fruits, leaves, roots, and stem bark extracted in ethanol are lethal to *B. alexandrina* snails within 24 hours in the lab. LC50 and LC90 readings were from 8.8 to 34.4 ppm for fruits, 12.5 to 64.3 ppm for leaves, 16.4 to 76.4 ppm for roots, and 32.8 to 136.6 ppm for stem bark. At 50 mg/l, an ethanolic extract of the fruits was 100% effective, but extracts of the leaves, roots, and stem bark were all ineffective. 24 hour LC50 and LC90 values for *B. alexandrina* egg masses ranged from 10.8 to 38.6 ppm, 18.5 to 68.3 ppm, 20.4 to 88.4 ppm, and 36.8 to 144.6 ppm, respectively [34].

Osteogenic activity
Ethanolic extracts of *Dalbergia sissoo* leaves produced isoflavones, flavonols, and their glucosides, as well as a new itaconic derivative, (E)-4-methoxy-2-(3, 4 dihydroxybenzylidene)-4- oxobutanoic acid. The osteogenic activity of these compounds was evaluated using primary calvarial osteoblast cells [35].

Anti-spermatogenic activity
Dalbergia sissoo Roxb's stem bark ethanol extract was tested for anti-spermatogenic properties. 15 healthy fertile males aged 25–35 provided semen for the in vitro investigation. Sander-Cramer tested sperm motility. Ethanol extract affected sperm motility and viability dose- and time- dependently. Concentrations impacted sperm motility. 20 mg/mL ethanol extract immobilized in 3 minutes. This concentration decreased sperm viability and hypo-osmotic edema. Swiss male albino mice were used in vivo. Testis and epididymis weight decreased significantly (p<0.001) with 200 mg/kg ethanol extract. Sperm motility and epididymal sperm count decreased (p<0.01). Epididymis and testis histology were examined [36].

Anti-termite activity
The combination of n-hexane, chloroform, and n-butanol extracts of *Dalbergia sisso* oil may have anti-termite effect. The chloroform fraction eluted with methanol, on the other hand, exhibited three times the anti-termite activity, reaching 92% [37].

11. *Dalbergia sissoo* Marketed Product in Bangladesh

Product name	Ingredients	Manufacturer	Indication	References
Hemosaf	*Dalbergia sissoo, Cassia angustifolia, Rheum emodi, Cassia sophera, Ocimum sanctum, Operculina turpethum, Rosa damascene* etc.	Drug International Limited	Acne vulgaris, pimples and boils, skin eruptions, impurities in blood, chronic & temporary constipation, general lassitude, heat rash and itching, epistaxis	[38]
Safi	*Dalbergia sissoo, Cassia angustifolia, Rheum emodi, Cassia occidentalis, Ocimum sanctum* etc.	Hamdard Laboratories (Waqf) Bangladesh	Acne, boils, rashes, eczema, psoriasis, scabs and itching, nosebleeds, constipation, obesity, measles, heartburn, general malaise	[39]

12. Conclusion
The *Dalbergia sissoo* has a lot of potential to be used to make new medicines and food supplements. Since they come from nature, medicinal plants are one of the best places to find molecules with healing properties. Phytochemicals include flavonoids, tannic carbohydrate, reducing sugars, antroquinones, steroids and phenoids, saponins, glycosides, alkaloids, proteins, free amino acids, oils, and lipids were found. *Dalbergia sissoo* leaves and bark have a lot of active ingredients that can prevent inflammation, bacterial infections, pain relief, diabetes, ulcers, and diseases of the nervous system. To make the structure clear and to separate, describe, and name these active principles. Even though these in vitro experiments are early, more research needs to be done on *Dalbergia sissoo*, especially pharmacological testing in vivo. Pharmaceutical companies might be able to get a lot of the raw materials they need to make drugs from these facilities.

Acknowledgement
The authors would like to use this opportunity to extend their appreciation to the Department of Pharmacy at Stamford University Bangladesh for their unwavering support and motivation.

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