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Review Article

DALBERGIA SISSOO: AN OVERVIEW

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Abstract

The present review is, therefore, an effort to give a detailed survey of the literature on its pharamacognosy, phytochemistry, traditional uses and pharmacological studies of the plant *Dalbergia sissoo*. *Dalbergia sissoo* is an important timber species around the world. Besides this, it has been utilized as medicines for thousands of years and now there is a growing demand for plant based medicines, health products, pharmaceuticals and cosmetics. *Dalbergia sissoo* is a widely growing plant which is used traditionally as anti-inflammatory, antipyretic, analgesic, anti-oxidant, anti-diabetic and antimicrobial agent. Several phytoconstituents have been isolated and identified from different parts of the plant belonging tothe category of alkaloids, glycosides, flavanols, tannins, saponins, sterols and terpenoids. A review of plant description, phytochemical constituents present and their pharmacological activities are given in the present article.

Keywords: - *Dalbergia sissoo*, phytochemical constituents, pharmacological activities.

Introduction

Medicinal plants have been the part and parcel of human society to combat diseases since the dawn of human civilization. The earliest description of curative properties of medicinal plants were described in the Rigveda (2500-1800 BC), Charak Samhita and Sushruta Samhita. Herbal medicine remains one of the most common forms of therapy widely available throughout the world population.**[1-3]**

Plants are the main source of treatment not only in developing countries, but also in developed countries where modern medicines are predominantly used.**[4]** The traditional medicines usually derived from medicinal plant, mineral and organic matter, but the herbal drugs are prepared from medicinal plants only.**[5]** The use of plants as a source of medicines has been inherited and is an important component of the health care system in India also.**[6]** Public,academic as well government interest in plant based medicines is growing exponentially due to the increased incidence of the adverse drug reactions and economic burden of the modern system of medicine.**[7]** To be accepted as viable alternative to modern medicine, the same vigorous method of scientific and clinical validation must be applied to prove the safety and effectiveness of a therapeutic product.**[8-9]**

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The genus, *Dalbergia*, consists of 300 species and about 25 species occur in India. Many species of *Dalbergia* are important timber trees, valued for their decorative and often fragrant wood, rich in aromatic oils**[10-11**].The generic name *Dalbergia* honours the Swedish brothers, Nils and Carl Dalberg, who lived in the 18th century. The former was a botanist and the latter explored Surinam.

TAXONOMICAL CLASSIFICATION:

Kingdom:	**Plantae**
Division:	Magnoliophyta
Class :	Magnoliopsida
Order:	Fabales
Family:	Fabaceae
Subfamily:	Faboideae
Genus:	Dalbergia
Species:	D. sissoo
Scientific name:	Dalbergia sissoo.

BOTANICAL DESCRIPTION:

Indian Rosewwod is a erect to large-sized deciduous tree. It grows up to a height of 25 meter and 2-3 meter in diameter. It has leathery leaves which are up to 15 cm long. The **leaves** are imparipinate; leaflets are 3-5, alternate, 2.5-3.6 cm in diameter, broad ovate, acuminate, glabrescent, petiolules 3-5 mm long. The

flowers are whitish pink in colour. Flowers are 5-8 mm long, pale white to dull yellow, racemes 2.5-3.7 cm long in short axillary panicles. Its crown is oval in shape. The fruit is brown and pod like in shape. **Pods** are 5-7.5 cm x 8-13 mm, narrowed at the base, indehiscent, glabrous, with 1-4 seeds. **Seeds** are 6-8 x 4-5 mm, kidney shaped, thin and flat, light brown. The fruit is dry and hard. The **sapwood** is white to pale brown in colour and the **heartwood** is golden to dark brown in colour. It develops a long taproot from an early age, and numerous lateral ramifying roots**.[12-13]**

GEOGRAPHICAL DISTRIBUTION:

Exotic range: Afghanistan, Bangladesh, Bhutan, India, Malaysia, Pakistan

Native range: Cameroon, Cyprus, Ethiopia, Ghana, Indonesia, Iraq, Israel, Kenya, Mauritius, Nigeria, Sudan,Tanzania, Thailand, Togo, US, Zimbabwe**.[13]**

TRADIONAL USES:

Ayurveda describes the bark and wood as bitter, hot and acrid used as aphrodisiac, abortifacient, expectorant, antihelmintic, antipyretic and diseases of the blood, leucoderma, dyspepsia and dysentery . The wood is good for diseases of the eye, and of the nose, used in scabies and syphilis. A decoction of the leaves are given in the acute stage of gonorrhea. The whole plant has long been employed in ancient Yunani preparations. **[14-15]**.

Ayurvedics has also prescribed the leaf juice for eye ailments **Yunana** use the wood for blood disorders, burning sensations, eye and nose disorders, scabies, scalding urine, stomach problems, and syphilis**[16]** The Sissoo plant is a folk remedy for excoriations, gonorrhea and skin ailments **[17].**

SYNONYMS:

English: Bombay blackwood, sissoo, Indian rosewood, sisso

Hindi:

Agaru,biridi,tali,gette,kara,shisham,sisam,sissai,sissu,sissoo

Sanskrit: Aguru,shinshapa

Bengali: Shisu,shishu,sisu

Tamil: Sisuitti,sisso,nukku kattai,yette,gette

Arabic: Dalbergia,sissoo

Nepali: Sissau,sisham

Indonesian: Pradu-khaek,du-khaek

Javanese: Sonowaseso

Spanish: Sisu

Thai: Du-khaek,pradu-khaek

CHEMICAL CONSTITUENTS:

The plant is having the isoflavones irisolidone, biochanin-A, muningin, tectorigenin, prunetin, genestein, sissotrin and prunetin-4-Ogalactoside. The flavone norartocarpotin and F3-amyrin, F3- sitosterol and stigmasterol were isolated and identified from the green branches of aerial parts of *Dalbergia sissoo* **[18].**

Form used	Pharmacological activity	Reference
Extract of aerial parts	Showed bronchodilation as well as significant antipyretic, analgesic, and estrogen-like activities	**[18]**
Dried leaves	Antibacterial, antiprotozoal, antiinflammatory activities	**[19]**
Leaf Juice	Used in gonorrhoea	**[20]**
Oil	Shows repellant activity against Anopheles stephensi, Aedes aegypti and Culex quinquefasciatus, and is also resistant to some wood boring insects	**[21]**
Wood and active extract of bark.	**Ayurvedics**: abortifacient, anthelmintic, antipyretic, aperitif, aphrodisiac, expectorant, and refrigerant, anal disorders, dysentery, dyspepsia, leucoderma, and skin ailments. **Yunani**: wood useful for blood disorders, scabies, eye and nose disorders, burning sensations, scalding urine, stomach problems and syphilis, boils, eruptions, leprosy and nausea	**[19], [21]**
Wood paste	Used in wound, itches, abscess and vomiting	**[20]**

Plant part	Chemical costituent	Reference
Leaves	Trisacchrides	**[22]**
Leaves	Oligosacchrides	**[23]**
Tree Trunk	Flavnoides	**[24]**
Flower	Tectorigeninbiochanin	**[25]**
Leaf	Phenols.	**[26-27]**
Stem bark, Heartwood	Neoflavenes **(**Dalbergichromene)	**[28]**
Pods	Tannins	**[28-30]**
Bark	Flavnoids	**[31]**
Pods	Caviunin 7-O-gentiobioside	**[32]**
Stem bark	Cinnamylphenols	**[33]**
Heart wood	Chalcones[Isoliquiritigenin], Isosalipurposide	**[34]**
Trunk exudates	Flavanones (Naringenin)	**[35]**
Heart Wood	Amino acids[Glycin, Alanine, Threonine, Isolucine, Phenylalanine]	**[36]**
Heart Wood	Myristic acid, palmitic acid, stearic acid, arachidic acid, linoleic acid, oleic acid.	**[37]**
Heart Wood	Dalbergin	**[38]**
Root bark	Chalcone (2,3-dimethoxy-4′-γ,γ-dimethylallyloxy-2′hydroxychalcone)	**[39]**
Root bark	Isoflavone(7-γ,γ-dimethylallyloxy-5-hydroxy-4′ methoxyisoflavone), biochanin A	**[39]**
Root bark	Flavone,7-hydroxy-6-methoxflavone	**[39]**
Root bark	Rotenoid, Dehydroamorphigenin	**[39]**
Stem bark, heart wood	4-phenyl chromene, Dalbergichromene	**[29]**
Roots	Cardiac Gycosides	**[40]**
Roots	Atnhraquinones	**[40]**
Roots	Saponins	**[40]**
Heart wood	Dalbergenone	**[41]**

Leaves contain sissotrin and an isoflavone-O-glycoside. **Flowers** contain biochenin A, tectorigenin, 7,4-dimethyl tectorigenin and 7-O-methyltectorigenin. **Green pods** contain meso-inisitol, 7-O-methyltectorigenin and its 4′-rhamnoglucoside. **Mature pods** contain isocaviumin, tectorigenin, dalbergin, biochamin A and 7-hydroxy-4-methyl coumarin, 7-O-glucosides of tectorigenin, caviunin and tannins. **Stem bark** contains dalberginone, dalbergin, methyldalbergin, a 4-phenylchromene, dalbergichromene and isotectorigenin. **Heartwood** contains dalbergin, nordalbergenones, dalbergichromene 3,5-dihydorxy-*trans*-stilbene, biochanin A and a allylphenol of latifolin type - dalbergiphenol **(Ghani, 2003; Rastogi & Mehrotra, 1993)**. Heartwood also contains fixed oil, containing Myristic, Palmitic, Stearic, Arachidic, Linoleic, Oleic acid and essential oil, containing two sesquiterpene derivatives bisabolene and nerolidol **(Ansari *et al*., 2000).**

PHARMACOLOGY:

Antidiabetic Activity:

In a study, the ethanolic extract of leaves was adminidtered orally at the doses of 250 and 500 mg/kg to normal rats. Dose of 500 mg/kg was found to be more effective then 250mg/kg; dcereased the blood glucose level (BGL) by 38.2% in normal healthy rats after 1 day administration. After daily treatment with both the doses of extract for 21 days to alloxan induced diabetic (FBG 300-350mg/Dl) rats, the BGL reduced to 125mg/dL by 250mg/kg and 104 mg /dL by 500mg/kg. This study indicated

the hypoglycemic and antihyperglycemic potential of the extract**.[19], [42-43]**

Anthelmintic Activity:

The ethanolic extract of bark of *Dalbergia sissoo* Roxb. was investigated for its activity against Indian earthworms *Pheretima posthuma* and nematode *Ascardi galli*. Various concentrations (10, 20, 50 mg/ml) of ethanolic extract were tested, which involved determination of time of paralysis and time of death of the worms. It was compared with Piperazine citrate (15 mg/ml) and Albendazole (20 mg/ml) as standard reference and normal saline as control. The study indicated the potential usefulness of *Dalbergia sissoo* Roxb. against helminthic infections**.[44]**

Anti-inflammatory Activity:

The methanolic extract of *Dalbergia sissoo* Roxb was investigated for anti-inflammatory activity in experimental animal models. Treatment with 70% methanolic extracts of *Dalbergia sissoo* demonstrate a diminished inflammation in rat hind paw when challenged with carrageenan induced paw edema. The methanolic extract of *Dalbergia sissoo* root at 1000 mg/kg showed the most potent anti-inflammatory activity compared to the other groups (100 and 500 mg/kg) throughout the observation period. *Dalbergia sissoo* Roxb. was devoid of ulcerogenic effect on the gastric mucosa of rats in acute and chronic tests. It was concluded that the *Dalbergia sissoo* root extract possessed significant anti-inflammatory activity without any side effect on gastric mucosa**.[45]**

The possible anti-inflammatory activity of a 90% ethanolic extract of Dalbergia sissoo bark was also studied in a model of inflammation using a right hind paw oedema method in Wistar rats. One percent carrageenan in 0.5% sodium carboxymethyl cellulose (CMC) was administered through the sub-plantar region of the right hind paw of the animals. CMC was used as a suspending agent because it does not produce evident changes in activity response. Phytochemical investigation of bark extract showed that it contained carbohydrates, proteins, amino acids, tannins and flavonoids. After oral administration of ethanolic extract at different doses (300, 500 and 1000 mg/kg), inhibition of right hind paw oedema was observed at 30, 60, and 120 min time intervals. The antiinflammatory effects of the extract were compared with a standard dose of indomethacin (10 mg/kg). In acute toxicity studies, the extract was found to be safe up to 3000 mg/kg, p.o. in the rats. The biological effects increased with increasing doses. The ethanolic extract of Dalbergia sissoo bark at 1000 mg/kg showed the most potent anti-inflammatory activity compared to the other groups (300 and 500 mg/kg) throughout the observation period**.[21]**

Antimicrobial Property :

In a study, a herbal preparation containing *Dalbergia sissoo* and *Datura stramoium* with cow urine (DSDS), was evaluated for its antibacterial potential against pathogenic strains of grampositive (*Staphylococcus aureus* and *Streptococcus pneumoniae*) and gram-negative (*Escherichia coli, Pseudomonas aeruginosa* and *Klebsiella pneumoniae*) bacteria. Antibacterial activity was compared to standard antibiotic drugs i.e. Chloramphenicol (30 mcg), Ampicillin (10 mcg), Nalidixic acid (10 mcg) and Rifampicin (30 mcg). Cow urine extract was found to be most active against both gram-positive as well as gram-negative bacteria. Clinical isolate of *S. aureus* showed higher sensitivity towards cow urine extract of DSDS than standard strains, and inhibited growth on most regulatory levels such as inhibition of protein, DNA, RNA and peptidoglycan synthesis. The results of the present study shows that the cow urine extract of DSDS may be used as a potent antiseptic preparation for prevention and treatment of chronic bacterial infections[**46]**

Analgesic And Antipyretic:

The peripheral analgesic activity of Sisam seed extract (SSE) was studied using acetic acid-induced writhing in mice and by Randall-Selitto assay in rats. Further, the central analgesic activity of SSE was studied by tail-clip test and hot plate method in mice. The antipyretic activity of SSE was studied in Brewer's yeast-induced pyrexia in rats. Results showed significant decreased writhing movements in mice by acetic acid-induced writhing test and significant increased in the pain threshold capacity in rats in Randall-Selitto assay and the reaction time in hot-plate test but not in tail-clip test for analgesic activity. Moreover, it also showed significant antipyretic activity in Brewer's yeast-induced pyrexia in rats throughout the observation period of 6 h. Thus, SSE has moderate analgesic and remarkable antipyretic activities**. .[47-48]**

Antinociceptive Activity:

The antinociceptive activity of ethanolic extract of the plant bark of *Dalbergia sissoo* (Roxb.) was investigated using tail flick method on Wistar rats. Three different dose levels (300, 500, and 1000 mg/kg) in 0.5% carboxyl methyl cellulose (CMC) were administered by p.o. route. The antinociceptive extract

activities of the all doses were compared with that of the standard drug asprin (300 mg/kg) administered by p.o. route and the results were found to be significant ($P < 0.01$). At the above doses, the extract exhibited significant and dose-dependent antinociceptive activity. Phytochemical investigation of the ethanolic extract indicated the presence of carbohydrates, proteins, amino acids, phenolic compounds, and flavanoids. The antinociceptive activity of the bark extract of *D. sissoo* may be due to the presence of phytochemical constituents such as flavanoids. The acute toxicity study revealed that ethanolic extract was not toxic up to 3000 mg/kg body weight**.[49]**

Antidiarroheal Activity:

Antibacterial, antiprotozoal, and antiviral activities of the plant *Dalbergia sissoo* were checked by agar dilution method, tube dilution method, and neutral red uptake assay, respectively. Cholera toxin (CT) and Escherichia coli labile toxin (LT) were assayed by ganglioside monosialic acid receptor ELISA. Suckling mouse assay was used to assess E. coli stable toxin (ST). As a measure of colonisation, the effect against adherence of E. coli and invasion of E. coli and Shigella flexneri to HEp-2 cells were studied. It reduced the production and the binding of CT and bacterial adherence and invasion. This study showed that *D. sissoo* is antidiarrhoeal as it affects bacterial virulence. **.[50-51]**

Antioxidant Activity:

A study reported the in vitro antioxidant activity of the successive petroleum ether (PEDS), chloroform (CEDS) and methanol (MEDS) extracts of the stem bark of *Dalbergia sissoo,* which was investigated through DPPH free radical scavenging activity, reducing power, FRAP (ferric reducing antioxidant power) assay, ferrous ion scavenging activity and nitric oxide (NO) radical scavenging activity. Among different extracts, the chloroform extract was found to be most potent showing the IC_{50} of 25 µg/ml for DPPH model, 21µg/ml for reducing power, 26 µg/ml for ferrous ion scavenging, 26 µg/ml for FRAP assay, 25 µg/ml for NO scavenging activity, which were comparable to positive control (ascorbic acid). The activity of petroleum ether and methanol extract was found to be moderate. Total phenolic contents of the various extracts were estimated by Folin-Ciocalteu method and chloroform extract was found to contain the highest amount (50.8 mg/g) of phenolics. Strong positive correlation (R= 0.97 – 1.0) between the antioxidant activity and total phenolic content of the different extracts was observed**.[52]**

In other study antioxidant activity of methanolic of *Dalbergia sissoo* root was investigated for its free radical scavenging activity by determining the nitric oxide and hydrogen peroxide scavenging activity. Maximum scavenging of nitric oxide and hydrogen peroxide found were 26.66% and 50.68% respectively at 250 µg/ml concentration. The results were compared with rutin as a standard. These results clearly indicate that *Dalbergia sissoo* is effective in scavenging free radicals and has the potential to be a powerful antioxidant.**[30]**

Anti-spermatogenic Activity:

A study was undertaken to evaluate the anti-spermatogenic efficacy of ethanol extract of stem bark of *Dalbergia sissoo* Roxb. For the *in vitro* study, semen samples were obtained from 15 healthy fertile men aged 25–35 years. Sperm motility was examined by the Sander-Cramer method. A dose-dependent and time-dependent effect of ethanol extract on sperm motility and sperm viability were observed. Various concentrations affected the motility of sperm. Ethanol extract at a concentration of 20 mg/mL caused complete immobilization within 3 minutes. Sperm viability and hypo-osmotic swelling was significantly reduced at this concentration. The *in vivo* studies were carried out on Swiss male albino mice. Ethanol extract at a dose of 200 mg/kg body weight resulted in a significant decrease ($p<0.001$) in weight of the testis and epididymis. A significant decrease ($p<0.01$) in sperm motility and sperm count in the epididymis were observed. Histological changes in the epididymis and testis were also investigated**.[53]**

Larvicidal and mosquito repellant activity:

The oil extracted from wood scrapings of *D. sisso* has shown dose dependent larvicidal activity against mosquitoes. A study was carried out to evaluate the larvicidal, growth inhibitor and repellent actions of *D. sissoo* oil against *Anopheles stephensi, Aedes aegypri* and *Culex quinquefasciacus* under laboratory conditions. pure oil was applied at 0.4-5ml/m^2 on a water surface. This showed the larvicidal activity was directly proportional to dosages. One hundred percent mortality of *Culex quinquefasciacus* immatures was observed with in 24 hrs at 4ml/m^2, followed by (90%) and Anopheles stephensi (60%), and pupation was totally inhibited. Adults which emerged from exposure to a sublethal dosage (2ml/m^2) either did not lay eggs (*Aedes aegypri*) or hatch *(Culex quinquefasciacus*, and *Anopheles stephensi*). The oil also showed strong repellent action when 1ml oil was applied on exposed parts of human volunteers. They were protected from mosquito bites for 8-11h. The protection (91.6+-2%) was obtained with sissoo oil as compared to that with

commercial available Mylol oil (93+-1.2%) consisiting of di-butyl and dimethyl phthalates **[54-55]**

Molluscicidal Activities:

In the search for molluscicidal compounds from plants, crude aqueous and ethanolic extracts from different parts of *Dalbergia sissoo* Roxb. were evaluated against egg masses and adults of *Biomphalaria pfeifferi* and the snail intermediate host of *Schistosoma manson* in Nigeria. Laboratory-bred adult *B. pfeifferi* and their viable 0–24 h old egg masses were separately exposed to five different concentrations (7.81–2000 mg l^{-1}) each, of the crude aqueous and ethanolic extracts of the fruits, leaves, roots and stem bark of *D. sissoo*, for 24 h. The LC_{50} and LC_{90} values of each extract for the target organisms were calculated using probit analysis. Only the ethanolic extracts of the fruits and roots showed significant activities against the adult snails (24 h LC_{90}<100 mg l^{-1}: 74.33 and 93.93 mg l^{-1}, respectively) and their egg masses (LC_{90}: 89.29 and 114.29 mg l^{-1}, respectively) while all other extracts demonstrated weak molluscicidal and ovicidal activities (24 h LC_{90} > 100 mg l^{-1}). There were concentration-dependent behavioural changes in snails exposed to test extracts, while egg mortalities, manifested at the gastrula/exogastrula stage and or the prehatch snail stage of development, were similarly concentration-dependent.

The crude ethanolic extracts of *D. sissoo* fruits and roots exhibited promising molluscicidal activities (LC_{90} values<100 mg l^{-1}) against adult *B. pfeifferi* with additional toxicities towards its 0–24 h-old egg masses. **[56-57]**

Osteogenic Activity:

One new isoflavone glucoside, caviunin 7-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] and a new itaconic derivative, (*E*)-4-methoxy-2-(3,4-dihydroxybenzylidene)-4-oxobutanoic acid along with series of isoflavones and flavonols with their glucosides and a lignan glucoside were isolated from the ethanolic extract of *Dalbergia sissoo* leaves. The structures of these compounds were established on the basis of IR, UV, ^{1}H and ^{13}C NMR, DEPT, COSY, HSQC, HMBC and MS data. All compounds were assessed for osteogenic activity in primary calvarial osteoblast cultures. Compounds and increased alkaline phosphatase activity and mineralization thus resulting in significant osteogenic activity.activity of the compounds isolated from the extract was assessed by measuring ALP activity in calvarial osteoblasts. At the end of experiment, ALP activity was measured colorimetrically**.[58]**

Conclusion:

Compounds obatined from *Dalbergia sissoo* like an isoflavone, biochanin is a potent chemotherapeutic cancer preventive agent with a distinct estrogenic activity has been isolated from the fresh flowers of *Dalbergia sisso*. Two rare glycosides kaempferol and quercetin rutinosides. Quercetin was also isolated in a low yield. Scientific Research is still need to prove these effects**.[59-60]**

In recent years, ethno medicinal studies has received much attention as this brings to light the numerous little known and unknown medicinal virtues especially of plant origin which needs evaluation on modern scientific lines such as phytochemical analysis, pharmacological screening and clinical trials.**[61-63]**

Dalbergia sissoo possesses various pharmacological activities as discussed in present paper. However, it is imperative that more clinical and pharmacological studies should be conducted to investigate the unexploited potential of this plant.

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