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Review Article

PHARMACOLOGICAL EFFECTS AND MEDICINAL IMPORTANCE OF *DALBERGIA SISSOO* –A REVIEW

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ABSTRACT

Many herbal remedies have been employed in various medical systems for the treatment and management of different diseases. The plant *Dalbergia sissoo* has been used in different systems of traditional medication for the treatment of diseases and ailments of human beings.

All parts of the plant have medicinal properties so it is a very valuable medicinal plant which is utilized in traditional system of medicine. The plant has been reported to possess Antidiabetic, Antioxidant, Analgesic and Antipyretic, Anti-termite, Anti-spermatogenic, Anti-inflammatory, Anthelmintic, Antidiarrhoeal, Molluscicidal, Antinociceptive, Neuroprotective, Antioxidant and Osteogenic activities. Phytochemical analysis of different parts of the plant of *Dalbergia sissoo* has revealed the presence of glycosides, flavanols, tannins, saponins, sterols and terpenoids.

Keywords: *Dalbergia sissoo,* Herbal remedies, Medicinal properties and Phytochemicals.

INTRODUCTION

Since times immemorial, men have relied on plants and their products as source of drugs and therapeutic agents since they are rich in bioactive compounds. Some of the natural products have provided lead for synthesis of many modern drugs and continue to play a dominant role in maintenance of human health. Plant products are becoming more popular than synthetic drugs even in developed countries. This is mainly attributed to their long standing experience of exposure of these drugs in ethnic medicine systems like Ayurveda and many others (Rates, 2001). 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 (Gupta SS, 1994 ; Shukla R, *et al.,* 2000 ; Vaidya AB, 1994).

Dalbergia sissoo belongs to (Fabaceae) family of flowering plants which is popularly known as 'Indian Rose Wood'/ 'Shisham' and various parts of the plants have been used in traditional medicine (Dixit *et al.,* 2012 ; Pund, 2012 ; Shaltout *et al.,* 2011).The plant is found throughout India, Pakistan, Bangladesh and Nepal. *Dalbergia sissoo* includes many members which are broadly used in folk medicine for several diseases. Different parts such as roots, bark, wood, leaves and seeds are being used as remedy in many diseases including skin diseases, blood diseases, syphilis, stomach problems, dysentery, nausea, eye and nose disorders, aphrodisiac, expectorant. Leaf extract has been used to treat sore throats, heart problems, dysentery, syphilis, and gonorrhoea. In India and Nepal rural people use *Dalbergia sissoo* leaves to treat animals suffering from non-specific diarrhoea. (Shah *et al.,* 2010). The heartwood is golden to dark brown; the sapwood, white to pale brownish white. The heartwood is extremely durable (the specific gravity is 0.7 – 0.8) and is very resistant to dry-wood termites; but the sapwood is readily attacked by fungi and borers. Isoflavones, biochanin-A, muningin, sissotrin, amyrin, stigmasterol have been isolated from the aerial parts of *Dalbergia sissoo* Roxb (Sarg *et al.,* 1999). The heartwood is very hard and close grained with a specific gravity of 0.62-0.82. It seasons well and does not warp or split; it is extremely durable and is one of the timbers which are least susceptible to dry-wood termites in India. Wood offers resistance to sawing and cutting but is excellent for turnery, takes a good polish and finishes to a smooth surface. It is used for high-

quality furniture, cabinets, decorative veneer, marine and aircraft grade plywood, ornamental turnery, carving, engraving, tool handles and sporting goods. Its root wood is used for tobacco pipes. In village industry, *Dalbergia sissoo* is popular for doors and windows. Oil obtained from the seeds is used to cure skin diseases. The powdered wood, applied externally as a paste, is reportedly used to treat leprosy and skin diseases. The roots contain tectoridin, which is used medicinally. The roots provide an astringent used to treat inflammations and infections. The roots can also be used to treat abdominal pain, hernia, gonorrhoea, and in abortion**.** (Orwa *et al.,* 2009).

Habitat and distribution

Dalbergia sissoo is a medium to large-sized deciduous tree, growing up to 30 m in height and 80 cm dbh under favourable conditions. Crown wide spreading and thin. Bark thin, grey, longitudinally furrowed, exfoliating in narrow strips. Develops a long taproot from an early age, and numerous lateral ramifying roots.

Native

Afghanistan, Bangladesh, Bhutan, India, Malaysia, Pakistan.

Exotic

Cameroon, Cyprus, Ethiopia, Ghana, Indonesia, Iraq, Israel, Kenya, Mauritius, Nigeria, Sudan, Tanzania, Thailand, Togo, US, Zimbabwe

Traditional use of various parts

Dalbergia sissoo has been reported to contain various biological activities. It is used in conditions like emesis, ulcers, leucoderma, dysentery, stomach troubles and skin diseases (Chopra *et al.,* 1956; Kirtikar and Basu, 1993 ; Nadkarn, 1954;).Various parts of *Dalbergia sissoo plant* are traditionally used in treating many diseases and are mentioned below:

Bark

Active extracts of bark possess carbohydrates, phenolic compounds, flavonoids and tannins. In the ayurvedic medicinal system, it has been shown to possess properties such as abortifacient, anthelmintic, antipyretic, aperitif, aphrodisiac, expectorant, and refrigerant and also used for controlling anal disorders, dysentery, dyspepsia, leucoderma, and skin ailments (Niranjan SP, *et al.,* 2010). Bark is used for treating Vata disorders such as sciatica, hemiplegia.

Seed

Dalbergia sissoo seed oil is used to treat blue itching, burning on the skin and scabies (Hari and Sanjay, 2012).

Leaves

Rural people in India and Nepal use *Dalbergia sissoo* leaves to treat animals suffering from non-specific diarrhoea. Leaf extract has been used to treat sore throats, heart problems, dysentery, syphilis, and gonorrhoea (Al-Quran, 2008). The juice of the leaves is good for anthelmintic, good for diseases of the eye and the nose. It is used in scabies, burning sensation of the body, scalding urine, syphilis, and digestive disorders (Kirtikar and Basu, 1933; Sharma *et al.,* 2001).Decoction of leaves is used in the treatment of gonorrhoea. Ayurvedics has also prescribed the leaf juice for eye ailments

Wood

The wood was used as anthelmintic, antileprotic and cooling. Arial parts were used as spasmolytic, aphrodisiac and expectorant. Wood is used for the treatment of leprosy, boils, vomiting. **Yunana** use the wood for blood disorders, burning sensations, eye and nose disorders, scabies, scalding urine, stomach problems, and syphilis **(**Kirtikar *et al.,* 1993).

Heart wood

The heart wood is used for treating herpes, vitiligo, and fever. Shimshapa Sara ksheerapaka is indicated in treating fever (Sushruta).

Root

Roots are used for treating diarrhoea and dysentery.

Phytoconstituents from *Delbergia sissoo*

Stem bark

Delbergione, Dalbergin, Methyldalbergin, 4-Phenylchromene, Dalbergichromene and Isotectorigenin (*Dalbergiasissoo* [online], 2012).

Leaves and trunk

Dalbergenone, Dalbergin and methyl dalbergin, 4-phenylchromene, dalbergichromene (Farag *et al.,* 2001; Mukerjee *et al.,* 1971).

Heart wood

Dalbergiphenol, Delbergenone, Dalbergin, Methlydalbergin.

Flowers

Biochenin A, tectorigenin, 7, 4 dimethyletectorigenin and 7-O-methyletectorigenin. Heart wood 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)

Green Pods
Mesoinisitol, 7-O- methyletectorigenin and 4'-rhamnoglucoside.

Mature Pods
Isocaviumin, tectorigenin, dalbergin, caviunin and tannins.

Pharmacological studies
Antidiabetic effect:
Study showed the ethanol, ethyl acetate, n-butanol and petroleum ether extracts of the leaves of *Dalbergia sissoo* were investigated for antidiabetic activity in alloxan induced diabetic rats. The extracts produced a significant antidiabetic effect on first, third, fifth and seventh days at 300 mg/Kg body weight. Among all the extracts of *Dalbergia sissoo,* ethanol extract of leaves exhibited highly significant antidiabetic activity which was comparable with the standard drug, Glibenclamide (Panda, 2016).
Studies showed that alcoholic extracts (250 and 500 mg/kg respectively) and aqueous extract (400 mg/kg) significantly reduced the blood glucose level (P0.05) when compared with glibenclamide. Alcoholic extracts and aqueous extracts significantly restored the lipid profile and showed improvement in liver glycogen, body weight and antioxidant status in diabetic rats (Saini and Sharma, 2013).
The present study was carried out to evaluate the Antidiabetic effect of ethanolic extract of *Dalbergia sissoo* bark was investigated in alloxan induced diabetic rats. Oral administration of *Dalbergia sissoo* at the doses of 250 and 500 mg/kg was studied in alloxan-diabetic rats. The two doses caused significant reduction in blood glucose levels in all the models. The effect was more pronounced in 500 mg/kg than 250 mg/kg. *Dalbergia sissoo* also showed significant increase in body weight and glycogen content in liver of alloxan -induced diabetic rats while there was significant reduction in the levels of serum triglyceride and total cholesterol. *Dalbergia sissoo* also improved significantly pancreas of alloxan-induced diabetic rats. The antidiabetic effect of *Dalbergia sissoo* was compared with glibenclamide, a well-known hypoglycemic drug (Pund *et al*., 2012).
A Study was conducted to investigate the hypoglycemic effect of ethanolic extract of *Dalbergia sissoo* L. leaves in alloxanized diabetic rats. The ethanolic extract of *Dalbergia sissoo* L. leaves was administered orally at different doses (250 and 500 mg kg-1) to normal rats. The dose of 500 mg/kg was found to be more effective dose in oral route and it decreases blood glucose Level (BGL) by 38.2 % in normal healthy rats after 1 day of administration. After daily treatment with the both doses (250 and 500 mg/kg) of ethanolic *Dalbergia sissoo* extract for 21 days to severely Diabetic (FBG 300mg dl -1 , 350 mg dl-1) rats, the BGL reduced to 125 mg dL-1 by 250 mg kg-1 and 104 mg dL-1 by 500 mg kg-1. (Niranjan *et al.,* 2010).

Analgesic and Antipyretic effects
Phytochemical, analgesic and antipyretic activities of ethanol extract of *Dalbergia sissoo* seeds were evaluated. It was concluded that *Dalbergia sissoo* seed extract has moderate analgesic and remarkable antipyretic activities (Hugar *et al.,* 2010).
Alcoholic extract of leaves of *Dalbergia sissoo* significantly decreased the writhing movements in mice in acetic acid-induced writhing test. *Dalbergia sissoo* leaf extract (1000 mg/kg) significantly increased the pain threshold capacity in rats in Randall-Selitto assay and the reaction time in hot-plate test but not in tail-clip test. It also showed significant antipyretic activity in Brewer's yeast-induced pyrexia in rats throughout the observation period of 6 h (Hajare *et al.,* 2000).
The ethanolic extracts of leaves and bark of *Dalbergia sissoo* under study were evaluated for peripheral analgesic activity using acetic acid-induced writhing test in Albino Wistar rats. The writhing movements were observed and counted for 20 min after acetic acid administration into Wistar rats. Results showed significantly decreased writhing movements in rats, throughout the observation period of 5 hrs and moderate peripheral analgesic activity in ethanolic extract of leaves at dose rate of 1000mg/kg and in standard drug Indomethacin this writhing movement were observed and counted for 20 min after acetic acid administration into Wistar rats. (Bhattacharya *et al.,* 2016).

Anti-termite activity
The crude extract of heartwood of *Dalbergia sissoo* Roxb. ex *Dalbergia sisso* possesses highest potential which was further fractionated. 0.2% concentration of a fraction in Chloroform: Methanol (99:1) showed anti-termite activity killing 92% of them (Kharkwal *et al*., 2014).
The Ethanol: toluene (2:1) extract of *Dalbergia sissoo* heartwood were investigated for antitermitic activities. Highest termite mortality occurred at 10 mg/ml with a LC50 at 5.54 and

3.89 mg/ml against *H. indicola* and *R. flavipes*, respectively (Hassan, 2016).

Anti-spermatogenic Activity

This 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 male Swiss albino mice. Ethanol extract at a dose of 200 mg/kg body weight resulted in a significant decrease in weight of the testis and epididymis. A significant decrease in sperm motility and sperm count in the epididymis were observed. The ethanol extract of *Dalbergia sisso* stem bark possesses an immobilizing factor that probably reduces motility by causing sperm nonviability by disrupting the membrane architecture of the sperm cell. (Vasudeva and Vats, 2011).

Aqueous leaf extract of *Dalbergia sissoo* (50 and 100 mg/kg body weight/day) treated mice showed dissimilar degenerative changes in the seminiferous tubules. Significant reductions were noted (i) in epididymal sperm motility, viability and number, and (ii) in level of serum testosterone in *Dalbergia*-treated mice as compared to controls. However, serum levels of alanine aminotransferase, aspartate aminotransferase and creatinine, and hematological parameters were not affected. Also libido of *Dalbergia*–treated males showed no change, but their fertility was markedly suppressed. By 56 days of treatment withdrawal, alterations induced in there parameters returned to control levels. (Verma and Singh, 2014).

Anti-inflammatory Activity

In this study the possible anti-inflammatory activity of a 90% ethanolic extract of *Dalbergia sissoo* bark was 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. 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 anti-inflammatory effects of the extract were compared with a standard dose of indomethacin (10 mg/kg). 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 other groups (300 and 500 mg/kg) throughout the observation period. The active extract of *Dalbergia sissoo* bark contains carbohydrates, phenolic compounds, flavonoids and tannins. Its ethanolic extract at a dose of 1000mg/kg had the most potent anti-inflammatory activity throughout the observation period. (Asif and Kumar, 2009).

This study showed the Treatment with 70% methanolic extract of *Dalbergia sissoo* root in wistar rat 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. A dose of 1000 mg/kg elicited a greater percent inhibition of inflammation after 4 hr. than other groups. Present results showed that test drug at the dose level of 1000 mg/kg have the most potent anti-inflammatory activity. It was concluded that the *Dalbergia sissoo* root extract possessed significant anti-inflammatory activity without any side effect on gastric mucosa. (Sagar and Upadhyaya, 2010).

The 90% ethanolic extract of *Dalbergia sissoo* leaves was studied in different models of inflammation in rats after oral administration at doses of 100, 300 and 1000 mg/kg ethanolic extract of *Dalbergia sissoo* leaves (DSELE) significantly inhibited carrageenin, kaolin and nystatin-induced paw oedema, as well as the weight of granuloma induced by a cotton pellet. It also inhibited dye leakage in acetic acid-induced vascular permeability test in mice. DSELE was devoid of ulcerogenic effect on the gastric mucosa of rats in acute and chronic tests. In acute toxicity studies, it was found to be safe up to 10.125 g_kg, p.o. in rat (Hajare *et al.,*2001).

Anthelmintic activity

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.Ethanolic extract of *Dalbergia sissoo* Roxb. Bark have potent antihelmintic

activity when compared with the conventionally used drug and is equipotent to standard antihelmintic drug tested against worm species. (Upwar *et al.,* 2011).

The extracts of *Dalbergia sissoo* Roxb. in petroleum ether, carbon tetrachloride, benzene and ethanol were used in different concentrations viz. 10, 25, 50 and 100 mg/ml of respectively for *in vitro* testing of anthelmintic potency by determination of time of paralysis and time of death of the worm. It was concluded that *Dalbergia sissoo* potentiate to paralyze earthworm and also caused its death after some time (Hood *et al.,* 2015).

Antidiarrhoeal activity

The findings of the biological assays are indicative of the selective antidiarrhoeal action of *Dalbergia sissoo* leaves. The results suggest that the leaves may not be active against diarrhoea induced by LT and ST or those caused by protozoa and virus. However, it appears to be most efficacious against cholera and diarrhoeal episodes caused by enteropathogenic and enteroinvasive bacterial strains. This study describes the possible mechanisms of antidiarrhoeal action of *Dalbergia sissoo* leaves. *Dalbergia sisso* is antidiarrhoeal and affects bacterial virulence. However, it has no antimicrobial activity. (Brijesh *et al.,* 2006).

Delbergia sisso. Leaf extract (400 mg/kg and 800 mg/kg) showed significant reduction in frequency of defecation up to 75.12% compared to control mice in castor oil induced diarrhoea.The inhibition of charcoal meal transit by *Delbergia sissoo* at dose of 400 mg/kg and 800 mg/kg treated groups was found to be 42.95 and 53.20%.in clinical case of diarrhoea in goats *Dalbergia sissoo* decoction treated group showed complete recovery and normalization of the faeces on 4th day of treatment (Hajare *et al.,* 2016)

The three solvent ether, ethanol, and aqueous extracts of *Dalbergia sissoo* bark were studied for anti-diarrhoeal properties in experimental diarrhoea, induced by castor oil in rats. As the 200 – 400 mg/kg per oral dose, the solvent ether extract showed significant and dose dependent anti-diarrhoeal activity. The extracts also significantly reduced the intestinal transit time in charcoal meal when compared with atropine sulphate (1 mg/kg ip) in the petroleum ether extract was found to be equipotent to atropine. These properties confirm the use of *Dalbergia sissoo* as an anti-diarrhoeal drug as proposed by traditional healers (Kalaskar *et al.,* 2010)

Molluscicidal activity

Crude aqueous and ethanolic extracts from different parts of *Dalbergia sissoo* Roxb. 1832, were evaluated against egg masses and adults of *Biomphalaria pfeifferi* (Krauss, 1848), the snail intermediate host of *Schistosoma mansoni* (Sambon, 1907) in Nigeria. 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 *Dalbergia sissoo* for 24 h. Only the ethanolic extracts of the fruits and roots showed significant activities against the adult snails (24 h LC90<100 mg l(-1): 74.33 and 93.93 mg l(-1), respectively) and their egg masses (LC90: 89.29 and 114.29 mg l(-1), respectively). The crude ethanolic extracts of *Dalbergia sissoo* fruits and roots exhibited promising molluscicidal activities (Adenusi and Odaibo, 2008).

Ethanolic extracts of *Dalbergia sissoo* (Leguminosae family) fruits, leaves, roots and stem bark against adult *Biomphalaria alexandrina*, the snail intermediate host of *Schistosoma mansoni* in Egypt and their egg masses. Adult snails (6 to 8 mm in diameter) and viable 24 h-old embryonated egg masses were separately exposed to seven different concentrations (6.25 to 400 ppm) of extracts for 24 h. The ethanolic extract of the fruits demonstrated significant activity on both adult snails and egg masses (24 h-LC90 value 34.4 and 38.6 ppm, respectively). Mortalities of eggs were manifested at the gastrula/exogastrula and or the pre-hatch snail stage of development. Ethanolic extract of the fruits was the most active with 100% mortality at 50 mg/l, followed by those of the leaves (at 100 mg/l), roots (at 200 mg/l) and stem bark (at 400 mg/l). Their respective 24 h-LC50 and LC90 values for *B. alexandrina* egg masses were 10.8 and 38.6 ppm, 18.5 and 68.3 ppm, 20.4 and 88.4 ppm, 36.8 and 144.6 ppm. The percentage of dead embryos at all stages increased with increasing concentration of extract. Lethality of the ethanolic extract of *Dalbergia sissoo* fruits to embryonated egg masses of *B. alexandrina* is an added advantage to its potential development for use as a plant molluscicide. (El-Din *et al*., 2011).

Antinociceptive activity

The ethanolic extract show antinociceptive activity of the bark extract of *Dalbergia sissoo* may be due to the presence of phytochemical constituents such as flavonoids. The acute toxicity study revealed that ethanolic extract was not toxic up to 3000 mg/kg body weight (Asif and Kumar, 2011).

The extract was assessed for antinociceptive activity using chemical and heat induced pain models such as hot plate, tail immersion, acetic acid-induced writhing, formalin, glutamate, and cinnamaldehyde test models in mice at the doses of 100, 200, and 400 mg/kg (p.o.) respectively. Morphine sulphate (5 mg/kg, i.p.) and diclofenac sodium (10 mg/kg, i.p.) were used as reference analgesic drugs. To confirm the possible involvement of opioid receptor in the central antinociceptive effect of MEDS, naloxone was used to antagonize the effect. This study indicated the peripheral and central antinociceptive activity of the leaves of *Dalbergia sissoo*. (Mannan, *et al.,* 2017).

Neuroprotective effect

Ethanolic extract of *Dalbergia sissoo* leaves was evaluated by checking brain weight, antioxidant levels, histopathological and TTC staining studies in cerebral ischemia induced rats. The extracts (ethanolic 300 and 600 mg/kg) were compared to negative control (global cerebral ischemic rats). It is observed that prior treatment of *Dalbergia sissoo* extract (300mg/kg and 600mg/kg, p.o. for 10days) markedly reversed the brain weight, antioxidant levels and restored to normal levels as compared to I/R groups. Moreover, brain coronal sections staining and histopathological studies revealed protection against ischemic brain damage in the DSE treated groups. From the results obtained, it is evident that the traditional herbal leaf extract had a significant neuroprotective effect. (Swaroop *et al.,* 2013).

Antioxidant activity

A detailed study was performed on the antioxidant activity of the aqueous and methanol extracts (AED and MED respectively) of the stem bark of the plant, *Dalbergia sissoo* Roxb. The antioxidant activity of the extracts was measured by *in vitro* chemical analyses involving the assays of (1) 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity (2) ferric ion reducing power (3) ferrous ion chelating activity and (4) Gold nanoparticle formation potential. A simplified method was developed based on Gold nanoparticles formation to assess the antioxidant activity of any plant extract, and was used for the first time to assay the antioxidant activity of AED and MED. In all the assays, AED showed significantly greater activity over MED. (Nayan Roy, *et al.,* 2011).

Quantitative analysis of antioxidative components like total phenolic content, total flavonoid content, total antioxidant capacity were estimated using spectrophotometric methods The reducing power assay was determined according to the method of Oyaizu. Various concentrations of plant extracts were mixed with 1ml of 200mmol/l sodium phosphate buffers (pH6.6) and 1ml of 1% potassium ferricyanide. Antioxidant activity of extracts of bark using two methods. The reducing power assay and hydrogen peroxide scavenging activity. The results obtained show that this plant contain high enough levels of phenolic and flavonoid compounds responsible for antioxidant activity (Lakshmi and Jayshree, 2014).

Antioxidant and free radical scavenging activities were performed by using Nitric oxide radical scavenging, DPPH radical scavenging activity, Hydrogen peroxide radical scavenging and reducing power methods. The reductive ability of DSME was more than that of standard i.e., ascorbic acid, Total phenolic contents, total flavonoid content was also measured by using standard procedures. On the basis of observations it can be concluded that the extract possesses potent antioxidant activities. It has shown free radical scavenging activity when tested in different models. The scavenging effect on DPPH and superoxide radicals represents the fraction direct radical scavenging activity. It is well documented that free radicals are responsible for several diseases. *Dalbergia sissoo* has an ability to combat various diseases having mechanism of oxidative stress (Govindula *et al.,* 2017).

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. The results of the present investigations established that, among the different extracts of stem bark of the plant *Dalbergia sissoo,* chloroform extract possesses marked antioxidant activity, whereas methanol extract showing moderate activity in different *in vitro* antioxidant assays. Strong positive correlation was observed between the total phenolic content and different antioxidant assays which helped to conclude that phenolic compounds in the extracts of *Dalbergia sissoo* are able to scavenge DPPH, ferrous and nitric oxide and have reducing potential in addition to their ability to chelate metals such as iron (Kaur *et al.*, 2011).

Osteogenic activity

One new isoflavoneglucoside, 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 a series of isoflavones and flavonols with their glucosides and a lignanglucoside were isolated from the ethanolic extract of *Dalbergia sissoo* leaves and were assessed for osteogenic activity in primary calvarial osteoblast cultures. Result showed that compounds exhibited significant osteogenic activity. (Dixit *et al.,* 2012).

In vitro antiosteoporotic activity of neoflavonoids, isolated from *Dalbergia sissoo* heartwood. was performed by Neoflavonoids were isolated using extensive column chromatography and identified as dalsissooal (1) a new compound and cearoin (2), dalbergin (3), 4-methoxy dalbergion (4), dalbergiphenol (5), dalbergichromene (6), methyl dalbergin (7) and latinone (8) as known compounds by comparison their spectroscopic data with those reported in the literature. Among the screened compounds, compounds 1, 3, 5-8 significantly increased proliferation as assessed by alkaline phosphatase activity and mineralization in calvarial osteoblast cells (Kumar *et al.,* 2014).

Antiulcer activity

The present study was aimed to evaluate the Antiulcer activity of crude ethanolic bark extract of *Dalbergia sissoo* using pylorus ligation and Indomethacin induced ulcer model in Wistar albino rats.Antiulcer activity was evaluated by using four groups as; control (tween 80 1% v/v solution, 5 ml/kg), standard (Ranitidine 80 mg/kg), 250 mg/kg and 500 mg/kg of bark extract given orally. The significant decrease in mean ulcer index in EBED treated group in both the models compared to control. Furthermore, significant decrease in the offensive factors like free and total acidity, pepsin content and protein content was observed whereas significant increase in the defensive factors like total carbohydrate content and TC:TP as compared to control in dose dependent manner. .The antiulcer effect of EBED may be due to any of the probable mechanisms viz. reduction in gastric acid secretion, antioxidant action, mucoprotection or gastric cytoprotection attributed by the presence of various secondary metabolites. (Baral *et al.,* 2016)

The *Dalbergia sissoo* stem bark methanol extract (200 mg/kg and 400 mg/kg body weight) was orally administered to rats once a day for 10 days in diclofenac-treated rats. The gastroprotective effects of DSME were determined by assessing gastric-secretory parameters such as volume of gastric juice, pH, free acidity, and total acidity. Administration of DSME significantly decreased the ulcer index, TBARSs, H2O2, and MPO activity in gastric mucosa of the ulcerated rats. Activities of enzymic antioxidants, CAT, SOD, GSH-Px, GST and GSH, and NP-SH contents were significantly increased with DSME administration in the gastric mucosa of diclofenac-treated rats (Khan *et al.,* 2013)

Immunomodulatory activity

The Immunomodulatory effect of *Dalbergia sissoo* bark by using four methods named as Humoral immune response, WBC count, cellular immune response, and Carbon clearance test. Administration of *Dalbergia sissoo* produced a significant stimulation of immune system. The Metabolic extract of *Dalbergia sissoo* bark dose of 250 and 500 mg/kg body weight was used. Control saline (0.9% w/v NaCl) was used as a general vehicle. Administration of *Dalbergia sissoo* produced a significant stimulation of immune system and also it can be concluded that the immunostimulatory property of extract was dose dependent. (Govindula, 2017).

Antibacterial Activity

Antibacterial activity of ethanolic, distilled water and methanol extract of the leaves of *Dalbergia Sisso* Roxb. was studied against *Escherichia coli* and *Bacillus licheniformis* by agar well diffusion method. The growth of both *E.coli* and *B.licheniformis* was inhibited by all the three extracts of dried Leaf Extracts of *Dalbergia Sisso* Roxb.The root extracts of *Dalbergia Sissoo* Roxb. have potent antibacterial activity when compared with conventionally used drugs and is almost equipotent to the standard (gentamycin) antibacterial drug (Chhabra *et al.,* 2016).

Toxicity

In a acute toxicity study, all mice survived and did not manifest any sign of toxicity and abnormality at the doses between 50–3000 mg/kg. After oral administration, there was no behavioral or body weight changes and no abnormal signs were observed for a period of 7 days. However it can be indicated that methanol extract of *Dalbergia sissoo* leaves (MEDS) has low toxicity profile and the LD50 is more than 3000 mg/kg. (Mannan *et al.,* 2017).

The bark extract of *Dalbergia sissoo* in ethanol was nontoxic up to 3000 mg/kg body weight in Swiss albino mice (Asif M and Kumar, 2011). Acute toxicity studies were carried out on Wistar rats. Alcohalic bark extracts at the dose of 50, 100, 300, 1000, and 3000 mg/kg body weight were administered after overnight fasting. Acute toxicity studies did not reveal any toxic symptoms or death in any of the animals up to the dose level of 3000 mg/kg body weight

(Ul-Islam and Elhddad, 2012). 90% ethanolic extract was also safe up to 3000 mg/kg, orally in the rats (Asif and Kumar, 2009).The single oral dose of *Dalbergia sissoo* did not produce any signs of toxicity or mortality within 04 hours in all animals, when observed continuously and was found to be safe at 5000 mg/kg in mice (Pund *et al.,* 2012).

CONCLUSIONS

All the parts of the medicinal plants *Delbergia sissoo* possess several pharmacological activites like Antidiabetic , Antioxidant, Analgesic, Antipyretic, Anti-termite, Anti-spermatogenic, Anti-inflammatory, Anthelmintic, Antidiarrhoeal, Molluscicidal, Antinociceptive, Neuroprotective, Antioxidant and Osteogenic activity. Different parts of the plant contain phytochemical constituents such as glycosides, flavanols, tannins, saponins, sterols and terpenoids. Despite the frequent use of *Delbergia sissoo* in traditional medicines, various systematic pharmacological and phytochemical studies are done, assessing its therapeutic properties. In this review article, effort has been taken to collect and compile the details regarding medicinal properties *Delbergia sissoo* which will be useful to the society to venture into field of alternative systems of medicine.

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