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A PHYTOCHEMICAL AND PHARMACOLOGICAL STUDY OF SHEESHAM

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ABSTRACT
In traditional medicinal trees, Dalbergia sissoo is a popular species around the world. It has been used for the therapeutic purpose from 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 as an antimicrobial agent. Several chemical constituents have been isolated and identified from different parts of the plant belonging to the category of alkaloids, glycosides, flavanols, tannins, saponins, sterols and terpenoids. Compounds isolated from Dalbergia sissoo like an isoflavone, biochanin is a potent chemotherapeutic cancer preventive agent with a distinct estrogenic activity. D. sissoo possesses several pharmacological activities; however, it is essential that more clinical and pharmacological studies should be conducted to investigate the unexploited potential of this plant. A review of plant description, phytochemical constituents present, traditional uses and pharmacological activities of Dalbergia sissoo. Natural plant products have been used throughout human history for many purposes. Dalbergia sissoo is also an herbal medicinal plant that belongs to the family Fabaceae (Leguminosae). Therefore, the aim of the present review is an effort to give a detailed survey of the literature on its traditionally medicinal use, morphology, phytochemistry, and pharmacological activities of the plant Dalbergia sissoo. Dalbergia sissoo is traditionally used to treat various systemic diseases and disorders such as cardiac diseases, gastrointestinal related disorders and diseases, sexual diseases, and skin diseases. It contains many active constituents, i.e., flavonoids, alkaloids, glycosides, carbohydrates, tannins proteins, fatty acids, and amino acids, useful in treating various types of diseases. Plant part extracts from Dalbergia sissoo are reported on anti inflammatory, anti-termite, anti-diabetic, analgesic and antipyretic, anti helminthic, antioxidant, antimicrobial, antinociceptive, osteogenic, anti spermatogenic, gastroprotective, neuroprotective, anti-molluscicidal, anti larvicidal, antiulcer, immunomodulatory, antibacterial activity. Dalbergia Sissoo, Indian rosewood which is a deciduous forest tree. It is natively found in Indian subcontinent. It is called as Shisham which is best known premier timber tree. It is also used as fuel wood with its multiple product uses and agro-forestry application, it is consider as best timber wood tree. Dalbergia is a genus of trees, shrubs and woody climbers widely distributed in tropical and sub- tropical regions. It possesses immense traditional application. Various species are widely used as analgesic, anti-inflammatory, antipyretic, antimicrobial, anti diarrheal, anti- ulcerogenic, anti-spermicidal, larvicidal and mosquito repellant in the traditional system of medicines. Chemical investigation has resulted in characterization and isolation of various phytoconstituents. This review is compilation of chemical composition and biological activities of the various species of the genus Dalbergia. Nature has been a good source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources, many based on their use in traditional medicine. Various medicinal plants have been used for years in daily life to treat diseases all over the world. The present study reveals the medicinal values of Dalbergia sissoo DC. (Fabaceae). In this communication, we reviewed the Phytochemistry and its applications in the treatment of various ailments. The genus consists of 300 species among which 25 species occur in India.

KEYWORDS: Dalbergia sissoo, Indian rosewood, Antipyretic, Antimicrobial, Antidiabetic.

D. sissoo is an important medicinal plant and generally known as sisu, shisham, tahli, apex at different corridor of world and belongs to family Fabaceae. Dalbergia sissoo (sheesham or seesam) is a precious tree in India. It grows naturally indeed without colony and mortal care and it can also be planted in alluvial soils it grows at a large scale in India. It grows in multitudinous corridor of india and can spread up to 900 m in sub Himalayan tracts, occasionally adding up to 1500 m. in its natural niche the tree grows truly diligently in new clod in the sub Himalayan sluice beds and sluice banks. It grows in mound ranging from 0 to 1500 m. it constantly forms mixed timbers with Acacia catechu, shorea robustu or pinus roxburghii. The tree can grow under mean periodic temperature of- 4 to 45c and requires mean periodic downfall of 500 to 4500 mm. The tree requires respectable moisture force and grows rather by well drained sandy earthy soils. The tree rarely grows on muddy soils under natural circumstances (Troup, 1921). The tree can survive occasional flooding but can't combat water logging. multitudinous provident uses of D. Sissoo's Hardwood are well-known in the whole world but lower people know that this plant's different corridor have various pharmacological uses.[1] Dalbergia sissoo, also known as Indian Rosewood or Sheesham, is a versatile and resilient tree native to the Indian Subcontinent and Southern Iran. Its presence spans various climates and terrains, thriving predominantly along riverbanks, where it can tolerate a range of soil types, from sandy to fertile alluvium. This deciduous tree plays a significant cultural and ecological role: it is the state tree of Punjab, India, and the provincial tree of Punjab, Pakistan. Indian Rosewood is well adapted to varied environmental conditions. It can endure moderate annual rainfall (up to 2,000 millimeters) and withstand droughts lasting 3-4 months. Its tolerance to slightly saline soils adds to its adaptability. However, seedlings require direct sunlight, as they are sensitive to shade. Dalbergia sissoo's ability to thrive at elevations ranging from sea level to 1,300 meters (4,300 feet) further showcases its resilience. Its durable, fragrant wood, prized for furniture and carpentry, contributes to its economic value across the region.[2] Antimicrobial: These are substances that kill or inhibit the growth of microorganisms like bacteria, fungi, or protozoa. They can be divided into two categories: Microbiocidal: Substances that kill microbes. Microbiostatic: Substances that prevent the growth of microbes. Antibiotics: Antibiotics are a specific type of antimicrobial agent that targets bacteria. The term "antibiotic" originally referred to compounds derived from microorganisms that inhibit or kill bacterial growth. Antibiotics are typically small, organic molecules that, at low concentrations, can significantly disrupt bacterial growth or metabolic processes. They are typically used to treat bacterial infections but may also affect other microorganisms. Antibacterial: This term refers to substances that specifically kill or inhibit the growth of bacteria. Although it was once used synonymously with "antibiotics," the term now has a broader meaning, referring to any antimicrobial compound with antibacterial properties. This includes not only antibiotics but also antifungals and other compounds used to treat various microbial infections.[3] Botanical and Ecological Information: Scientific Name: Dalbergia sissoo Family: Fabaceae (Legume family) Common Names: Indian Rosewood, Sheesham, Sisu, Tahli, Tali Native Region: Himalayan foothills in Northern India, also found in Pakistan, Burma, Sri Lanka, Mauritius, and has been introduced in tropical and subtropical regions of Africa, America, and other countries. Habitat: Prefers riverbanks and can grow at elevations up to 1,300 meters. It thrives in areas with average rainfall up to 2,000 millimeters and can endure drought conditions lasting up to 3-4 months. Soil Type: Grows in a range of soils, from pure sand and gravel to rich alluvium, and even slightly saline soils. Economic and Ecological Importance: Timber: Dalbergia sissoo is an important timber tree, valued for its hard, strong, and elastic wood. The wood is used for a wide range of products, including furniture, doors, window frames, flooring, boats, and cabinets. It is also used in papermaking. Soil Enrichment: The tree has nitrogen- fixing bacteria in its roots, which enriches the soil. The fallen leaves contribute to improving the soil quality by returning organic matter and nutrients. Medicinal Uses: Dalbergia sissoo is also valued for its medicinal properties, particularly

in traditional practices like Ayurveda: Wood and Bark: The wood and bark are used for treating various ailments, including: Abortifacient: Used in traditional medicine to induce abortion. Anthelmintic: Helps expel parasitic worms. Antipyretic: Reduces fever. Aphrodisiac: Improves sexual health. Expectorant: Helps in clearing mucus from the airways. Refrigerant: Used to cool the body and relieve heat. In Africa, it is commonly used for treating wounds and gonorrhea. Ecological Role and Growth: Growth Conditions: The tree can adapt to a wide range of climatic conditions, making it suitable for various environments. It grows well in both wet and dry conditions and is a resilient species. Cultural Importance: Dalbergia species, especially D. sissoo, are also culturally significant in many parts of the world for their timber and medicinal uses. This combination of ecological adaptability, timber value, and medicinal uses makes Dalbergia sissoo a highly valuable and versatile species.[11] Flavones and isoflavones (compounds with antioxidant and anti-inflammatory properties) Quinones and coumarins (which may have antimicrobial or anticancer effects) Specific compounds like tectoridin, caviunin-7-O- glucoside, iso-caviunin, tectorigenin, dalbergin, bio-chanin A, and 7-hydroxy-4- methylcoumarin, which might have diverse medicinal benefits. Additionally, the heartwood of the tree has yielded other bioactive compounds like: 3,5-dihydroxy-trans-stibene Dalbergichromene, Dalbergenone, Iso-dalbergin The medicinal benefits of Dalbergia sissoo are extensive, as it is traditionally used in treating a wide range of ailments: Blood diseases, syphilis, stomach issues, dysentery, nausea, and ulcers Eye and nose disorders, skin diseases As an aphrodisiac and expectorant Known for its anti-inflammatory, analgesic, antipyretic, and larvicidal properties It also has nitric oxide production inhibition activity, which can have various health benefits, especially in the cardiovascular system.[4] The genus *Dalbergia*, which includes around 300 species, with about 25 species found in India. Many of these species are significant for their timber, often valued for their decorative qualities, fragrance, and the presence of aromatic oils. The wood of *Dalbergia* is used in various industries, including furniture-making, musical instruments, and carvings. Additionally, *Dalbergia* species have a long history of use in traditional medicine. The plant's different parts—such as the bark, leaves, and wood—are said to possess medicinal properties. Some of the reported uses of *Dalbergia* species in traditional medicine include:

Aphrodisiac, Abortifacient, Expectorant (helps with mucus clearance from the respiratory tract), Anthelmintic (against intestinal worms),Antipyretic (reducing fever), AppetizerRelieving thirst, Treating vomiting, burning sensations, and skin diseases, Healing ulcers, Blood disorders, Treating eye and nose diseases, syphilis, stomach issues, leprosy, scabies, and ringworm.[7] Dalbergia Sissoo, commonly known by various names like Sisu, Shisham, Tahli, Iruguduyam, and Jag, is a species native to regions of South Asia, particularly in India, Pakistan, Burma, Sri Lanka, and Mauritius.

In India, Dalbergia Sissoo is primarily found growing in the central Himalayas, particularly along the hilly areas and riverbanks with rich alluvial soil. It thrives at an elevation of around 3,000 feet above sea level. Its prominent distribution in Punjab (both in India and Pakistan) makes it an important species in the region. The trees of Dalbergia Sissoo are quite tall, typically ranging in height from 30 meters to 80 meters.

This tree is valued for its hardwood, which is used in various applications, including furniture and construction, as well as its ecological role in maintaining soil health and preventing erosion in the regions it grows.[1] Shisham (Indian Rosewood) is highly regarded internationally for its timber, which varies in characteristics depending on the species. The heartwood of Shisham typically ranges from golden to dark brown, while the sapwood is lighter, from white to brown. This wood is known for being durable, tough, and resistant to wear, making it a valuable material in various applications.

Shisham is commonly used in forestry for afforestation efforts due to its adaptability and growth speed. It is also planted along roadsides and used as a shade tree in tea plantations.

The tree's morphology exhibits considerable variation, particularly in its leaves, pods, and flowers. One of its remarkable features is its excellent coppicing ability, allowing it to regenerate from stumps or roots after being cut back. This quality makes it an attractive choice for sustainable forestry practices.

Shisham has a long taproot system, which allows it to anchor deeply into the soil, along with a surface root system that supports its growth. The tree also produces suckers, which can be used for propagation, further aiding in its cultivation.[6]

Fig. 1: Dalbergia sissoo leaves.

Fig. 2: Dalbergia sissoo Po.

This structured plan ensures a comprehensive study that integrates phytochemical and pharmacological aspects, enabling the discovery of *Dalbergia sissoo's* full potential.

Morphology - General Characteristics: Size: Medium to large tree, typically growing up to 25 meters in height. Trunk: Grey-yellow with longitudinal cracks, and twigs that are drooping. Root system: Features a long taproot and numerous surface roots, which can produce suckers. Leaves: Type: Pinnately compound and alternate. Size: The leaves are leathery and about 15 cm in length. The individual leaflets are 6 cm long, broadest at the base, and taper to a fine pointed tip. Petiole: The leaflets are attached via a petiolated stalk. Flowers: Color: Whitish to pink, fragrant. Structure: Nearly sessile, clustered densely. Pods and Seeds: Pod: The pods are oblong, flat, thin, strap-like, measuring 4–8 cm long and about 1 cm wide. They turn light brown when mature. Seeds: Each pod contains 1 to 5 flat, bean-shaped seeds measuring 8–10 mm in length. Bark and Shoots: Bark: The bark is light brown to dark grey, 2.5 cm thick, shedding in narrow strips. Shoots: Young shoots are downy and drooping. Crown: Crown: The upper branches are large and support a spreading crown, giving the tree a broad canopy. Ecological Notes: Dalbergia sissoo is often found in riverine and floodplain habitats and is valued for its hardwood, which is used in furniture-making and construction. It is also known for its resilience to various environmental conditions, making it a popular species in afforestation projects, especially in areas prone to soil erosion.[2] General Characteristics Height Can grow up to 25 measures (about 82 bases) in height. box The box has a slate- unheroic color and can reach a periphery of 2 to 3 measures. Root System It has a deep taproot with multitudinous face roots that produce suckers. Dinghy The dinghy of the tree is light brown to dark slate, with a consistence of over to 2.5 cm, and sheds in narrow strips. Leaves Type Pinnately emulsion and alternate size each splint measures roughly 15 cm long, with individual circulars being 4 to 6 cm long. Shape The circulars are widest at the base and have a fine, pointed tip. Texture The leaves are tough and have a petiolated stalk. Flowers Color Whitish to pink fragrance the flowers are ambrosial. Arrangement Nearly sessile and grow in thick clusters. Capsules and Seeds capsules the capsules are oblong, flat, swatch- suchlike, and measure 4 to 8 cm long and 1 cm wide. They're light

brown in color. Seeds The capsules contain 1 to 5 flat, bean- shaped seeds, each about 8 to 10 mm long. The seeds are light brown, dry, hard, order- shaped, and flat. Wood Sapwood White to blench brown in color. Heartwood Golden to dark brown, known for its continuity and fine texture, making it precious in the cabinetwork and woodcraft diligence. Other Features Young Shoots Downy and drooping. Growth Habit Known for being a fast- growing species and frequently cultivated for its wood. Dalbergia sissoo is prized for its high- quality wood, which is used in cabinetwork timber, flooring, and for ornamental purposes due to its continuity and seductive appearance. It's also valued for its shade and capability to grow in a variety of soil types, making it a useful tree for agroforestry and afforestation systems.[4,8] Root System: The long taproot and numerous surface roots, with the ability to produce suckers, point to a plant that is resilient and capable of vegetative propagation. Bark and Growth Habit: Established stems with light brown to dark grey bark that sheds in narrow strips suggest a species with a somewhat rough or peeling bark, which could be indicative of a tree or large shrub. Nitrogen Fixation: The plant has root nodules that house nitrogen-fixing bacteria, which enriches the soil around it, benefiting other plants in the area. Soil Fertility: The leaf litter of this plant contributes to soil fertility by adding important nutrients such as nitrogen, potassium, iron, manganese, and organic carbon, further suggesting its role in ecosystem health. Propagation: The plant can propagate by seeds and root suckers, which helps it spread quickly in suitable environments. Medicinal Use: Various parts of the plant are used for medicinal purposes, which implies it might have a history of traditional or herbal medicinal use.

Flowering Period: The flowering period from March to May indicates its season of bloom, potentially relevant to its medicinal or ecological benefits.[10]

(i) Macromorphology- Height - 45 to 60 feet Spread - 30 to 40 feet Crown Uniformity - Irregular Outline or Silhouette Crown Shape - Oval Crown Density - Open Growth Rate - Fast Texture - Medium

(ii) Foliage-Leaf Arrangement – Alternate Leaf. Type - Odd pinnately compound Leaflet Margin - Entire Leaflet Shape - Elliptic (Oval) Orbiculate Leaflet Venetions - Pinnate Leaf type and – Semi green Persistant Leaflet blade length - 2 to 4 inches Leaf colour - Green (dark) Fall Colour - No change

(iii) Flower- Flower colour - White Flower characteristics - Pleasant, fragrance, inconspicuous and not showy spring flowering.

(iv) Fruit -Shape - Elongated; pod Length - 3 to 6 inches; general 1 to 3 inches Fruit covering - dry or hard Fruit- does not attract characteristics wildlife; not showy; persistent on tree.

(v) Trunk and Branches- Trunk/bark/branches:- Bark is thin and easily damaged from mechanical impact, droop as the tree grows and will require pruning for vehicular, not showy, no thorns. Wood - breaks or cracks weak stem Twig colour - brown-older ones green - younger ones Twig thickness- medium Light cast - The tree casts light shade due to the open canopy .Wood - Hard, heavy, strong durable, elastic, decay, resistant.

(vi) Light Requirement Tree grows in part shade/part sun; or tree grows in full sun. Soil tolerance - clay, loam, sand, acidic, occasionally wet, well-drained. Draught tolerance - moderate Aerosol salt tolerance - low Roots - tape root system\surface roots.

(vii) Habitat -. Temperature varies from 39 to 49 0C – maximum 4 to 6 0C – minimum rainfall varies from - 760 to 457 mm.

(viii) Soil state-. 1. Typical alluvial ground soil. 2. Beds of river. 3. Sand or gravel soil. 4. Often gregariously. 5. Porous well irrigated soil. 6. Adequate moisture 7. Often grown in hilly cliffs. 8. It is moisture losing species. 9. Morphology variation in different seasons and on same plant.

(ix) Leaf Variation- . Two types morphotypes have been identified.
(i) Very small leaflet (ii) Large leaf (iii) Average size of leaves recorded with scale manually.

(x) Leaf- Pinnately compound swollen base Rachis - 3.4 - 9 cm long Leaflet - 3-5 in number Petiole - 3.5 - 6 mm Small leaves - 2.69 - 0.27 cm length - 2.19-0.26 mm breadth Average length - 5.44 - 0.28 cm Average breadth - 4.91 - 0.22 cm.

(xi) Branching - Branching ranged from upright branching to looping type pattern. Bark colour - brown to black.

(xii) Flowering intensity. Trees with very dense flowering and very thin flowering were also identified. Difference was identified in flowering period also. The change of flowers observed due to environmental changes. Trees bears more flowers, bears more pods while those bears less flowers bears less pods Flowering behaviour Flowering starts (a) Initiation - 2nd week of March (b) Peak - 1st week of April (c) Decline - 4th week of April.

(xiii) Inflorescense -An axillary panicle composed of several short spikes with sessile to sub sessile flowers. 7-14 in a twig of inflorescence. Flower - Pea shaped toothed calyx 5-petals include - 2 wings, 1-standard, 2- kell. colour - white to yellowish. Variability: change from white to yellow. After pollination: yellow to orange - yellowish. Androecium - 9-stamens united to a broad stalk monadelphous 5 large + 4 small Petals size - 0.9 - 0.7 cm Length of stamens- 0.79 to 0.2 cm Gynoecium (pistle) - Hairy - 0.85 - 0.69 cm Ovary stalked ovules - 5-6 style - short stigma - dot like Anthesis data on flower opening. Opening time - 10.00 hrs to 14.00 hrs. with a peak between 11.30 to 13.30 hrs. Dehiscence of anthers - mornings hours stigma - Shiny and sticky Pallon grains - 3 zonocolpate thin walled spherical size - 10.2 μm to 0.11 μm Pollination - 56% Mode of Pollination - by inserts and birds when the flowers were in stage of withering self pollination. Pollination in bud stage effective.

(xiv) Pods- Number - 4,7 or 5. Length - 4.7 to 5 cm Breadth - 7.4 mm to 7.48 mm 100 pod weight = 6.459 to 8.315 gm Average = 7.055 gm Number of seeds in pods - 1 to 4 seeds Cotyledons - endospermic - funicle attachment to the pod wall At maturity - Testa becomes hard and brown in colour. - dehydration takes place Colour - brown to black.

(xv) Distribution in India - Dalbergia Sissoo is Indian rosewood tree, it is timber species of India, grows naturally, planted on alluvial soil, widely distributed on river in beds in sub-Himalayan tract grom Indus to Assam and Himalayan valleys. Grows at 900 m tract to 1500 m. Grows pure or mixed species khair-Sissoo (Acacia catechu) Found in - Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Uttar Pradesh, Delhi, Bihar, Orissa, West Bengal, Sikkim, Arunachal Pradesh, Assam, Nagaland, Manipur, Mizoram, Meghalaya, Tripura, Madhya Pradesh, Gujarat, Maharashtra. Andhra Pradesh, Pondicherry, Tamil Nadu, Karanataka, Kerala

(xvi) Alien Range-Atlantic Ocean Australia Benin Cameroon Costa Rica Cyprus Ethiopia French Polynesia Gabon Ghana Indonesia Iraq Kenya Mauritius New Caledonia Nigeria Senegal South Africa Sri Lanka Sudan Taiwan Tanzania Thailand Togo USA Zimbabwe Native Range Bhutan, India, Myanmar, Nepal, Oman, Pakistan.[6]

Geographical distribution

Dalbergia sissoo, commonly known as Indian rosewood or Sissoo, is a species of leguminous tree that is native to the Indian subcontinent and is widely distributed across various tropical and subtropical regions. It is found in both natural and planted forests, thriving in countries such as: Pakistan India Bangladesh Israel Afghanistan Persia (modern-day Iran) Iraq Kenya United States Tanzania The tree is highly valued for its durable wood, which is used in furniture making, cabinetry, and sometimes in the production of musical instruments. It is also known for its ability to tolerate a wide range of climatic conditions, making it suitable for a variety of environments.[2,10] The Exotic Range refers to the areas where this species has been introduced but is not native, including countries such as Afghanistan, Bangladesh,

Bhutan, India, Malaysia, and Pakistan. The Native Range includes the countries where the species originates, such as Cameroon, Cyprus, Ethiopia, Indonesia, and others.[4,8]

Fig. 3: Dalbergia sissoo seeds.

Fig. 4: Dalbergia sissoo flower buds.

Phytochemical constituents of Dalbergia sissoo

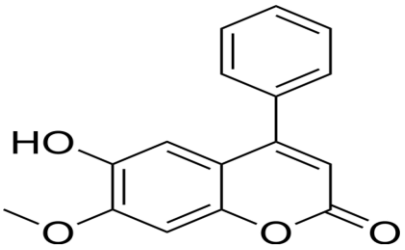
Isoflavone-Oglycoside – This class of compounds, which includes isoflavones, is noted for its estrogenic properties and potential anti-cancer activities. Isoflavones are sometimes used for their potential to influence hormone-related cancers and have antioxidant properties. Biochanin A – A type of isoflavone that exhibits potential chemotherapeutic properties. It is particularly recognized for its estrogenic activity, which could be useful in the prevention and treatment hormone-sensitive cancers such as breast cancer. Tectorigenin and Derivatives (7,4-dimethyl tectorigenin, 7-O-methyl tectorigenin) – These flavonoid compounds are noted for their antioxidant, anti-inflammatory, and potentially anti-cancer effects. Mesoinositol – A type of inositol that may have neuroprotective properties, potentially useful for cell signaling and metabolic regulation. 4'-Rhamnoglucoside – A glycoside derivative that may contribute to the pharmacological effects of Dalbergia sissoo. Isocaviumin – Likely related to the flavonoid class, but specific details about its activity are less well-known. It could have potential antioxidant or anti-inflammatory effects. Dalbergin, Caviunin, and Tannins – These compounds are typically associated with strong antioxidant and anti-inflammatory properties, with potential applications in cancer prevention and other therapeutic areas. Dalberginone, Dalbergia, Methyl Dalbergia, Dalbergichromene – These compounds are derived from Dalbergia species and are thought to contribute to its therapeutic potential, especially in terms of anti-inflammatory, anti-cancer, and antioxidant properties. Nordalberginones – These are related to dalberginones and may also contribute to the biological activities of the plant. Fixed Oils and Essential Oils – Often used for their aromatic and medicinal properties, these oils could have antimicrobial, anti-inflammatory, and pain-relieving effects.[2] Delbergione – A bioactive compound that may contribute to the plant's medicinal properties. Dalbergin – Known for its antioxidant and anti-inflammatory activities. Methyldalbergin – A derivative of dalbergin with possible additional therapeutic effects. 4-Phenylchromene – A flavonoid-like compound that may exhibit antioxidant and anti-inflammatory properties. Dalbergichromene – A compound related to the chromene family, possibly with bioactivity. Isotectorigenin – A flavonoid with potential anti-inflammatory and antioxidant effects.[11] Dalbergin: A flavonoid glycoside often associated with the Dalbergia species, with potential antioxidant or anti- inflammatory effects. Methyl Dalbergin: A methylated derivative of Dalbergin, which could alter its bioactivity or pharmacological effects. 4-Phenylchromene: A flavonoid-related compound, typically associated with various bioactive properties, such as antioxidant effects. Dalbergichromene: Another compound of the Dalbergia species, possibly related to the plant's pharmacological properties. 2. Heartwood:

Dalbergiphenol: A polyphenolic compound, likely with antioxidant properties. Delbergenone: Possibly another variation of Dalbergenone or a related compound with similar activity. Dalbergin: As above, present in both leaves/trunk and heartwood. Methyl Dalbergin: Again, a methylated form, which might have distinct bioactive properties from the non-methylated form. 3. Flowers: Biochanin A: A type of isoflavonoid, known for its antioxidant and anti-inflammatory activities. It's commonly found in various legumes and may contribute to the plant's therapeutic properties. Tectorigenin: A flavonoid with potential anti-cancer, anti-inflammatory, and antioxidant effects. 7,4-Dimethyl Tectorigenin: A methylated derivative of tectorigenin, which might exhibit altered potency or bioactivity. 7-O-Methyl Tectorigenin: Another methylated form, which could have different pharmacokinetic or bioactive properties than the parent compound.[10] Heartwood: Fixed oil: Contains fatty acids such as: Myristic acid Palmitic acid Stearic acid Arachidic acid Linoleic acid Oleic acid Essential oil: Includes sesquiterpene derivatives like: Bisabolene Nerolidol Green Pods: Mesoinositol (a sugar alcohol) 7-O-methyl tectorigenin (a flavonoid or isoflavonoid glycoside) 4'-rhamnoglucoside (a glycoside containing rhamnose, a sugar) Mature Pods: Isocaviumin (a flavonoid glycoside) Tectorigenin (a flavonoid) Dalbergin (likely another flavonoid or related compound) Caviunin (possibly a flavonoid or isoflavonoid) Tannins (polyphenolic compounds with astringent properties) These components suggest that the plant may be of medicinal or therapeutic interest, given the presence of bioactive compounds like flavonoids, tannins, and essential oils, which are known for their antioxidant, anti- inflammatory, and antimicrobial properties.[4]

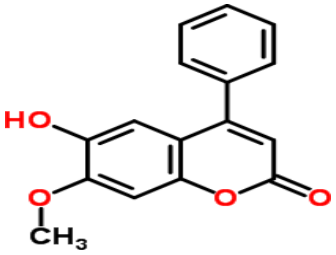
Chemical constituents

Dry weight of Dalbergia sissoo leaves was found to contain the following constituents: The crude protein (18.4–24.1%), fat (3.5–4.9%), nitrogen-free extract (48.5%), crude fiber (19.3–26.1%), ash (8.43–12.0%), calcium (1855.0 mg/100g), and phosphorus (270.0 mg/100g). Phytochemical analysis of the ethanolic extract revealed the presence of carbohydrates, proteins, amino acids, phenolic compounds, flavonoids, alkaloids, saponins, phytosterols, steroids, and tannins. The ethyl acetate fraction of Dalbergia sissoo yielded several compounds, including: R-(2,2,3,3-2H4) Butyrolactone (3.58%), Formic acid, 1-methylethyl ester (7.38%), Propene 3,3,3-D3 (4.22%), 2-Propanamine (3.03%), 2-Amino-1-propanol (1.71%), Pentanal (2.29%), Guanosine (2.02%), Acetaldehyde (1.47%), Cyclobutanol (0.47%), 3-Amino-2- ethylbutanoic acid (2.63%), 2-Oxo-Butanoic acid (1.49%), Benzenemethanol, 2-2-aminopropoxy (7.29%), 2-Fluoro-betahydroxy benzeneethanamine (1.00%), L-Alanine, methyl ester (1.49%), 3-Hydroxycarbonyl-2,5-diethylpyrrolidine (7.83%), 1,2- Benzenedicarboxylic acid dibutyl ester (13.68%), 2,2-Dimethyl-4-methylaminobutanone (5.27%), 5-Nitro,2,4-Pyrimidinedione (7.94%), 2-Isocyanato-Propane (6.56%), and Oxirane (1.98%). A chalcone (E)-3-(3,4-dihydroxyphenyl)-1-(2,3,4-trihydroxyphenyl) prop-2-en-1- one, also known as okanin, was isolated from the leaves. Three water-soluble polysaccharides were purified from the leaves, with the repeating unit composed of α-L-rhamnose, β-D- glucuronic acid, β-D-galactose, and β-D-glucose in a molar ratio of 1.00:1.00:2.00:2.33. The polysaccharide's structure primarily consists of (1→2), (1→3), and (1→4) linkages. Dalbergia sissoo leaves produced 14.0% pure polysaccharide, containing 15.7% glucuronic acid. Hydrolysis and GLC analysis of alditol acetate derivatives confirmed the presence of L- rhamnose, D-glucuronic acid, D-galactose, and D-glucose in the same molar ratio (1.00:1.00:2.00:2.33). Seed oil, constituting 4.1% of the total, contained fatty acids such as palmitic (16.2%), stearic (7.0%), oleic (14.6%), linolenic (9.8%), and linoleic (52.5%) acids, along with lipids, including neutral lipids (88.5%), glycolipids (7.2%), and phospholipids (4%). Pods were found to contain 2% tannins. Additionally, two isoflavone glycosides, sissotrin and biochanin A 7-O-[beta-D-apiofuranosyl-(1→5)-beta-D-apiofuranosyl-(1→6)-beta-D- glucopyranoside], as well as tectorigenin 7-O-[beta-D-apiofuranosyl-(1→6)-beta-D-glucopyranoside], were isolated from Dalbergia sissoo.[17]

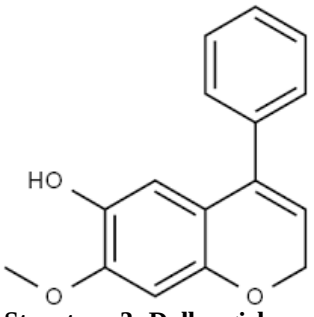
The ethanolic extract of Dalbergia sissoo leaves yielded isoflavone glucoside caviunin 7-O-[β- d-apiofuranosyl-(1→6)-β-d-glucopyranoside], a new itaconic derivative (E)-4-methoxy-2- (3,4-dihydroxybenzylidene)-4-oxobutanoic acid, along with a series of isoflavones, flavonols with their glucosides, and a lignan glucoside. Additionally, the stem bark of Dalbergia sissoo provided known compounds such as dalbergenone, dalbergin, and methyl dalbergin, as well as a new 4-phenyl chromene, dalbergichromene, whose structure was determined as 7-methoxy- 6-hydroxy-4-phenyl chrom-3-ene. Two isoflavone glycosides, caviunin 7-O-gentiobioside and isocaviunin 7-O-gentiobioside, were isolated from the mature pods of Dalbergia sissoo. The bark also contained dalbergenone, methyldalbergin, and dalbergichromene. From the green branches of the aerial parts, compounds such as irisolidone, biochanin-A, muningin, tectirigenin, prunetin, genistein, sissotrin, prunetin-4-O-galactoside, norartocarpetin, β-amyrin, β-sitosterol, and stigmasterol, along with 13 fatty acids, were isolated. The total phenolic content in various extracts of Dalbergia sissoo was estimated to be 50.8 mg/g. However, Kumari and Kakkar reported a total phenolic content of 58.06 mg gallic acid equivalents (GAE)/g of extract, with tannin content ranging from 218.34 to 61.75 mg catechin equivalents (CE)/g. The plant parts of Dalbergia sissoo contain a variety of chemical constituents: the leaves include trisaccharides, oligosaccharides, phenols, and neoflavenes; the stem bark contains flavonoids, dalbergichromene, cinnamylphenols, and 4-phenylchromene; the root bark contains chalcones (e.g., 2,3-dimethoxy-4′-γ,γ-dimethylallyloxy-2′-hydroxychalcone), isoflavones, biochanin A, flavones, and retenoid compounds; and the heartwood includes 4- phenylchromene, dalbergichromene, chalcones, isosalipurposide, amino acids, fatty acids, dalbergin, and dalbergenone. Phytochemical isolation from Dalbergia sissoo holds significant potential for identifying new sources of therapeutically and industrially important compounds such as alkaloids, flavonoids, phenolic compounds, and saponins. Therefore, the present study was conducted to evaluate the phytochemical composition of D. sissoo by extracting and isolating two compounds from it.[9]



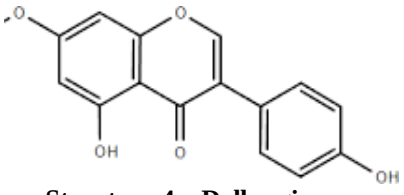
Structure 1: – Dalbergin.



Structure 2: – Methyl Dalbergin.



Structure 3: Dalbergichromene.



Structure 4 – Dalberginone.

Synonyms - Amermnon Sissoo (Roxb.) Kuntze.[8] Include Amerimnon P. Browne, Ecastaphyllum P. Browne, Coroyo Pierre, and Triptolemea Mart.[2] Vernacular names for this tree are as follows: in Sanskrit, it is called Shinshapa or Aguru; in English, it is known as Indian Rosewood or Bombay Blackwood; in Hindi, it is referred to as Shisham, sissu, sissai, or sisam; in Tamil, it is called Sisso or gette; in Kannada, it is Betti, shista baage agaru, or bindi; in Bengali, it is

Shishu or Sissoo; in French, it is Ebenier Juane; in Arabic, it is Arabic; in Indonesia, it is du Khaek Pradu Khack; in Japanese, it is Sonowaseso; in Spanish, it is Sisu; in Thai, it is du-Khaek Pradu Khaek; and in Persian, it is Jag. The trade name is Sisso.[6]

Scientific Classification

Kingdom – Plantae Unranked - Angiospermae Unraked – Ecidicots Unranked – Rosids Order – Fabales Family – Fabaceae (Leguminoseae) Sub Family – Faboideae Tribe – Dalbergia Genus – Dalbergia Species – Sissoo.[4]

Taxonomical Classification

Domain: Eukaryota Kingdom: Plantae Division: Magnoliophyta Phylum: Tracheophyta Class: Magnoliopsida Order: Fabales Family: Fabaceae Sub Family: Faboideae Tribe: Dalbergieae Genus: Dalbergia Species D. sissoo Binomial Name: Dalbergia.[6]

LIST OF DIFFERENT SPECIES OF DALBERGIA GENUS[4,10]

(Rosewood) D. abrahamii	(Bombay Blackwood) D. latifolia
(Burmese Rosewood) D. bariensis	(Bois de Rose) D. maritima
(Palisander) D. baronii	(African Blackwood) D. melanoxylon
(Caroba-Brava) D. brasiliensis	(Canela-De-Burro) D. miscolobium
(Brown's Indian Rosewood) D. brownei	(Rosewood) D. mollis
(Granadillo) D. calycina	(Bejuco De Peseta) D. monetaria
(Dalbergia) D. candenatensis	(Bahia Rosewood) D. nigra
(Jacarand) D. catingicola	(Fragrant Rosewood) D. odorifera
(Brazilian Kingwood) D. cearensis	(Burma Rosewood) D. oliveri
(Rosewood) D. abrahamii	(Dalbergia) D. palauensis
(Burmese Rosewood) D. bariensis	(Akar Laka) D. parviflora
(Burma Blackwood) D. cultrata	(Dalbergia) D. palauensis
(Burma Blackwood) D. cultrata var. cultrata	(Nambar) D. retusa var. retusa
(Bastiao-De-Arruda) D. decipularis	(Rabo-De-Guariba) D. riparia
(Bejuco De Peseta) D. ecastaphyllum	(Malabar Blackwood) D. sissoides
Mussuta) D. elegans	(Indian Rosewood) D. sissoo
(Jacarand -Rosa) D. foliolosa	(Sabuarana) D. spruceana
(Jacarandá-Rosa) D. frutescens	(Rosewood) D. stevensonii
(Pau-De-Estribo) D. frutescens var. frutescens	(Ver“nica) D. subcymosa
(Jacarand -Rosa) D. frutescens var. tomentosa	(Rosewood) D. trichocarpa
(Ebano) D. funera	(Dalbergia) D. tucurensis
(Tripa-De-Galinha) D. gracilis	(Heliotropio) D. villosa
(Sebastiao-De-Arruda) D. hortensis	(Heliotropio) D. villosa var. barretoana
(Jacaranda) D. inundata	Rosewood) D. xerophila
(Shisham) D. lanceolaria	(Yucatan Rosewood) D.yucatensis

Phytochemistry

Phytochemicals similar as flavonoids, isoflavonoids, glycosides, steroids, quinones, and others have been linked in colorful species of the Dalbergia rubric. It’s essential to fete that the specific phytoconstituents may differ between species within this rubric. The process of segregating and relating these composites generally involves ways chromatography and spectroscopy (Verma et al., 2015). likewise, the presence and attention of these phytochemicals can be told by factors similar as the factory's part, age,environmentalconditions, Quercetin A flavonoid with antioxidant parcels (Farag et al., 2001). β- Sitosterol A factory sterol known for its cholesterol- lowering eventuality. EpicatechinAflavonoid with antioxidant goods, set up in foods like chocolate and tea. Rutin A glycoside within the flavonoid group, known for its antioxidant parcels. Quinones composites with implicit medicinal parcels and

places in redox responses. Tannins Polyphenolic composites that may offer antioxidant and anti-inflammatory benefits. coumarins are the groups of chemicals with natural conditioning. For Dalbergia sissoo, the splint extractive values were as follows 4.88 ± 0.04 for the chloroform excerpt, 9.82 ± 0.02 for the ether excerpt, 7.81 ± 0.91 for the hexane excerpt, 8.86 ± 0.48 for the petroleum excerpt, 22.78 ± 0.81 for the ethanol excerpt, 28.74 ± 0.71 for the 70 ethanol excerpt, 21.47 ± 0.01 for the methanol excerpt, and 18.94 ± 0.74 for the waterless excerpt. The water-answerable ash content was 4.2 ± 0.90, the water- undoable ash was 7.8 0.91, the total ash ranged from 8.43 to 12.00, and the acid- undoable ash was 3.33 ± 0.97(Rashida et al., 2012).[5]

Traditional uses

Dalbergia sissoo is a medicinal factory known for its colorful natural conditioning and remedial operations. It's generally used in the treatment of conditions similar as emesis, ulcers, leukoderma, dysentery, stomach troubles, and skin conditions. Bark the active excerpts of the dinghy contain carbohydrates, phenolic composites, flavonoids, and tannins. In Ayurveda, the dinghy of Dalbergia sissoo is used as an abortifacient, anthelmintic, antipyretic, aperitif, aphrodisiac, expectorant, and refrigerant. It's also employed for managing anal diseases, dysentery, dyspepsia, leukoderma, and skin affections. Also, the dinghy is effective in treating Vata- related diseases similar as sciatica and hemiplegia. Seed The seed oil painting of Dalbergia sissoo is used to treat conditions like blue itching, burning sensations on the skin, and scabies. Leaves In pastoral areas of India and Nepal, the leaves of Dalbergia sissoo are used to treatnon-specific diarrhoea in creatures. The splint excerpt is employed to treat sore throats, heart problems, dysentery, syphilis, and gonorrhea. The juice from the leaves is salutary as an anthelmintic and is also used for eye and nose affections. It's also effective in treating scabies, burning sensations, parboiling urine, syphilis, and digestive diseases. A decoction of the leaves is generally used for treating gonorrhea, and Ayurvedic interpreters recommend splint juice for eye- related conditions. Wood the wood of Dalbergia sissoo is used for its anthelmintic, antileprotic, and cooling parcels. The upstanding corridors of the factory are known for their spasmolytic, aphrodisiac, and expectorant goods. In traditional drug, the wood is used to treat leprosy, boils, and puking. The Yunani people also use the wood for blood diseases, burning sensations, eye and nose problems, scabies, parboiling urine, stomach issues, and syphilis. Heartwood The heartwood of Dalbergia sissoo is employed in the treatment of herpes, vitiligo, and fever. It's also used in the medication of Shimshapa Sara Ksheerapaka, which is recommended for treating fever (according to Sushruta). Root The roots are traditionally used to treat diarrhoea and dysentery.[4] Extract of Aerial Parts: Known for its bronchodilator, antipyretic, and analgesic properties, the aerial part of Dalbergia sissoo also exhibits estrogen-like activities. Dried Leaves: The dried leaves possess antibacterial, antiprotozoal, and anti-inflammatory effects. Leaf Juice: Used in the treatment of gonorrhea. Wood Paste: Applied to treat wounds, itching, abscesses, and vomiting. Oil: The oil has demonstrated repellent activity against Anopheles stephensi, Aedes aegypti, Culex quinquefasciatus, and is also resistant to certain wood-boring insects. Wood and Active Bark Extract: Ayurvedic Use: The wood and bark extract in Ayurvedic medicine is used as an abortifacient, anthelmintic, antipyretic, aperitif, aphrodisiac, expectorant, and refrigerant. It also treats anal disorders, dysentery, dyspepsia, leukoderma, and various skin ailments. Yunani Use: In Yunani medicine, the wood is beneficial for blood disorders, scabies, eye and nose problems, burning sensations, scalding urine, stomach issues, syphilis, boils, eruptions, leprosy, and nausea. Dalbergia sissoo is widely used in folk medicine for treating numerous diseases. Concentrated extracts of the heartwood mixed with milk are prescribed for fever, while bark extracts are utilized for their anti-inflammatory effects in conditions such as piles and sciatica, as well as for purifying the blood. The oil is applied externally to treat skin diseases and infected ulcers. The wood is used for its anthelmintic, antileprotic, and cooling properties, while the aerial parts serve as spasmolytic, aphrodisiac, and

expectorant agents. The leaf extract is known for its anti-diabetic, antioxidant, anticancer, analgesic, antipyretic properties, and is also used for jaundice. The flowers are used to address skin problems, act as blood purifiers, and enhance immunity.[8]

Beneficial Impact on the Environment The root system helps in preventing soil erosion. Nitrogen from the atmosphere is fixed through Rhizobium bacteria in the root nodules. Decomposing leaf litter contributes to soil fertility by adding nitrogen, potassium, iron, manganese, and organic carbon. B) At Field Fences No inhibitory effect on germination was observed. C) Timber Tree Uses Dalbergia decipularis: The wood is cream-colored with red or salmon stripes, commonly used in crossbanding. Sissoo (Dalbergia Sissoo): Known for its strong, durable, and tough wood, it is used for furniture, plywood, bridge piles, sport goods, railway sleepers, and decorative carvings. Melanoxylon: The wood is used in making musical instruments and cabinets. D. latifolia: The wood is used to make chess pieces. D) Fuel Wood Both sapwood and heartwood have excellent calorific values: 4,908 Kcal/kg for sapwood and 5,181 Kcal/kg for heartwood. E) Toxicology The ethanolic extract of D. Sissoo fruit has demonstrated molluscicidal effects against the eggs of the freshwater snail Biomphalaria Pfeifer. F) Fodder the leaflets and leaf branches are used as fodder. G) Pulp Production The sulphate pulp from Dalbergia Sissoo wood is used in the production of writing and printing paper.[6]

Reported pharmacological activities

1. Anti-Inflammatory Activity

The anti-inflammatory effects of hexane and methanol extracts of Dalbergia sissoo leaves, along with okanin, were assessed using the carrageenan-induced paw edema model in rats. The methanolic extract of the leaves demonstrated the highest activity (Behera et al., 2013). In a separate study, Sidana et al. (2012) investigated the analgesic and anti-inflammatory properties of the methanolic leaf extract of Dalbergia sissoo using the acetic acid-induced writhing test and hot plate test in mice, as well as the carrageenan-induced paw edema model in rats. Oral administration of the leaf extracts significantly reduced writhing movements in the acetic acid-induced writhing test and increased the mean pain latency time in the hot plate test (at 50°C) in a dose-dependent manner. In the carrageenan-induced paw edema model, the methanolic extract resulted in a 68.2% inhibition of hind paw edema at the highest dose of 600 mg/kg, compared to a 73.4% inhibition observed with the reference drug, diclofenac (5 mg/kg), at the third hour following carrageenan injection.[1] The evaluation of the anti-inflammatory activity of the ethanolic extract of Dalbergia sissoo bark showed that the extract at 1000 mg/kg exhibited the most significant anti- inflammatory effects throughout the observation period, in comparison to the 300 mg/kg and 500 mg/kg doses.[2] An assessment was conducted on the anti-inflammatory properties of the ethanolic Dalbergia sissoo bark extract. In comparison to the other groups (300 and 500 mg/kg), the ethanolic extract at 1000 mg/kg demonstrated the strongest anti-inflammatory activity throughout the observation period, it can be concluded (Asif M et al.2009).[5]

2. Anti-Termite Activity

The anti-termite properties of Dalbergia sissoo heartwood were evaluated, and it was concluded that plant extracts from this species could serve as an alternative to synthetic pesticides for termite control in buildings.[2]

3. Anti diabetic potential

Panda and colleagues (2016) assessed the antidiabetic potential of ethanol, ethyl acetate, n-butanol, and petroleum ether extracts from Dalbergia sissoo leaves in diabetic rats induced by alloxan. The extracts demonstrated significant antidiabetic effects at a dose of 300 mg/kg body weight on the first, third, fifth, and seventh days. Among

the various extracts, the ethanol extract exhibited the most pronounced antidiabetic activity, comparable to the standard drug glibenclamide. The hypoglycemic effect of the ethanol extract was further investigated in alloxan- induced diabetic rats. Healthy rats were administered the ethanol extract orally at doses of 250 and 500 mg/kg. The 500 mg/kg dose was more effective, reducing blood glucose levels (BGL) by 38.2% after just one day of treatment. After 21 days of daily administration of both doses (250 and 500 mg/kg) to severely diabetic rats (with fasting blood glucose levels ranging from 300 to 350 mg/dl), BGL decreased to 125 mg/dl with the 250 mg/kg dose and to 104 mg/dl with the 500 mg/kg dose. The ethanol extract was more effective than glibenclamide in reducing blood glucose levels. Specifically, at the 500 mg/kg dose, the BGL decreased to 189.2, 115.2, and 104.6 mg/dl on days 7, 14, and 21, respectively, compared to 250.2, 141.2, and 120.4 mg/dl for glibenclamide. The ethanol extract of Dalbergia sissoo leaves was found to be 12% more effective than glibenclamide in lowering blood glucose levels (Niranjan et al., 2010).[1] The antidiabetic eventuality of both alcoholic and waterless stem dinghy excerpts of Dalbergia sissoo and their fragments was assessed in streptozotocin- nicotinamide convinced type 2 diabetic rats. The study estimated colorful parameters, including blood glucose situations, lipid profile, liver glycogen content, body weight, and antioxidant status in both normal and diabetic rats. The results indicated that the alcoholic excerpts (250 and 500 mg/ kg) and the waterless excerpt (400 mg/ kg) significantly reduced blood glucose situations (P< 0.05) </mark> In discrepancy, hexane and butane answerable excerpts did n't produce a significant reduction in blood glucose situations. Both the alcoholic and waterless excerpts also significantly bettered the lipid profile, liver glycogen content, body weight, and antioxidant status in diabetic rats. likewise, the antidiabetic goods of the ethanolic excerpt of Dalbergia sissoo dinghy (at boluses of 250 mg/ kg and 500 mg/ kg) were delved in alloxan- convinced diabetic rats. Both boluses caused a significant reduction in blood glucose situations, with the effect being more pronounced at the 500 mg/ kg cure compared to 250 mg/ kg. also, Dalbergia sissoo redounded in a significant increase in body weight and liver glycogen content in alloxan- convinced diabetic rats. also, there was a significant drop in serum triglyceride and total cholesterol situations. Histopathological advancements were also observed in the pancreas of the alloxan- convinced diabetic rats.[8]

4. Analgesic and Antipyretic Effects

The phytochemical, analgesic, and antipyretic activities of the ethanol extract of Dalbergia sissoo seeds were evaluated. The results concluded that the extract of Dalbergia sissoo seeds exhibited moderate analgesic effects and significant antipyretic activity.[2] The alcoholic extract of Dalbergia sissoo seeds was assessed for its analgesic and antipyretic activities. The peripheral analgesic effect of the seed extract was evaluated using the acetic acid-induced writhing test in mice and the Randall-Selitto assay in rats. For central analgesic activity, the tail-clip test and the hot plate method were employed in mice. The antipyretic effect of the seed extract was studied using Brewer’s yeast-induced pyrexia in rats. The results showed that the alcoholic extract significantly reduced writhing movements in the acetic acid-induced writhing test in mice. It also notably increased the pain threshold in the Randall-Selitto assay and improved the reaction time in the hot plate test, though no significant effect was observed in the tail-clip test. Additionally, the extract demonstrated significant antipyretic activity in Brewer’s yeast-induced pyrexia in rats over a 6-hour observation period.[8] The analgesic activity of the ethanol extract from the bark of Dalbergia sissoo was evaluated using the tail flick method in Wistar rats. The extract, at doses of 300, 500, and 1000 mg/kg, demonstrated significant, dose-dependent central analgesic effects, with activity comparable to the standard drug, aspirin (300 mg/kg). Additionally, the ethanol extract of the leaves of Dalbergia sissoo exhibited both peripheral and central analgesic effects in a dose-dependent manner. Peripheral analgesic activity was assessed through the acetic acid-induced writhing reflex and the Randall-Selitto assays in mice, while central analgesic activity was measured using the hot-plate and tail-clip tests in mice. In

the writhing test, the extract (100, 300, and 1000 mg/kg) moderately inhibited writhing in mice. In the Randall-Selitto assay, the extract did not significantly alter the pain threshold at doses of 100 and 300 mg/kg, but it exhibited significant activity ($P < 0.01$) at</mark> a dose of 1000 mg/kg. The extract (1000 mg/kg) increased the reaction time at 2 and 3 hours, whereas pathidine (5 mg/kg) enhanced the reaction time at 1 and 2 hours. Furthermore, the ethanol extract of the leaves of Dalbergia sissoo demonstrated significant antipyretic activity in a Brewer's yeast-induced pyrexia model in rats. At doses of 100 and 300 mg/kg, the extract showed notable antipyretic effects 1 hour post-administration. At 1000 mg/kg, the extract exhibited activity throughout the entire observation period, lasting up to 6 hours, with effects comparable to those of aspirin (300 mg/kg).[9] The analgesic potential of the ethanolic extract of Dalbergia sissoo bark was assessed using the Radiant Heat method (tail flick test). The extract exhibited significant analgesic activity, as indicated by an increase in the reaction time to the pain stimulus. While doses of 300 mg/kg and 500 mg/kg did not affect the pain threshold, a significant increase in reaction time was observed at the 1000 mg/kg dose after 30 minutes.[6] The ethanol extract of Dalbergia sissoo seeds was evaluated for its phytochemical, analgesic, and antipyretic properties. According to the findings of Hugar et al. (2010) the extract demonstrated significant antipyretic effects and mild analgesic activity.[5]

5. Anti- helminthic potential

The anti-helminthic activity of Dalbergia sissoo was investigated, revealing its potential effectiveness against helminthic infections.[2] The study highlighted the efficacy of Dalbergia sissoo in treating such infections (Upwar et al., 2011).[5]

6. Antioxidant potential

The antioxidant eventuality of the dinghy excerpt of Dalbergia sissoo Roxb.(Fabaceae) was estimated through colorful in- vitro assays. Lakshmi and associates (2014) assessed its antioxidant exertion using hydrogen peroxide scavenging and reducing power assays, chancing that the excerpt displayed significant antioxidant goods. Also, the ethanol excerpt of Dalbergia sissoo dinghy was tested for its lipid peroxidation (LPO) inhibitory exertion, showing a 69.1 inhibition of LPO per 10 µg of excerpt (Kumari et al., 2008). Farther examinations of the waterless and methanol excerpts of the stem- dinghy by Roy et al. (2011) assessed antioxidant exertion through DPPH radical scavenging, ferric ion reducing power, ferrous ion chelation, and gold nanoparticle conformation. The waterless excerpt demonstrated specially stronger antioxidant exertion compared to the methanol excerpt across all assays. In another study, the antioxidant parcels of petroleum ether, chloroform, and methanol excerpts of Dalbergia sissoo stem- dinghy were estimated through DPPH free revolutionary scavenging, FRAP (ferric reducing antioxidant power) assay, reducing power, ferrous ion scavenging, and nitric oxide (NO) radical scavenging exertion. Among these, the chloroform excerpt was set up to be the most biologically active, with IC50 values of 25 µg/ ml for the DPPH model, 26 µg/ ml for the FRAP assay, 21 µg/ ml for reducing power, 26 µg/ ml for ferrous ion scavenging, and 25 µg/ ml for NO scavenging exertion, all similar to ascorbic acid. The petroleum ether and methanol excerpts showed moderate antioxidant exertion. The antioxidant exertion of the methanol excerpt from the roots of Dalbergia sissoo was also assessed for free radical scavenging, fastening on nitric oxide and hydrogen peroxide scavenging. At a attention of 250 µg/ ml, the excerpt showed maximum scavenging of nitric oxide (26.66) and hydrogen peroxide (50.68), with results similar to the standard, rutin (Pooja et al., 2010). Yasmeen and Gupta (2016) estimated the methanolic excerpts of the leaves, fruits, and dinghy for DPPH, ABTS, FRAP, and Sun Protection Factor (SPF). They set up that the methanolic excerpt of the leaves had the smallest IC50 values for DPPH and FRAP, while the fruit excerpt displayed the loftiest SPF value and the splint excerpt had the

smallest. Eventually, the antioxidant exertion of the ethanolic excerpt of Dalbergia sissoo leaves was assessed using DPPH free revolutionary scavenging, with ascorbic acid as the standard. The IC50 value for the ethanolic excerpt was set up to be 106.3 µg/ mL (Rijhwani and Bharty, 2016).[1] The antioxidant potential of the stem bark of Dalbergia sissoo was evaluated, with the results indicating that among the various extracts, the chloroform extract displayed pronounced antioxidant activity. In contrast, the methanolic extract exhibited moderate activity in different in vitro antioxidant assays.[2] The antioxidant potential of the stem bark of Dalbergia sissoo was assessed, with the results revealing that the chloroform extract demonstrated significant antioxidant activity. In comparison, the methanolic extract showed moderate activity across various in vitro antioxidant assays.[4] Butein, isolated from D. odorifera, has been shown to inhibit iron- convinced lipid peroxidation in rat brain homogenates in a attention-dependent manner, with an IC50 value of 3.3 ± 0.4 µM. It was set up to be as potent as α- tocopherol in reducing the stable free revolutionary DPPH, exhibiting an IC50 value of 9.2 ± 1.8 µM. also, butein inhibited xanthine oxidase exertion with an IC50 value of 5.9 ± 0.3 µM. Butein also scavenged peroxyl revolutionaries derived from 2,2- azobis (2- amidinopropane) dihydrochloride (AAPH) in the thirsty phase. Likewise, butein demonstrated the capability to inhibit bull - catalyzed oxidation of mortal low- density lipoprotein (LDL) in an attention-dependent manner. also, butein convinced endothelium-dependent relaxation of rat aorta that had been precontracted with phenylephrine.[7]

7. Antimicrobial Property

Behera and colleagues (2012) demonstrated that okanin, a compound isolated from the methanol extract of Dalbergia sissoo leaves, exhibited strong antibacterial activity against a range of pathogens, including both Gram-positive (Staphylococcus aureus and Micrococcus luteus) and Gram-negative bacteria (Escherichia coli, Acinetobacter, and R. planticola). Aly et al. (2013) reported that two phytochemicals isolated from different parts of Dalbergia sissoo—1,2-benzenedicarboxylic acid dibutyl ester (13.68%) and 5- nitro-2,4-(1H, 3H)-pyrimidine dione—also showed antibacterial effects against Bacillus cereus, Staphylococcus aureus, Proteus mirabilis, and Serratia marcescens. Yadav et al. (2008) investigated a concoction of Dalbergia sissoo and Datura stramonium for its antibacterial potential against both Gram-positive (Staphylococcus aureus and Streptococcus pneumoniae) and Gram-negative (Klebsiella pneumoniae, Pseudomonas aeruginosa, and E. coli) bacterial strains. The fractions from the concoction demonstrated biological activity against both bacterial groups, with Gram-positive bacteria showing higher sensitivity. Further research on Dalbergia sissoo by Hussain et al. (2014) (12). explored its antibacterial activity against eight pathogenic bacterial strains harmful to humans. The in vitro antimicrobial test, conducted using the disc diffusion method, revealed that the methanol extract of the whole plant exhibited significant antibacterial effects against E. coli (19.00 mm), S. aureus (18.00 mm), B. cereus (17.90 mm), S. pneumoniae (17.50 mm), K. pneumoniae (17.45 mm), B. pumilus (16.45 mm), P. aeruginosa (16.20 mm), and C. freundii (15.00 mm). The relative inhibition percentages for these bacteria were 81.00%, 80.54%, 78.45%, 76.65%, 72.45%, 70.37%, 64.65%, and 62.30%, respectively, compared to the leaf extract, which showed inhibition rates of 70.56%, 67.32%, 62.80%, 57.03%, 54.20%, 51.05%, 43.24%, and 36.65% against the same pathogens. The minimum inhibitory concentration (MIC) of the whole plant extract was determined using a modified agar well diffusion method. MIC values for the whole plant extract ranged from 75 to 300 µg/mL for Gram-positive strains and 75 to 600 µg/mL for Gram-negative strains.[1] A study was conducted to estimate the antibacterial eventuality of a herbal drug containing Dalbergia sissoo and Datura stramonium against pathogenic strains of both gram-positive (e.g., Staphylococcus aureus and Streptococcus pneumoniae) and gram-negative bacteria (e.g., Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae). The antibacterial goods were compared to those of standard antibiotics analogous as Chloramphenicol (30 mcg), Ampicillin (10 mcg), Nalidixic acid (10

mcg), and Rifampicin (30 mcg). The extract demonstrated strong exertion against both gram- positive and gram-negative bacteria. A clinical isolate of S. aureus showed lower perceptivity to the extract than the standard strains, inhibiting growth at multiple situations, including protein, DNA, RNA, and peptidoglycan emulsion. These findings suggest that the Dalbergia sissoo and Datura stramonium extract could serve as a potent antiseptic for preventing and treating habitual bacterial infections.[2] An herbal preparation containing Dalbergia sissoo and Datura stramonium was evaluated in this study for its antibacterial efficacy against gram-positive bacteria (Staphylococcus aureus and Streptococcus pneumoniae) and gram-negative bacteria (Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae). The findings suggest that the extract of Dalbergia sissoo and Datura stramonium holds potential as a powerful antiseptic for preventing and treating chronic bacterial infections.[4] The citric acid extract of D. melanoxylon bark has demonstrated significant antibacterial activity against gram-negative bacteria, including Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium, and Yersinia pestis, as well as gram-positive bacteria, such as Bacillus subtilis, Klebsiella pneumoniae, and Staphylococcus aureus. Additionally, the plant exhibits potential antifungal activity against Candida albicans and Aspergillus niger.[7] The methanol and hexane extracts, along with isolated okanin from the methanol extracts, displayed significant antibacterial activity against various pathogens, including gram-positive bacteria (Micrococcus luteus and Staphylococcus aureus) and gram-negative bacteria (Escherichia coli, R. planticola, and Acinetobacter). Compounds such as 1,2-benzenedicarboxylic acid dibutyl ester (13.68%) and 5-nitro-2,4-(1H,3H)- pyrimidine dione, isolated from the plant, exhibited antibacterial activity against Staphylococcus aureus, Bacillus cereus, Serratia marcescens, and Proteus mirabilis. A herbal preparation containing Dalbergia sissoo and Datura stramonium was assessed for its antibacterial efficacy against gram-positive (Staphylococcus aureus and Streptococcus pneumoniae) and gram-negative (Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae) bacteria. The extracted fractions of this herbal preparation were effective against both gram-positive and gram-negative bacteria, with gram-positive bacteria showing higher sensitivity.[12] Further, Dalbergia sissoo was evaluated for its antibacterial potential against eight human pathogenic bacterial strains. Methanolic extraction was performed using the triple maceration method on the whole plant and leaves. Antimicrobial activity was tested in vitro using the disc diffusion method. The whole plant extract demonstrated strong antibacterial activity against Staphylococcus aureus (18.00 mm), Streptococcus pneumoniae (17.50 mm), Bacillus cereus (17.90 mm), Bacillus pumilus (16.45 mm), Escherichia coli (19.00 mm), Klebsiella pneumoniae (17.45 mm), Pseudomonas aeruginosa (16.20 mm), and Citrobacter freundii (15.00 mm), with relative inhibition percentages of 81.00, 80.54, 76.65, 64.65, 78.45, 72.45, 70.37, and 62.30, respectively. Comparatively, the leaf extract exhibited lower inhibition percentages of 70.56, 67.32, 54.20, 43.24, 62.80, 57.03, 51.05, and 36.65 against the same microbes. The minimum inhibitory concentration (MIC) was determined using the modified agar well diffusion method. For gram-positive strains, MIC values ranged from 75 to 300 µg/mL, while for gram- negative strains, the range was 75 to 600 µg/mL.[8]

8. Antinociceptive Activity

The antinociceptive activity of ethanolic extract of the plant bark of Dalbergia sissoo was evaluated using tail flick method on Wistar rats. Three different dose levels (300, 500, and 1000 mg/kg) in 0.5% carboxymethyl cellulose were administered. The antinociceptive extract activities of all doses were compared with that of the standard drug aspirin (300 mg/kg). The results were found to be significant ($P<0.01$) At the above doses, the extract possesses significant dose-dependent antinociceptive activity. Phytochemical investigation of the ethanolic extract showed the presence of carbohydrates, proteins, amino acids, phenolic compounds, and flavonoids. The antinociceptive activity of the bark

extract may be due to the presence of phytochemical constituents such as flavonoids.[2] The antinociceptive activity of ethanolic extract of the plant bark of Dalbergia sissoo 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 were administered orally. At these doses, the extract exhibited significant and dose-dependent antinociceptive activity.[4]

9. 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- dihydroxy benzylidene)-4-oxobutanoic acid along with series of isoflavones and flavonols with their glucosides, and a lignan glucoside was isolated from the ethanolic extract of Dalbergia sissoo leaves and were assessed for osteogenic activity in primary calvarial osteoblast cultures. The result showed that compounds exhibited significant osteogenic activity.[2] The effect of Dalbergiphenol (DGP), the neoflavonoid isolated from heartwood was evaluated in bone loss in ovariectomized mice. Adult BALB/c mice were ovariectomized and administered DGP (1 and 5 mg/kg/d) or 17β-estradiol (E2) orally for 6 weeks. The sham group and the ovariectomy (OVX) + vehicle group served as controls. Uterine estrogenicity, bone microarchitecture, biomechanical strength, new bone formation (based on bone formation rate and mineral apposition rate), and skeletal expression of osteogenic and resorptive gene markers were studied. The sham group and the ovariectomy (OVX) showed marked increase in body weight and a decrease in femoral and vertebral trabecular bone volume that were prevented by DGP or E2 treatment. DGP treatment increased bone biomechanical strength and new bone formation rate in ovariectomized mice, comparable with E2 treatment. However, increase in uterine weight and estrogenicity were observed in E2-treated ovariectomized mice, but not in response to DGP treatment. Treatment with DGP increased messenger RNA expression of runt-related transcription factor 2, osterix, and collagen type I, and decreased messenger RNA expression of tartrate-resistant acid phosphatase and the osteoprotegerin-to-receptor activator of nuclear factor-κB ligand ratio in the femur of ovariectomized mice. The authors concluded that DGP treatment can effectively prevent OVX-induced increase in bone loss and decrease in bone strength possibly by increasing osteoblastic activities and by decreasing osteoclastic activities.[14] The skeletal effects of an extract made from the leaves and pods of Dalbergia sissoo (butanol-soluble standardized fraction [BSSF]) was studied in ovariectomized rats, a model for postmenopausal osteopenia. In comparison with ovariectomized rats treated with vehicle, BSSF treatment in improved trabecular microarchitecture of the long bones, increased biomechanical strength parameters of the vertebra and femur, decreased bone turnover markers (osteocalcin and type I collagen) and expression of skeletal osteoclastogenic genes, and increased new bone formation and expression of osteogenic genes in the femur. Overall, the osteoprotective effects of BSSF were comparable to those of 17β-estradiol.[96] The new isoflavone glucoside, caviunin 7-O-[β-D- apiofuranosyl-(1→6)-β-D-glucopyranoside] and four known compounds namely genstein, biochanin A, pratensein and biochanin 7-O-glucoside, isolated from the leaves of Dalbergia sissoo, showed osteogenic activity in primary calvarial osteoblast cultures. These compounds showed increased alkaline phosphatase activity and mineralization, which substantiated potential osteogenic activity. The compounds at the concentrations ranging from 1 pM to 1 μM were applied to calvarial osteoblast cells to screen alkaline phosphatase activity as well as stimulatory activity on osteoblast formation mediated via estrogen receptor (ER). It was found that differentiation of osteoblast formation was ER independent. Caviunin 7-O-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside], genstein, pratensein and biochanin 7-O-glucoside, failed to inhibit ALP production except mild response from biochanin A. Biochanin A inhibited osteoblast formation at the concentration of 10 nM in the presence of ICI-182780 (antiestrogen). All these five compounds also induced the formation of mineralized nodules in osteoblast cultures. Caviunin 7-O [β-D-apiofuranosyl-(1→6)-β-D-

glucopyranoside] showed most potent osteogenic activity than the other four compounds.[16] The leaves and pods extract of Dalbergia sissoo showed antiresorptive and bone-forming effects. The positive skeletal effect attributed to active molecules present in the extract of Dalbergia sissoo.[17] Caviunin 7-O-[β-D-apiofuranosyl-(1-6)-β-D-glucopyranoside] (CAFG), a novel isoflavonoid found in high percentage in the extract was studied as an alternative for anabolic therapy for the treatment of osteoporosis by stimulating bone morphogenetic protein 2 (BMP2) and Wnt/β-catenin mechanism. CAFG supplementation improved trabecular micro-architecture of the long bones, increased biomechanical strength parameters of the vertebra and femur and decreased bone turnover markers better than genistein. Oral administration of CAFG to osteopenic ovariectomized mice increased osteoprogenitor cells in the bone marrow and increased the expression of osteogenic genes in femur and showed new bone formation without uterine hyperplasia. CAFG increased mRNA expression of osteoprotegerin in bone and inhibited osteoclast activation by inhibiting the expression of skeletal osteoclastogenic genes. CAFG was also an effective accelerant for chondrogenesis and has stimulatory effect on the repair of cortical bone after drill-hole injury at the tissue, cell and gene level in mouse femur. At cellular levels, CAFG stimulated osteoblast proliferation, survival and differentiation. Signal transduction inhibitors in osteoblast demonstrated involvement of p-38 mitogen-activated protein kinase pathway stimulated by BMP2 to initiate Wnt/β- catenin signaling to reduce phosphorylation of GSK3-β and subsequent nuclear accumulation of β-catenin. Osteogenic effects were abrogated by Dkk1, Wnt-receptor blocker and FH535, inhibitor of TCF-complex by reduction in β-catenin levels. CAFG modulated MSC responsiveness to BMP2, which promoted osteoblast differentiation via Wnt/β-catenin mechanism. CAFG at 1 mg/kg/day dose in ovariectomy mice (human dose ∼0.081 mg/kg) led to enhanced bone formation, reduced bone resorption and bone turnover better than well-known phytoestrogen genistein. Accordingly, it could be positioned as a potential drug, food supplement, for postmenopausal osteoporosis and fracture repair.[8] 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-dihydroxy benzylidene)-4-oxobutanoic acid along with series of isoflavones and flavonols with their glucosides, and a lignan glucoside was isolated from the ethanolic extract of Dalbergia sissoo leaves and were assessed for osteogenic activity in primary calvarial osteoblast cultures. The result showed that compounds exhibited significant osteogenic activity.[4]

10. 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. Ethanol extract at a concentration of 20 mg/mL caused complete immobilization within 3 minutes. The in vivo studies ethanol extract at a dose of 200 mg/kg body weight resulted in a significant decrease ($p< 00.01$) in weight of the testis and epididymis. s. 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.[4] The anti- spermatogenic efficacy of ethanol extract of stem bark of Dalbergia sissoo was evaluated in healthy fertile men. 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. An in vivo antifertility 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. Histopathological changes in the epididymis and testis were also recorded. Antifertility effects of Dalbergia sissoo was investigated in male mice. Adult Parkes strain male mice were orally administered aqueous leaf extract of Dalbergia sissoo (50 and 100 mg/kg body weight/day) for 35 days. Motility, viability and number of spermatozoa in the cauda epididymidis; testis histology; serum level of testosterone; and toxicological effects were evaluated. To assess reversibility, mice were treated with 100 mg/kg body weight of Dalbergia sissoo or distilled water for 35 days and sacrificed 56 days later. The fertility parameters were also assessed separately. Histologically, testes of Dalbergia sissoo -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 serum level of testosterone in Dalbergia sissoo -treated mice compared to controls. However, serum levels of alanine aminotransferase, aspartate aminotransferase and creatinine, and haematological parameters were not affected. Libido in Dalbergia sissoo -treated males showed no change, but their fertility was markedly suppressed. By 56 days of treatment withdrawal, the alterations induced in fertility parameters were returned to control levels.[8] Triterpenoid glycosides, DSS, isolated from the root of D.saxatilis have shown antifertility activity in female Wistar rats at the dose rate of 200mg/kg body weight at the premating period, inhibiting the conception in 71.4% of the treated animals. Fertility index was 107.82 compared to 373.5 for control rats.[7]

11. Gastro Protective Action

This study was conducted to evaluate the antiulcer effects of D. sissoo stem bark methanol extract (DSME) against the diclofenac sodium-induced ulceration in rats. The results of this study showed that DSME exhibits a potential gastroprotective activity probably due to its antioxidant and cytoprotection ability.[4]

12. Neuroprotective Action

This research was performed in 3- Nitro propionic acid- induced neurotoxic rats to characterize the neuroprotective effect of ethanolic extract of Dalbergia sissoo leaves. The ethanolic extract of Dalbergia sissoo leaves was administered 300 and 600mg/kg orally to neurotoxic rats. These results suggest that ethanolic extract of Dalbergia sissoo leaves may have potential therapeutic value in various neurological disorders, probably by its antioxidant, anti-inflammatory and estrogenic properties.[4] The effect of ethanolic leaf extracts of Dalbergia sissoo (ELDS) on learning and memory activity was evaluated in mice. ELDS was given as 300, 450 and 600 mg/Kg respectively. The effect of ethanolic leaf extract of Dalbergia sissoo was investigated in mice for memory enhancing activity using various experimental paradigms of learning and memory (Transfer latency (TL) on elevated plus maze and passive avoidance). For memory and learning activity vehicle/ extracts / STD drug administered daily for first seven days, on 8th day dementia was induced by scopolamine. ELDS significantly enhanced the learning and memory activities against the scopolamine induced dementia and significant decrease in acetylcholinesterase level in brain in animals. The memory enhancement activity was due to cholinergic facilitatory effect in animals.[8] The neuroprotective effects of the ethanolic extract of Dalbergia sissoo leaves was evaluated by checking brain weight, antioxidant levels, histopathological and TTC staining studies in cerebral ischemia induced in rats. The ethanolic extracts was given at 300, 600 mg/kg and were compared to negative control (global cerebral ischemic rats). It was observed that prior treatment with Dalbergia sissoo extract (300mg/kg and 600mg/kg, po for 10days) markedly reversed the brain weight, antioxidant levels and restored to normal levels as compared to ischemia- reperfusion induced oxidative stress groups. Moreover, brain coronal sections staining and histopathological studies revealed protection against ischemic brain damage in the extract treated groups. The neuroprotective effect of ethanolic extract of Dalbergia sissoo leaves was evaluated in 3-nitropropionic acid induced

neurotoxic rats. The ethanolic extract of Dalbergia sissoo leaves was administered orally at different doses (300 and 600 mg/kg) to neurotoxic rats. During treatment psychopharmacological parameters were recorded, and 24 hours after experiment antioxidant profiles from brain isolates were estimated and histopathology of brain was performed. The ethanolic extract significantly attenuated behavioral alterations, oxidative damage, mitochondrial dysfunction, and striatal/hippocampus damage in 3-nitropropionic acid treated rats.[8]

13. Anti-molluscicidal Activity

The crude aqueous and ethanolic extracts from different parts of Dalbergia sissoo were evaluated against egg masses and adults of Biomphalaria pfeifferi the intermediate snail host of Schistosoma mansoni in Nigeria. Only the ethanolic extracts of the fruits and roots showed significant activities against the adult snails and their egg masses, while all other extracts demonstrated weak molluscicidal and ovicidal activities.[4]

14. Anti-larvicidal Activity

Studies were carried out to evaluate the growth inhibitor, repellent action & anti-larvicidal action of D. sissoo oil against Aedes aegypti, Anopheles stephensi, and Culex quinquefasciatus under laboratory conditions. The oil also showed strong repellent action when oil was applied on exposed parts of human volunteers. They were protected from mosquito bites for 8±11 h. The protection obtained with sissoo oil was comparable to that with commercial Mylol oil consisting of di-butyl and dimethyl phthalates.[4]

15. Antiulcer Activity

This study evaluates the Antiulcer activity of crude ethanolic bark extract of Dalbergia sissoo using pylorus ligation and Indomethacin induced ulcer model in Wistar albino rats. The antiulcer effect of EBED may be due to any of the probable mechanisms viz. reduction in gastric acid secretion, antioxidant action, much protection, or gastric cytoprotection attributed by the presence of various secondary metabolites.[4] The antiulcer effects of Dalbergia sissoo stem bark methanol extract (DSME) was studied against the diclofenac sodium-induced ulceration in rat. The DSME (200 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. Biochemical studies of gastric mucosa were conducted to estimate the levels of nonprotein sulfhydryls (NP-SHs), lipid peroxidation [thiobarbituric acid reactive substances (TBARSs)], reduced glutathione (GSH), hydrogen peroxide (H2O2), levels of scavenging antioxidants, catalase (CAT), superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), glutathione-S-transferase (GST), and myeloperoxidase (MPO). Moreover, adherent mucus content and histological studies were performed on stomach tissues. 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 treatment in diclofenac-treated rats. Volume of gastric juice, total and free acidity were decreased, whereas pH of the gastric juice was increased with the administration of DSME + diclofenac.The antiulcer activity of crude ethanolic bark extract of Dalbergia sissoo(EBED) was evaluated using pylorus ligation and indomethacin induced ulcer model in Wistar albino rats. The study revealed significant decrease ($P < 0.01$) in mean ulcer index in EBED treated group in both models compared to control. Furthermore, there were significant decrease ($P < 0.01$ and $P < 0.001$) in the offensive factors like free and total acidity, pepsin content and protein content, with a significant increase in the defensive factors like total carbohydrate content ($P < 0.01$) and ratio of total carbohydrates and

proteins as compared to control in dose dependent manner.[8] Indomethacin, ethanol, pylorus ligature, and hypothermic restraint stress have all been shown to cause gastric lesions that can be inhibited by D. monetaria's lyophilized aqueous extract (LAE) when taken orally. Any of the possible mechanisms, such as decreased gastric acid secretion, antioxidant action, increased protection, or gastric cytoprotectant brought on by the presence of different secondary metabolites, could account for the antiulcer effect of EBED (Baral et al.2016).[5] The lyophilized aqueous extract (LAE) of D. monetaria have shown a dose dependant inhibition of gastric lesions induced by indomethacin, ethanol, pylorus ligature and hypothermic restraint stress on oral administration.[7]

16. 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 the 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 the immune system, and also, it can be concluded that the immunostimulatory property of extract was dose dependent.[4]

17. 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 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.[4]

18. Antiparasitic effect

Various extracts of leaves of Dalbergia sissoo such as petroleum ether, carbon tetrachloride, benzene and ethanol were assessed by Hood and colleagues in 2011 for antihelmintic activity against Indian earthworms (Pheretima posthuma) at different concentrations of (10, 25, 50, and 100 mg/ml), and they were compared with piperazine citrate. All the extracts revealed antihelmintic activity against the earthworms. Carbon tetrachloride extract showed the most potent activity with the paralysis time of 19.14 ± 2.78 min and death time of 48.15 ± 3.23 min at the concentration of 100 mg/ml, while piperazine citrate showed paralysis time and death time of 5.23 ± 0.72 and 20.45 ± 2.33 min, respectively at the concentration of 10 mg/ml. Adult immersion test was employed by Singh and colleagues in 2016, to study the acaricidal activity of leaf extracts of Dalbergia sissoo against resistant ticks. Mortality and fertility of ticks exposed to leaf aqueous and ethanolic extracts were evaluated at concentrations of 0.625, 1.25, 2.5, 5.0 and 10.0% and controls (distilled water and 10% ethanol). Higher acaricidal activity was recorded in aqueous extract with a lower LC50 (95% CL) value of 1.58% (0.92-2.71%) than ethanolic extract viz. 5.25% (4.91-5.63%). A noticeable decrease in egg mass and reproductive index was observed in treated ticks along with an increase in percent inhibition of oviposition. A complete inhibition of hatching was recorded in eggs laid by ticks treated with higher concentrations of aqueous extract, whereas, ethanolic extract, showed no effect on the same. The larva- killing, growth inhibiting and repellent actions of Dalbergia sissoo oil was studied against Anopheles stephensi, Aedes agyria and Culex quinquefasciatus and found to be highly effective for Culex quinquefasciatus and Anopheles stephensi (Ansari et al., 2000).[1] 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 recorded with Dalbergia sissoo oil as compared to that with commercial available Mylol oil (93±1.2%) consisiting of di-butyl and dimethyl phthalates.[8] In 2011, Hood et al. evaluated the antihelmintic activity of several Dalbergia sissoo leaf extracts, including petroleum ether, carbon tetrachloride, benzene, and ethanol, against Indian earthworms (Pheretima posthuma) at varying concentrations (10, 25, 50, and 100 mg/ml) and compared the results with piperazine citrate. The larva- killing, growth inhibiting, and repellent actions of Dalbergia sissoo oil were studied against Anopheles stephensi, Aedes agyria, and Culex quinquefasciatus and found to be highly effective for Culex quinquefasciatus and Anopheles stephensi (Rana et al., 2019).[5]

19. Dermatological effects

The cytotoxicity and in vitro melanogenic activity on bark of Dalbergia sissoo were studied. The various successive bark extracts have been individually evaluated for trials of spontaneous melanin content, and cell viability by the MTT assay in murine B16F10 melanoma cells in vitro. Based on the percentage of cell viability assay, graded concentration of extracts were taken for in vitro melanogenic activity. The result indicated that ethyl acetate extract of bark of Dalbergia sissoo was non-toxic and increased melanin activity as compared to hexane and ethanol extracts. The authors concluded that the bark of Dalbergia sissoo stimulates B16F10 melanogenesis at very low concentrations which support the folk medicinal use of Dalbergia sissoo in the treatment of hypopigmentation diseases, such as vitiligo.[8]

20. Antidiarrhoeal effect

The ether, ethanol, and aqueous extracts of Dalbergia sissoo bark were studied for anti-diarrhoeal properties in experimental diarrhoea, induced by castor oil in rats at the dose of 200 – 400 mg/kg orally, the 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) The ether extract was found to be equipotent to atropine.The protective effect of ethanol extract from Dalbergia sissoo leaves (EDSL) was studied in experimentally induced diarrhoea and peristalsis in mice. Castor oil-induced diarrhoea and magnesium sulphate (MgSO4)-induced diarrhoea tests were used to assess the antidiarrhoeal activity of Dalbergia sissoo. Gastrointestinal tract transit of charcoal meal test and barium sulphate milk was used to assess the peristalsis activity of the extract. The EDSL significantly reduced faecal output in castor oil induced and MgSO4-induced diarrhoea and also significantly reduced the number of diarrhoeal episodes. Dalbergia sissoo significantly delayed the onset of diarrhoea induced by both castor oil and MgSO4 comparable to loperamide, a standard antidiarrhoeal drug. Both Dalbergia sissoo and atropine sulphate significantly reduced the peristalsis activity of charcoal meal and barium sulphate milk in mice.[8] The effect of a decoction of dried leaves of Dalbergia sissoo was evaluated in diarrhea. Antibacterial, antiprotozoal, and antiviral activities of the plant decoction were checked by agar dilution method, tube dilution method, and neutral red uptake assay, respectively. Cholera toxin and Escherichia coli labile toxin (LT) were assayed by ganglioside monosialic acid receptor. 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. The decoction had no antibacterial, antiprotozoal, and antiviral activity. It inhibited the production of cholera toxin, and increased the production of labile toxin.

Binding of both LT and CT to the GM1 receptor was reduced.[8] The decoction of dried leaves of D. sisso possesses antidiarrhoeal activity. The ethanolic extract of the bark of D. lanceolaria have shown activity against castor oil and magnesium sulphate induced diarrhoea in albino mice.[7]

21. Cardiac effect

The effect of alcoholic extract of Dalbergia sissoo leaf extract (DSE) (30, 100 and 300 mg/kg of body weight) was studied in isoproterenol (ISP)-induced myocardial injury in rats. Assessment of myocardial injury was done by estimation of different cardiac injury markers like LDH, CK-MB. Serum cholesterol, LDL, HDL, triglycerides in serum, myocardial infarcted area, oxidative stress and histopathology of heart tissue in rats. Mean arterial pressure and heart rate were recorded in all the groups. Rats pretreated with DSE (30, 100 and 300 mg/kg of body weight) showed significant (P< 0.05-0.001) improvement in the relative heart weight, myocardial infarcted areas, heart rate and mean arterial pressure in ISP-induced myocardial injury. DSE showed significant (P< 0.05-0.001) improvement in serum LDH, CK-MB, cholesterol, LDL and triglyceride levels at all the dose levels. However, DSE pretreatment had no significant effect on serum HDL level. Pretreatment with DSE (30, 100 and 300 mg/kg body weight) showed significant (P< 0.001) reduction in MDA level in 65 Chemical constituents and pharmacological effects of Dalbergia sissoo - A review comparison with myocardial injured rats. Furthermore, antioxidant potential was also improved in terms of improved activities of reduced glutathione, superoxide dismutase and catalase with the DSE pretreatment. Histopathology also showed significant improvement in heart tissue.[8]

22. Toxicity

The acute toxicity study showed that the ethanol bark extract of Dalbergia sissoo was nontoxic up to 3000 mg/kg body weight in Swiss albino mice. Acute toxicity studies were carried out on Wistar rats. Alcohalic bark extracts at 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 animal up to the dose level 3000 mg/kg boy weight. 90% ethanolic extract was also safe up to 3000 mg/kg, orally in the rats.[8]

23. Antiartitic activity

The petroleum ether, alcohol and aqueous extracts of D. lanceolaria had been found effective against arthritis when tested against formaldehyde-induced arthritis in young growing albino rats. The effects of extracts were comparable with cortisone, a standard anti-inflammatory and anti-arthritic drug.[7]

24. Antigiarrdial activity

The extracts and formononetin an isoflavone from the bark of D. frutescans have shown significant activity against Giardia intestinalis with an IC 50 value of 30ng/ml (approx. 0.1 μm) as compared to the value for metronidazole, the current drug of choice of 100 ng/ml (approx. 0.6 μm).[7]

25. Cancer chemopreventive activity

Ethanolic extracts of the stem bark of the D. cultrate Grati and D. nigrescens Kurz were found to exhibit a significant antitumor promoting activity on TPA (12-o-tetradecanoylphorbol-13 acetase, EBV-EA (Epstein Barr virus early antigen) and TPA induced EBV-EA activation.[7]

26. Antiplasmodial activity

The air-dried powdered heartwood of D. Lovella contained flavonoids that exhibited Antiplasmodial activity, with IC 50 values ranging from 5.8 to 8.7 um. (Beldjoudi et al., 2003).[5] The flavanoids isolated from air dried powdered heartwood of D. louvelli showed antiplasmodial activity with IC 50 values ranging from 5.8 to 8.7 um.[7]

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