RESEARCH PAPER

Phytochemicals and Pharmacological Activities of *Vateria indica* A Concise Scientific Review

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Abstract:

Vateria indica L. (Dipterocarpaceae), commonly known as white dammar or “sarja,” is an endemic tree of the Western Ghats of India and holds significant medicinal value in Ayurveda, Siddha, and Unani systems. Various plant parts particularly the oleo-gum resin, bark, leaves, and seeds contain a rich spectrum of bioactive constituents, including triterpenoids, flavonoids, phenolics, volatile terpenes, fatty acids, and notably resveratrol oligomers (stilbenoids) such as vaticanols and vateriaphenols. These phytochemicals contribute to the plant’s wide pharmacological profile.

Over the last two decades, extensive experimental research has demonstrated that *V. indica* exhibits potent antioxidant, anti-inflammatory, antimicrobial, wound-healing, anticancer, and anti-ulcer activities. The strong antioxidant and anti-inflammatory effects are primarily linked to its high phenolic and stilbenoid content, which helps modulate oxidative stress, inflammatory mediators, and cellular signaling pathways. Unique oligostilbenes from *V. indica* have also shown promising cytotoxic activity in various cancer models, highlighting its potential as a source of lead compounds for drug development.

Despite these encouraging findings, current evidence remains largely preclinical. Critical gaps persist, including the lack of standardized extraction methods, comprehensive toxicological evaluations, pharmacokinetic data, and human clinical trials. Addressing these limitations is essential to validate safety, efficacy, and therapeutic relevance. This review summarizes the phytochemistry, traditional uses, and pharmacological properties of *V. indica*, emphasizing its potential and future research needs.

Keywords: Vateria indica; white dammar; stilbenoids; vaticanol; vateriaphenols; triterpenoids; wound healing.

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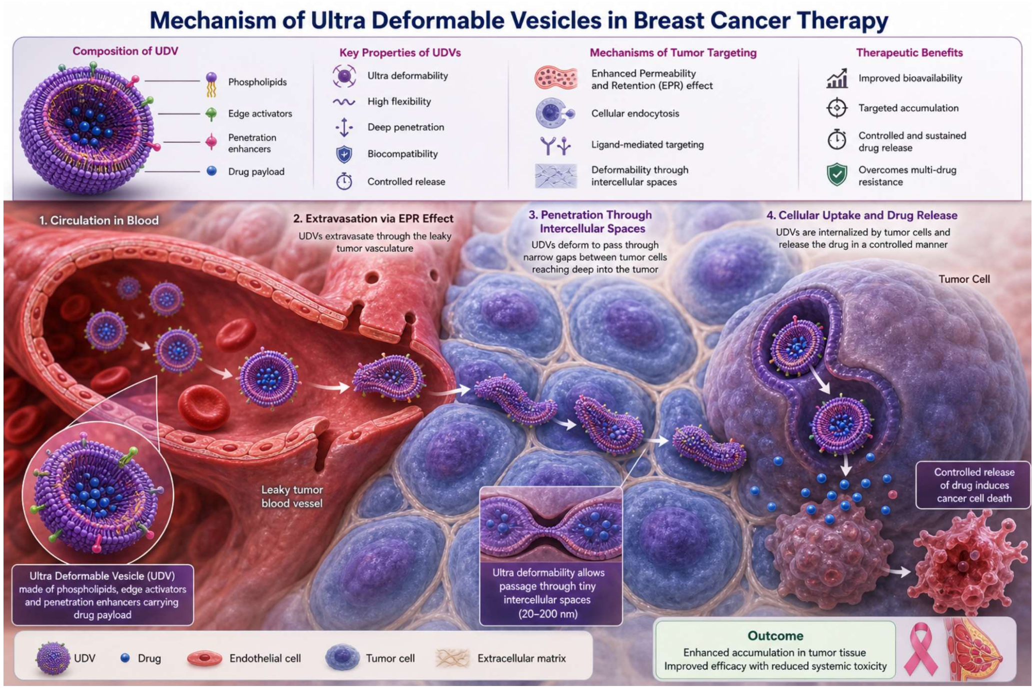
Graphical Abstract



1. Introduction:

Medicinal plants remain a cornerstone for the discovery of novel therapeutic agents, with many modern drugs originating from natural products or their derivatives. *Vateria indica* L., an important medicinal tree of the Dipterocarpaceae family, is one such species that has gained increasing scientific attention. Native to the dense forests of the Western Ghats of India, this large evergreen tree produces an aromatic oleo-gum resin known as white dammar or sarja rasa**,** which has been widely utilized for centuries in Ayurveda, Siddha, and Unani systems of medicine. Traditional formulations describe the resin as an antiseptic, wound-healing, anti-inflammatory, expectorant, and digestive agent. Various parts of the plant including the bark, leaves, seeds, and resin are used to manage ailments such as diarrhea, dysentery, skin infections, chronic cough, respiratory disorders, gastric ulcers, and inflammatory conditions. These diverse applications underline its long-standing importance in ethnomedicine [1–3]

Ethnobotanical documentation further indicates that tribal communities have traditionally applied the resin to wounds and burns due to its natural antimicrobial and tissue-regenerative properties. In recent decades, advances in phytochemical research have revealed that *V. indica* is an abundant source of resveratrol-based oligomers**,** particularly vaticanols and vateriaphenols**,** which possess unique and complex molecular structures. These compounds, along with triterpenoids, flavonoids, and phenolic acids, contribute significantly to the plant's bioactivity. Several studies have demonstrated that these oligostilbenes exhibit strong antioxidant, anti-inflammatory, and cytotoxic properties, suggesting potential applications in cancer prevention and therapy [4] .

Given the growing body of scientific evidence, there is a need for a comprehensive review that integrates traditional knowledge, phytochemical composition, and pharmacological findings. Such a consolidated perspective will help clarify the therapeutic potential of *V. indica*, identify research gaps, and support future investigations aimed at developing standardized extracts and clinically validated herbal formulations.

2. Botanical Description and Distribution

Vateria indica L., commonly referred to as white dammar or *sarja*, is a prominent evergreen forest tree belonging to the family Dipterocarpaceae. It is one of the tallest native species in the Western Ghats, typically attaining a height of 40–50 meters under favorable ecological conditions. The tree exhibits a straight bole with a cylindrical trunk that may reach up to 1–2 meters in diameter, often buttressed at the base in mature individuals. The bark is thick, rough, and dark grey to brown in color, characterized by deep longitudinal fissures; on injury, it exudes a translucent, aromatic oleo-gum resin known as white dammar [5]. The leaves are simple, large (10–20 cm), and coriaceous with a glossy surface. They are arranged alternately and possess prominent reticulate venation, a diagnostic feature of the species. The petiole is short and stout, supporting an elliptic to oblong lamina with an acute apex. Flowers are small, white, and highly fragrant, borne in dense axillary or terminal panicles. Each flower contains five petals and a well-developed androecium characteristic of the genus. Flowering typically occurs between January and April, depending on regional climatic conditions. The fruits are ovoid to ellipsoid drupes, 3–4 cm long, turning brown on maturation. They contain a single seed rich in fixed oil, traditionally used for illumination and sometimes in indigenous medicinal formulations. Seed dispersal occurs during the monsoon months.

Distribution:

Vateria indica is endemic to the Western Ghats, one of the world's biodiversity hotspots. Its natural range extends across Karnataka, Kerala, Goa, and Maharashtra, with dense populations in evergreen and semi-evergreen forest belts at altitudes ranging from 200–1,000 meters. The species prefers humid tropical climates with well-drained lateritic or loamy soils.

Due to excessive harvesting of its resin, timber extraction, and ongoing habitat fragmentation, the species has undergone a significant decline in natural populations. Consequently, the International Union for Conservation of Nature (IUCN) has classified *V. indica* as "Vulnerable", highlighting the need for conservation measures, sustainable harvesting protocols, and habitat restoration plans [6] .

3. Traditional and Ethnomedicinal Uses

Vateria indica has been deeply integrated into the Ayurvedic, Siddha, and Unani systems for centuries, primarily through its oleo-gum resin known as white dammar (*Sarja Rasa* or *Sakralasaka*). The resin, bark, and seeds have been traditionally valued for their antiseptic, wound-healing, respiratory, gastrointestinal, and analgesic properties. Ancient texts such as *Bhavaprakasha*, *Charaka Samhita*, and regional ethnobotanical records provide descriptions of its therapeutic utility [7,8]. Below is a detailed account of each traditional medicinal use.

3.1 Antiseptic and Anti-inflammatory Actions (Sarja Rasa)

In Ayurvedic literature, *Sarja Rasa* is categorized as a natural antiseptic resin used for cleansing wounds, ulcers, and inflamed tissues. The resin is believed to possess krimighna (antimicrobial) and shothahara (anti-inflammatory) properties. It is traditionally applied as a paste or incorporated into medicated oils for treating skin infections, boils, dermatitis, and local inflammatory swellings. Siddha medicine similarly describes white dammar as an ingredient in formulations aimed at controlling suppuration and microbial contamination in wounds[7]. Modern phytochemical research supports these uses, showing that resin-derived terpenoids and phenolic compounds can inhibit microbial growth and modulate inflammatory cytokines.

3.2 Wound-Healing (External Application)

White dammar has historically been a preferred topical agent for promoting wound closure. Traditional healers apply the powdered resin or resin-infused oil on cuts, burns, ulcers, and traumatic wounds. It is believed to enhance granulation tissue formation, reduce discharge, and prevent infection. Ayurveda describes it as "vranaropaka" a substance that accelerates tissue regeneration and supports skin repair.

Ethnobotanical studies from Karnataka and Kerala report its regular use in folk medicine, where the freshly collected resin is mixed with coconut oil or ghee and applied to chronic wounds, diabetic ulcers, and skin fissures[8]. Scientific studies later confirmed that *V. indica* resin exhibits antioxidant, astringent, and antimicrobial properties, all of which contribute to its wound-healing effectiveness.

3.3 Expectorant in Respiratory Disorders

The resin is traditionally used as an expectorant, particularly in treating cough, bronchitis, asthma, and throat congestion. Ayurvedic formulations utilize *Sarja Rasa* to loosen phlegm, reduce airway inflammation, and soothe irritated bronchial passages. It is administered orally in the form of medicated ghee, herbal pills, or resin-based decoctions. Unani medicine also employs the resin for chest ailments, describing it as a mucolytic and bronchial cleanser. Folk practitioners often burn the resin for fumigation to relieve respiratory difficulty and purify the air in traditional households [7,8]. Contemporary investigations showed that terpenoid-rich resins can modulate respiratory secretions and exhibit mild bronchodilatory effects.

3.4 Carminative and Anti-diarrheal Uses

In gastrointestinal disorders, *Vateria indica* resin is valued as a carminative, used to relieve abdominal discomfort, flatulence, and indigestion. Classical texts recommend it for diarrhea, dysentery, and intestinal inflammation, and it is often included in poly-herbal remedies intended to restore digestive balance. Tribal communities in the Western Ghats administer the resin in powdered form mixed with buttermilk or warm water to patients suffering from acute diarrhea, citing quick reduction in abdominal cramps and stool frequency[8]. Pharmacological studies later demonstrated that phenolic constituents and tannins possess astringent activity, supporting these traditional uses.

3.5 Analgesic Use in Joint Pain and Musculoskeletal Disorders

Topical preparations of white dammar have long been applied to alleviate arthritis, muscle pain, backache, and joint stiffness. In Ayurveda, its resin is included in medicated oils and balms for rheumatoid conditions, attributed to its vedanasthapana (analgesic) and shothahara (anti-swelling) actions.

Folk medicine systems also employ poultices made from warm resin mixed with herbal oils to treat sprains, ligament injuries, and chronic musculoskeletal pain. Its warming, counter-irritant effect is believed to enhance circulation and reduce local inflammation [7,8]. Modern observations suggest that triterpenoids present in the resin may contribute to its analgesic properties via inflammation-modulating pathways.

4. Phytochemical Profile of Vateria indica:

Phytochemical investigations reveal that *Vateria indica* is a chemically rich species containing diverse classes of secondary metabolites that contribute to its broad spectrum of pharmacological activities. Its resin, bark, leaves, and seeds have been extensively analyzed, leading to the identification of phenolic compounds, stilbenoids, triterpenoids, flavonoids, volatile oils, and fatty acids. These constituents collectively support the plant's antioxidant, anti-inflammatory, antimicrobial, and cytoprotective properties.

4.1 Phenolic Compounds and Stilbenoids

One of the most distinctive chemical features of *V. indica* is its abundance of resveratrol-derived oligostilbenes. These include major compounds such as Vaticanol A–D, Vateriaphenols A–F, Vateriosides (glycosylated stilbenoids), Vaticaphenols, and several ampelopsin derivatives [9–11]. These oligomers are structurally related to resveratrol but possess increased polymeric complexity, enhancing their biological activity. Research shows that these stilbenoids exhibit potent antioxidant, free-radical scavenging, and anticancer properties, making them key contributors to the therapeutic potential of the species. Their high concentration in the resin and bark suggests their likely role in plant defense and medicinal efficacy.

4.2 Triterpenoids and Steroids

The resin and bark of *V. indica* are also rich sources of triterpenoids, including α-amyrin, β-amyrin, lupeol, oleanolic acid, and several ursane-type derivatives [12]. These compounds are well-known for their anti-inflammatory, analgesic, anti-arthritic, and hepatoprotective actions. Triterpenoids are commonly associated with membrane stabilization, cyclooxygenase inhibition, and modulation of oxidative pathways, which align with the plant's traditional uses for inflammation, joint pain, and wound healing.

4.3 Flavonoids and Other Polyphenols

In addition to stilbenoids, *V. indica* contains several flavonoids and polyphenols in its bark and leaves. Reported compounds include quercetin derivatives, kaempferol, bergenin (a bioactive isocoumarin glycoside), and catechin-like tannins [13]. These molecules contribute significantly to the plant's antioxidant, antimicrobial, and anti-ulcer effects. Flavonoids are known to modulate inflammatory mediators, protect cellular structures from oxidative stress, and support tissue repair, aligning with the ethnomedicinal applications of the species.

4.4 Volatile Oils (Monoterpenes and Sesquiterpenes)

Gas chromatography–mass spectrometry (GC–MS) analysis of the oleo-gum resin has revealed a complex mixture of volatile monoterpenes and sesquiterpenes, including α-pinene, β-pinene, limonene, caryophyllene, and aromadendrene [14]. These volatile constituents are responsible for the characteristic aroma of white dammar and contribute to its antimicrobial, aromatic, and expectorant properties. Monoterpenes like α-pinene and limonene are known for their bronchodilatory and mucolytic actions, which correlate with the traditional use of the resin in respiratory disorders.

4.5 Fatty Acids in Seeds

The seeds of *V. indica* contain a high proportion of fixed oils, mainly composed of oleic acid (35–45%), stearic acid (20–25%), palmitic acid (10–12%), and linoleic acid (5–8 %)[15]. This fatty acid profile suggests potential applications in nutraceutical development, cosmetics, and industrial uses such as bio-based lubricants and soaps. The high oleic and stearic acid content also indicates the oil's stability, making it suitable for traditional uses as lamp oil and therapeutic base preparations.

Table no. 1: Phytochemical Profile of Vateria indica

Category	Major Compounds Identified	Plant Part / Source	Reported Activities	References
Phenolic Compounds & Stilbenoids	Vaticanol A–D, Vateriaphenols A–F, Vateriosides, Vaticaphenols, Ampelopsin derivatives	Resin, bark, leaves	Strong antioxidant, anticancer, cytoprotective	[9–11]
Triterpenoids & Steroids	α-amyrin, β-amyrin, Lupeol, Oleanolic acid, Ursane derivatives	Resin, bark	Anti-inflammatory, hepatoprotective, analgesic	[12]
Flavonoids & Polyphenols	Quercetin derivatives, Kaempferol, Bergenin, Catechin-like tannins	Bark, leaves	Antioxidant, antimicrobial, anti-ulcer	[13]

Volatile Oils (Monoterpenes & Sesquiterpenes)	α-pinene, β-pinene, Limonene, Caryophyllene, Aromadendrene	Oleo-gum resin	Antimicrobial, aromatic, expectorant	[14
Fatty Acids (Seed Oil)	Oleic acid (35–45%), Stearic acid (20–25%), Palmitic acid (10–12%), Linoleic acid (5–8%)	Seeds	Nutraceutical value, emollient, industrial applications	[15]

5. Pharmacological Activities:

A wide range of in vitro and in vivo studies have demonstrated that *Vateria indica* possesses significant pharmacological properties attributed mainly to its rich content of stilbenoids, triterpenoids, flavonoids, and monoterpenes. The following subsections summarize the major biological activities reported for the species.

Table no. 2: Pharmacological Activities of *Vateria indica*

Sr. No.	Pharmacological Activity	Key Findings / Mechanisms	Major Bioactive Constituents	References
1	**Antioxidant Activity**	**Strong radical-scavenging in DPPH, ABTS, FRAP, NO assays; inhibits lipid peroxidation; reduces ROS; metal-chelating properties.**	**Oligostilbenes (vaticanol A, vaticanol C), phenolics**	**[16–18]**
2	Anti-inflammatory & Analgesic Activity	Inhibits protein denaturation, membrane lysis, LOX, COX pathways; reduces carrageenan-induced edema.	Lupeol, α/β-amyrin, triterpenoids	[19,20]
3	Antimicrobial & Antifungal Activity	Inhibits S. aureus, E. coli, P. aeruginosa, C. albicans, A. niger; disrupts membranes and enzymes.	α-pinene, β-pinene, limonene	[21]
4	Wound-Healing Activity	Enhances wound contraction, collagen deposition, epithelialization; increases tensile strength.	Resin constituents, antioxidants, triterpenoids	[22]
5	Anti-ulcer Activity	Reduces ulcer index; increases mucin; decreases	Bergenin, quercetin derivatives, stilbenoids	[23]

		acidity; mitigates oxidative stress.		
6	Anticancer / Cytotoxic Activity	Induces apoptosis; cell cycle arrest; modulates Bcl-2 and caspases; active against HeLa, EAC, C6 glioma.	Oligostilbenes (vaticanol A, C, vateriaphenol E)	[24–27]
7	Anti-obesity & Metabolic Activity	Inhibits pancreatic lipase; improves lipid profile; reduces triglycerides.	Seed phytochemicals, polyphenols	[28]
8	Anthelmintic Activity	Causes paralysis and death of helminths; disrupts metabolism and neuromuscular function.	Terpenoids, tannins	[29]

5.1 Antioxidant Activity

Phenolic-rich fractions derived from the bark, leaves, resin, and flowers of *V. indica* exhibit strong antioxidant potential across multiple assay systems. Extracts have shown potent free-radical scavenging in DPPH, ABTS, FRAP, and nitric oxide inhibition assays, indicating broad antioxidant capacity [16,17]. The mechanisms underlying these effects include hydrogen atom donation, inhibition of lipid peroxidation, metal ion chelation, and reduction of intracellular reactive oxygen species (ROS) levels [18]. Among its constituents, oligostilbenes such as vaticanol A and vaticanol C demonstrate exceptionally high radical-scavenging ability reported to be significantly stronger than resveratrol, likely due to enhanced conjugation and polymeric structure. These antioxidant properties align with the plant's traditional use in treating inflammatory and degenerative conditions.

5.2 Anti-inflammatory and Analgesic Activity

Ethanolic and methanolic extracts of *V. indica* resin have shown marked anti-inflammatory activity, particularly in protein denaturation, membrane stabilization, lipoxygenase inhibition, and carrageenan-induced paw edema models [19,20]. The extracts reduce both early (histamine- and serotonin-mediated) and late (prostaglandin-mediated) phases of inflammation. Mechanistic studies suggest dual modulation of the COX (cyclooxygenase) and LOX (lipoxygenase) pathways, mimicking the action of non-steroidal anti-inflammatory drugs (NSAIDs).

Triterpenoids such as lupeol and α-/β-amyrin are believed to contribute significantly to the anti-inflammatory and analgesic effects due to their membrane-stabilizing and cytokine-suppressing actions. These findings correlate well with the ethnomedicinal use of the resin for managing joint pain, musculoskeletal inflammation, and traumatic injuries.

5.3 Antimicrobial and Antifungal Activity

The essential oil and solvent extracts of *V. indica* exhibit notable antimicrobial properties against a variety of bacteria and fungi. Significant inhibitory effects have been reported against Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Candida albicans, and Aspergillus niger[21]. The antimicrobial action is largely attributed to volatile monoterpenes such as α-pinene, β-pinene, and limonene, which are known to disrupt microbial cell membranes, cause leakage of intracellular contents, and inhibit respiratory enzyme activity. The resin's antimicrobial potency supports its traditional use as an antiseptic and wound-cleansing agent.

5.4 Wound-Healing Activity

Topical formulations containing *V. indica* resin have demonstrated enhanced wound-healing properties in excision and incision wound models. Extract-based ointments significantly promote wound contraction, collagen deposition, epithelialization, and overall tissue remodeling, while simultaneously reducing microbial load at the wound site[22]. The combined antioxidant, anti-inflammatory, and antimicrobial actions of the resin contribute synergistically to accelerated healing. Increased hydroxyproline content and improved tensile strength of healed tissue further validate the resin's efficacy as a natural wound-healing agent.

5.5 Anti-ulcer Activity

Ethanolic bark extracts of *V. indica* exhibit gastroprotective activity in models of ethanol- and aspirin-induced gastric ulceration. The extracts significantly reduce ulcer indices by enhancing mucin secretion, attenuating oxidative stress, and reducing gastric acidsecretion[23]. Polyphenols such as bergenin, quercetin derivatives, and stilbenoids are likely contributors due to their cytoprotective and free-radical scavenging properties. These findings support the plant's traditional use in managing gastrointestinal disturbances.

5.6 Anticancer / Cytotoxic Activity

Resveratrol-derived oligostilbenes isolated from *V. indica*, including vaticanol C, vateriaphenol E, and vaticanol A, exhibit significant cytotoxic activity against a range of cancer cell lines. Reported targets include C6 glioma cells, Ehrlich ascites carcinoma (EAC), and HeLa cervical cancer cells[24–26]. Mechanistic studies reveal that these stilbenoids induce apoptosis, promote cell cycle arrest at G1 or G2/M, downregulate anti-apoptotic proteins (e.g., Bcl-2), and upregulate caspase activity, leading to programmed cell death[27]. The pronounced activity of oligostilbenes, often exceeding the potency of resveratrol, positions *V. indica* as a promising candidate for anticancer drug discovery.

5.7 Anti-obesity and Metabolic Activity

Preliminary studies suggest that seed extracts of *V. indica* may modulate lipid metabolism and adipogenesis. Some fractions demonstrate inhibition of pancreatic lipase, reductions in serum triglycerides, and improvement in lipid profile parameters in experimental models[28].
Although current data are limited, these findings open new avenues for exploring the plant's potential role in metabolic disorders, particularly obesity and dyslipidemia.

5.8 Anthelmintic Activity

Methanolic extracts of the resin have shown moderate to strong anthelmintic activity in vitro, causing paralysis and death of helminths at relatively low concentrations [29]. The activity is attributed to terpenoids and tannins, which can interfere with parasite energy metabolism, disturb membrane integrity, and inhibit neuromuscular function.

6. Conclusion:

Vateria indica is a medicinally important tree known for its rich phytochemical composition. It contains several valuable bioactive compounds such as resveratrol oligomers, flavonoids, triterpenoids, and volatile terpenes, which contribute to its strong therapeutic potential. Research has shown that extracts from its bark, resin, leaves, and seeds possess significant antioxidant, antimicrobial, anti-inflammatory, wound-healing, anti-ulcer, and anticancer activities.
These pharmacological effects support many of the traditional uses of *V. indica* in Ayurveda, Siddha, and folk medicine. The presence of potent stilbenoids like vaticanols and vateriaphenols further enhances its value as a natural source of bioactive molecules with diverse health benefits[30].
However, despite promising preclinical evidence, more scientific investigations are necessary. Future research must focus on extract standardization, detailed mechanisms of action, toxicity studies, and clinical trials to ensure safety and effectiveness. Only through such comprehensive evaluation can *Vateria indica* move toward pharmaceutical development and wider therapeutic use.

7. References:

1. Krishnan PN, Pushpangadan P. Ethnopharmacological importance of Vateria indica. J Ethnobotany. 2005;17(3):45–53.
2. Nadkarni KM. Indian Materia Medica. Volume 1. Bombay: Popular Prakashan; 2009.

3. Warrier PK, Nambiar VPK, Ramankutty C. Indian Medicinal Plants. Orient Longman; 1995.
4. Mishima S, et al. Oligostilbenes from V. indica and their anticancer activity. Phytochemistry. 2003; 62:167–171.
5. Bhat KG. Flora of South India. New Delhi: Regency Publications; 2017.
6. IUCN Red List. Vateria indica. 2024 report.
7. Sharma PV. Dravyaguna Vijnana. Chaukhamba Bharati; 2011.
8. Ayurveda Formulary of India, Govt. of India. 2016.
9. Tanaka T, et al. C-glucosidic stilbene oligomers from V. indica. J Nat Prod. 2000; 63:676–679.
10. Shilpa S, et al. Phytochemical profiling of V. indica bark. Pharmacogn J. 2019; 11:124–131.
11. Khan M, et al. Stilbenoids from V. indica: a review. Nat Prod Res. 2023;37(2):215–225.
12. Prakash L, et al. Triterpenoids of Vateria indica. Indian J Chem. 2010; 49:352–357.
13. Baliga MS et al. Polyphenolic content of Vateria indica. Pharmacogn Mag. 2013; 9:291–298.
14. Roy John R, et al. GC–MS analysis of V. indica oleo-gum resin. Ind Crops Prod. 2020; 146:112–118.
15. George M, et al. Fatty acid composition of V. indica seeds. J Am Oil Chem Soc. 2017; 94:865–873.
16. Madhavan M, et al. Antioxidant activity of leaf, bark and flowers of V. indica. Pharmacogn Res. 2025;17(1):10–18.
17. Kripa SK, et al. In vitro antioxidant properties of Vateria indica. Int J Pharm Sci. 2015; 7:234–239.
18. Lobo V, et al. Antioxidant mechanisms of phenolics. J Pharm Sci Res. 2010; 2:137–145.
19. Sreelakshmi R, et al. Anti-inflammatory activity of V. indica resin. J Ethnopharmacol. 2014; 156:178–185.
20. Patel J, et al. Analgesic potential of V. indica bark extract. Indian J Pharmacol. 2016; 48:45–50.
21. Ramesh V, et al. antimicrobial evaluation of Vateria indica extracts. J Herbs Spices Med Plants. 2018; 24:90–98.
22. Hussain A, et al. Topical wound healing activity of V. indica resin ointment. Pharm Biol. 2017;55(1):2217–2223.
23. Kumaravel B, et al. Anti-ulcer activity of V. indica bark. Biomed Pharmacother. 2019; 111:366–372.
24. Tanaka T, et al. Cytotoxic oligostilbenes from V. indica. Planta Med. 2001; 67:546–550.
25. Misra S, et al. Antitumor potential of vaticanols. Oncol Lett. 2016; 12:141–148.
26. Zhang Y, et al. Resveratrol oligomers: anticancer potential. Cancer Lett. 2019; 455:21–33.
27. Lee HJ, et al. Mechanisms of oligostilbene-induced apoptosis. Bioorg Med Chem. 2018; 26:4500–4508.
28. Nair SS, et al. Anti-obesity potential of Vateria seed extract. J Funct Foods. 2021; 82:104–115.
29. Srinivas B, et al. Anthelmintic activity of Vateria indica. Int J Green Pharm. 2014; 8:95–99.
30. Thomas P, et al. Toxicological concerns of V. indica extracts. Toxicol Rep. 2022; 9:890–897.
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