RESEARCH PAPER

A Comprehensive Review on Vateria indica.

1. B. Nagaveni [1], Dr. Kishore D.V [2], Dr. T.VedaVijaya[3], Dr.G.Bhavani [4], Dr. Mehdi Ali Mirza[5], Dr.Satrasala Ramesh[6].

1.Ph.D. Scholar, Meenakshi Academy of Higher Education and Research (MAHER), Chennai, India
Email: jastiveni123@gmail.com &
Assistant Professor, Department of Pharmacology, SHADAN Institute of Medical Sciences Teaching Hospital & Research Centre, Hyderabad, India
Email: jastiveni123@gmail.com
2. Professor, Department of Pharmacology, SHADAN College of Pharmacy, Hyderabad, India
Email: kishoredv2000@gmail.com
3. Professor and Head, Department of Pharmacology, Meenakshi Ammal Dental College and Hospital, Madhuravoyal, MAHER, Chennai, India
Email: trivijaya73@yahoo.co.in
4. Associate Professor, Department of Pharmacology, Meenakshi Ammal Dental College and Hospital, Madhuravoyal, MAHER, Chennai, India
Email: drbhavani.pharmacology@madch.edu.in
5. Assistant Professor, Department of Pharmacology, ESIC Medical College and Hospital, Sanath Nagar, Hyderabad, India
Email: mehdialimirza@gmail.com
6. Ex- Professor and Head, Department of Pharmacology, SHADAN Institute of Medical Sciences Teaching Hospital & Research Centre, Hyderabad, India
Email: rsathrasala52@gmail.com

Corresponding Author:
DR.G. BHAVANI
Associate Professor, Department of Pharmacology, Meenakshi Ammal Dental College and Hospital, Madhuravoyal, Meenakshi Academy of Higher Education and Research [MAHER], Chennai, India
Email: drbhavani.pharmacology@madch.edu.in

ABSTRACT
Vateria indica Linn., belonging to the family Dipterocarpaceae, is a large tropical evergreen tree indigenous to the Western Ghats of India[12]. It is widely recognized for its medicinal, ecological, and commercial significance. The plant produces a valuable oleoresin known as white dammar, which has been extensively used in traditional medicine and industrial applications[3]. Phytochemical investigations have revealed the presence of flavonoids, triterpenoids, phenolic compounds, steroids, and resin acids that contribute to its biological activities[10]. Pharmacological studies have demonstrated antioxidant, anti-inflammatory, antimicrobial, wound-healing, and anticancer properties[9][10]. The species also plays a crucial ecological role in maintaining biodiversity and forest stability[18]. However, due to overexploitation, deforestation, and habitat fragmentation, its population is declining, making conservation strategies essential[18]. This review provides a comprehensive overview of its taxonomy, botanical features, phytochemistry, traditional uses, pharmacological activities, industrial importance, ecological relevance, and conservation status...
Keywords: Vateria indica; Dipterocarpaceae; White dammar; Phytochemistry; Pharmacological activities; Conservation.
How to cite this article: Nagaveni B, Kishore DV, Veda Vijaya T, Bhavani G, Mirza MA, Ramesh S. A Comprehensive Review on Vateria indica. Int J Drug Deliv Technol. 2026;16(64s):999-1006. DOI: 10.25258/ijddt.16.64s.97
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Medicinal plants form the backbone of traditional healthcare systems across the world. In India, a vast diversity of medicinal plants has been utilized for centuries in Ayurveda, Siddha, and Unani systems of medicine[24]. *Vateria indica* is one such important medicinal tree species known for its therapeutic potential and economic value. It is commonly referred to as the White Dammar tree due to the white resin obtained from its bark[3].

*Author for Correspondence: jastiveni123@gmail.com.

Fig:1.Vateria indica plant

Historically, various parts of the plant such as bark, leaves, resin, and seeds have been used to treat ailments including wounds, ulcers, rheumatism, and skin disorders[12]. The resin, in particular, has been valued for its antiseptic, anti-inflammatory, and wound-healing properties[3]. With the increasing interest in plant-based medicines and natural products, *Vateria indica* has gained attention in modern pharmacological research.

Recent scientific studies have focused on identifying and isolating bioactive compounds responsible for its medicinal effects[10]. These compounds exhibit multiple therapeutic activities, including free radical scavenging, inhibition of microbial growth, and modulation of inflammatory pathways[910]. In addition, the plant has significant industrial applications, especially in varnish, paint, and incense industries[3]. Therefore, *Vateria indica* represents an important link between traditional medicine and modern pharmacological research.

Taxonomical Classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Malvales
Family: Dipterocarpaceae
Genus: Vateria
Species: *Vateria indica* Linn.

The family Dipterocarpaceae consists of tropical trees known for their resin production and ecological importance in forest ecosystems[6].

Botanical Description

Vateria indica is a massive evergreen tree that can grow up to 40–50 meters in height under optimal environmental conditions[6]. The trunk is straight, cylindrical, and often buttressed at the base, which provides stability in dense forest environments. The bark is thick, smooth to slightly rough, and greyish-brown in color. When injured, it exudes a characteristic white oleoresin known as dammar[3].

The leaves are simple, alternate, oblong to elliptic, and leathery with a glossy surface. Young leaves are reddish or copper-colored, gradually turning green as they mature[7]. The venation is prominent, aiding in efficient transport of nutrients and water.

The flowers are small, white, and fragrant, usually arranged in terminal or axillary inflorescences. They attract insects for pollination, thereby supporting ecological interactions[7]. Flowering generally occurs during the dry season.

The fruits are winged nuts, which facilitate dispersal by wind. The seeds are rich in fatty oils and serve as a source of industrial raw material[3]. The plant thrives in humid tropical climates with high rainfall and fertile soils[8].

Geographical Distribution and Habitat

Vateria indica is endemic to the Western Ghats, a biodiversity hotspot in India[18]. It is predominantly found in states such as Kerala, Karnataka, Tamil Nadu, and parts of Goa[78]. The species grows in tropical evergreen forests at elevations ranging from sea level to about 1200 meters.

The plant prefers well-drained, lateritic soils and high humidity conditions. It contributes significantly to forest structure by forming part of the upper canopy layer. Its presence supports various forms of wildlife, including birds, insects, and mammals.

Due to its ecological importance, *Vateria indica* plays a role in maintaining microclimatic balance, preventing soil erosion, and contributing to nutrient cycling within forest ecosystems[18].

Phytochemical Constituents

Phytochemical analysis of *Vateria indica* has revealed a diverse range of secondary metabolites responsible for its therapeutic properties[6].

Flavonoids

Flavonoids are important polyphenolic compounds known for their antioxidant activity. They protect cells from oxidative damage and play a role in reducing inflammation and chronic diseases[4].

Triterpenoids

Triterpenoids possess anti-inflammatory, antiviral, and anticancer activities. They contribute to the pharmacological effects of the plant by modulating biological pathways[9].

Phenolic Compounds

Phenolics are strong antioxidants that neutralize free radicals and prevent cellular damage. They are essential for the plant's protective mechanisms[10].

Steroids

Steroidal compounds present in the plant may exhibit anti-inflammatory and immunomodulatory properties.

Resin Components

The white dammar resin contains complex mixtures of resin acids, essential oils, and aromatic compounds responsible for antimicrobial and wound-healing activities[3].

Seed Oil Constituents

Seeds contain fatty acids such as stearic and oleic acids, which are useful in industrial applications including soap and cosmetic production[3].

Chemical Constituents and Structures of Vateria indica outlines of the major chemical constituents of Vateria indica along with their structural characteristics, functional groups, and pharmacological roles.

1. Resveratrol Derivatives & Polyphenolic Stilbenoids

The stem bark and resin of Vateria indica are exceptionally rich in complex polyphenol compounds derived from resveratrol .

Resveratrol Tetramers (e.g., Hopeaphenol, Vateriaphenols B and C)

Structure: Highly intricate multi-ring frameworks consisting of four interconnected resveratrol (stilbene) units .
Core Framework: Fused benzofuran rings linked to multiple peripheral hydroxyphenyl groups.
Key Functional Groups: Abundant phenolic hydroxyl (-OH) groups.
Biological Role: These highly polymerized polyphenols act as powerful free radical scavengers, provide strong antioxidant protection, and exhibit selective cytotoxic (anticancer) and immunomodulatory traits.
Mechanism of action:
The architectural complexity of resveratrol tetramers allows them to interface with cellular targets much more efficiently than simpler resveratrol monomers:
Antioxidant Powerhouse: Tetramers like hopeaphenol demonstrate multi-fold superiority over basic resveratrol monomers in scavenging superoxide anions, terminating free radical chain reactions, and reducing ferric ions.
Enzymatic Inhibition: Their specific 3D shapes can dock into and block pro-inflammatory pathways, showing strong inhibition of the biosynthesis of inflammatory mediators like leukotriene B4 (LTB4) and key digestive enzymes like α-glucosidase.
Antiviral & Cytotoxic Traits: Certain specialized configurations actively block viral transcription mechanisms (such as HIV and SARS-CoV-2 spike protein pathways) and disrupt the cell membrane integrity of targeted human carcinoma cell lines.
Oligostilbenoids
Structure: Oligomeric structures containing multiple repeating phenolic ring units.
Biological Role: Formed as part of the plant's natural protective mechanism, these configurations stabilize and neutralize reactive oxygen species (ROS)
Mechanism of Action
Research has shown that the multi-ring, highly polymerized configurations of oligostilbenoids extracted from Vateria indica offer specific therapeutic benefits:
Enzyme Inhibition: Hopeaphenol has been shown to bind effectively with target proteins to inhibit digestive enzymes (like alpha-glucosidase), making it a candidate for diabetes research.
Cytotoxicity: Certain resveratrol tetramers exhibit selective tumor-inhibiting and cytotoxic (anticancer) properties in in vitro models.
Antioxidant: Because of the high number of hydroxyl groups, these compounds act as direct free-radical scavengers
2. Flavonoids
Flavonoids are polyphenolic secondary metabolites distributed throughout the leaves, bark, and extracts of the plant
Core Structure: Standard (C6-C3-C6) carbon skeleton framework. It consists of two phenyl aromatic rings (designated as Rings A and B) linked together via a central three-carbon oxygen-containing heterocyclic ring (Ring C).
Key Functional Groups: Multiple hydroxyl (-OH) groups attached at various positions around the aromatic rings, along with a carbonyl group (C=O) on the central heterocycle in many sub-classes (like flavones and flavonols).
Biological Role: The spatial arrangement of the hydroxyl groups allows these molecules to readily donate electrons or hydrogen atoms. This structural trait enables them to terminate free radical chain reactions, stabilize cell membranes, and downregulate pro-inflammatory cellular pathways
Mechanism of action :
The therapeutic efficacy of the phytochemicals found in Vateria indica is driven by precise, multi-targeted biochemical mechanisms. Rather than interacting with just a single cellular receptor, its core constituents resveratrol tetramers (stilbenoids), flavonoids, and triterpenoids modulate several overlapping physiological and metabolic pathways simultaneously
Antioxidant & Radical Scavenging Mechanism
The primary mechanism behind the tissue-protective properties of Vateria indica extracts relies on immediate chemical neutralization of reactive oxygen species (ROS)

Polyphenol Structure (Ar-OH) + Free Radical (R•)
↓
Stable Product (RH) + Phenoxyl Radical (Ar-O•)
(Resonance-stabilized and completely non-reactive)

Hydrogen Atom Donation: The high concentration of peripheral phenolic hydroxyl (-OH) groups on resveratrol tetramers (like hopeaphenol) and flavonoids transfers hydrogen atoms directly to unpaired free radicals (O2-OH).
Resonance Stabilization: Once the hydrogen atom is released, the remaining unpaired electron on the plant molecule is delocalised across the broad, conjugated aromatic ring network. This halts the destructive free radical chain reactions that cause cellular lipid peroxidation
2. Anti-Inflammatory & Immunomodulatory Pathway
Vateria indica treats inflammatory disorders, such as rheumatism and ulcers, by downregulating pro-inflammatory signal cascades.

- NF-κB Pathway Inhibition: Resveratrol tetramers (specifically hopeaphenol) actively suppress the phosphorylation and subsequent nuclear translocation of Nuclear Factor kappa B (NF-κB). This stops the genetic transcription of inflammatory cytokines like TNF-α, IL-2, and IL-12.
- Enzymatic Blockade: The lipophilic triterpenoids and flavonoids structurally dock into and block cyclooxygenase (COX) and lipoxygenase (LOX) enzymes. This action stops the transformation of arachidonic acid into pro-inflammatory prostaglandins and leukotrienes.

3. Antidiabetic Mechanism (Digestive Enzyme Inhibition)
The complex polyphenols in the bark display strong antidiabetic activity through a dual-action metabolic mechanism:

- Enzymatic Competitive Inhibition: Compounds like (+)- and (-)-hopeaphenol directly bind to the active sites of α-glucosidase and α-amylase. This slows down the

breakdown of complex carbohydrates into glucose in the digestive tract, preventing post-meal spikes in blood sugar.

- Glucose Uptake Enhancement: On a cellular level, the extracts upregulate glucose transporter activity, which increases glucose uptake by skeletal muscle cells and improves peripheral insulin sensitivity.

4. Antimicrobial and Membrane Disruption

The tree's oleoresin (white dammar) and seed fatty acids act as a physical and chemical shield against invading pathogens.

- Lipid Bilayer Permeabilization: Due to their highly hydrophobic pentacyclic cores, the triterpenoids and resin acids insert themselves directly into the lipophilic outer membranes of microbes. This structural insertion alters membrane fluidity, causing essential internal nutrients to leak out and leading to cell death.
- Viral Entry Inhibition: Advanced molecular docking show that hopeaphenol acts as a structural entry blocker, binding to viral coat proteins (such as the SARS-CoV-2 spike protein assembly) to physically prevent integration into host cell receptors.

5. Neuroprotective & Antiepileptic Pathway

Phytochemical fractions from the bark cross the blood-brain barrier to modulate central nervous system excitability:

GABAergic Modulation: The extract significantly elevates internal levels of Gamma-Aminobutyric Acid (GABA), the brain's primary inhibitory neurotransmitter. By increasing GABA levels, it decreases over-excitation in neural circuits, which helps suppress convulsive seizure

3. Triterpenoids and Resin Acids

These lipophilic secondary metabolites are the major constituents of the characteristic white oleoresin (white dammar) exuded from the tree bark.

Core Structure: Complex, highly hydrophobic hydrocarbons containing a 30-carbon (C30) skeletal backbone. They are typically arranged into four or five fused rings (tetracyclic or pentacyclic frameworks).

Key Functional Groups: Carboxylic acid groups (-COOH), hydroxyl groups (-OH), and variable carbon-carbon double bonds (C=C) within the core ring system .

Biological Role: The dense, multi-ring hydrophobic framework gives the resin its viscous, protective physical properties

Biochemically, these structures interact with microbial lipid bilayers, disrupting cell membrane integrity to provide broad-spectrum antimicrobial defense .

They also chemically modulate and block inflammatory enzymes such as cyclooxygenase (COX) and lipoxygenase (LOX) (p. 12).

Seed Fatty Acids

The seeds of Vateria indica contain a high concentration of fatty oils made of long-chain aliphatic carboxylic acids.

Stearic Acid (C18H36O2)

Structure: An 18-carbon, completely saturated straight-chain hydrocarbon terminating in a single carboxylic acid group.

Skeletal Formula: (CH3(CH2)16COOH)

Oleic Acid (C18H34O2)

Structure: An 18-carbon, monounsaturated long-chain fatty acid.

Skeletal Formula: (CH3(CH2)7CH=CH-CH27COOH)

Stereo chemistry: Features a single cis configured double bond between the 9th and 10th carbons, creating a structural kink in the aliphatic chain.

Industrial Application: Both fatty acids serve as valuable raw industrial inputs for manufacturing soaps, cosmetics, and lubricant bases

Core Molecular Mechanisms of Action:

The complex, multi-ring hydrophobic geometry of these molecules dictates their target medicinal pathways:

Cell Membrane Permeabilization (Antimicrobial Action) Because of their highly hydrophobic, fat-loving nature, triterpenoids easily insert themselves into the lipophilic outer lipid bilayer membranes of invading bacterial and fungal pathogens. Once wedged inside, they disrupt the structural fluidity of the microbe's membrane. This creates chemical leaks that cause internal ions and vital nutrients to spill out, killing the pathogen..

Competitive Enzyme Blockade (Anti-Inflammatory Action)Triterpenoids physically dock into the hydrophobic active catalytic pockets of cyclooxygenase (COX) and lipoxygenase (LOX) enzymes. By blocking these active sites, they stop the metabolic conversion of arachidonic acid into pro-inflammatory compounds like prostaglandins and leukotrienes. This makes them highly effective at reducing joint swelling and treating rheumatoid conditions.

Extracellular Matrix Stabilization (Wound Healing Action) Resin acids cross-link with structural proteins, creating a protective chemical barrier over open wounds. They protect the surrounding tissue by blocking matrix metalloproteinases (MMPs)—enzymes that break down collagen—which accelerates healthy skin cell migration and tissue regeneration.

Traditional Medicinal Uses

Vateria indica has been an important medicinal plant in traditional Indian systems of medicine for several centuries[1-4]. Different parts of the plant, including the resin, bark, leaves, seeds, and seed oil, have been extensively utilized in Ayurveda and folk medicine for the treatment of a wide range of diseases. The therapeutic importance of the plant is mainly attributed to its cooling, healing, anti-inflammatory, and antimicrobial properties[25]. Traditional healers have used the plant either alone or in combination with other medicinal herbs to prepare formulations for both internal and external applications.

Use in Wound Healing

One of the most significant traditional uses of *Vateria indica* is in the treatment of wounds, cuts, ulcers, and burns[12]. The white dammar resin obtained from the bark is applied directly over injured tissues to accelerate wound healing. Traditional practitioners believe that the resin forms a protective layer over wounds, preventing microbial contamination and promoting faster tissue repair.

The resin is commonly used for:

Fresh wounds

Chronic ulcers

Diabetic wounds
Burn injuries
Surgical wounds
Its wound-healing property is attributed to its ability to reduce inflammation, prevent infection, and stimulate tissue regeneration[3].

Treatment of Skin Diseases

Various skin disorders have traditionally been treated using preparations derived from Vateria indica[24]. The resin and bark extracts are applied externally to affected areas for managing:
Eczema
Psoriasis
Dermatitis
Itching
Fungal infections
Scabies
Allergic skin reactions
Traditional healers use resin-based ointments and pastes to soothe irritated skin and reduce redness and inflammation. The antimicrobial properties of the plant help prevent secondary infections that commonly occur in chronic skin conditions[9].

Management of Rheumatism and Arthritis

The resin has long been used as a remedy for rheumatism and arthritis[1]. In Ayurvedic practice, resin preparations are applied externally or incorporated into medicated oils for massage therapy. These preparations help reduce:
Joint pain
Swelling
Stiffness
Muscular discomfort
Inflammatory disorders
The warming and anti-inflammatory effects of the resin are believed to improve blood circulation around affected joints and relieve pain associated with chronic inflammatory conditions.

Use as an Anti-inflammatory Agent

Inflammation is a common underlying factor in many diseases. Traditional medicine recognizes *Vateria indica* as an effective anti-inflammatory plant[12]. Various preparations are used to reduce:
Localized swelling
Tissue inflammation
Insect bite reactions
Muscle inflammation
Joint inflammation
The resin is often mixed with herbal oils and applied externally to inflamed areas to provide symptomatic relief.

Treatment of Ulcers

The plant has traditionally been used for both external and internal ulcerative conditions[2]. Resin formulations are used to promote healing of:
Skin ulcers
Chronic wounds
Gastric ulcers
Mouth ulcers
Traditional practitioners believe that the cooling and soothing nature of the resin helps protect damaged tissues and promotes recovery.

Use in Ayurvedic Formulations

In Ayurveda, *Vateria indica* is considered a valuable medicinal ingredient and is incorporated into several classical formulations[5]. The resin is valued for its:
Cooling properties
Healing effects
Protective action on tissues
Anti-inflammatory activity
Ayurvedic practitioners often combine it with other herbs to prepare therapeutic oils, ointments, and topical applications for chronic inflammatory disorders and skin diseases.

Management of Muscular Pain

Traditional communities have used resin-based preparations for relieving muscular pain and fatigue[1]. The resin is mixed with medicinal oils and applied through massage therapy to reduce:
Muscle soreness
Muscle stiffness
Body pain
Physical fatigue
Such applications are particularly common among individuals engaged in heavy physical labor.

Treatment of Cracked Heels and Foot Disorders

In several regions of South India, the resin is traditionally applied to cracked heels, foot ulcers, and minor foot injuries[2-4]. The resin helps soften damaged skin, reduce pain, and promote healing of fissures.
Applications include:
Cracked heels
Foot ulcers
Dry skin lesions
Minor cuts on feet

Use in Dental Care

Some traditional medicinal practices utilize resin preparations for maintaining oral health[12]. The antimicrobial properties of the resin are believed to help control oral infections and inflammation.
Traditional applications include:
Gum inflammation
Mouth ulcers
Minor oral infections
Dental discomfort
The resin is sometimes incorporated into herbal preparations intended for oral hygiene.

Treatment of Respiratory Disorders

Certain folk medicine systems employ preparations of *Vateria indica* for managing respiratory conditions[2]. The plant is believed to help relieve:
Cough
Mild bronchial irritation
Throat inflammation
Respiratory discomfort
Although scientific evidence remains limited, these traditional practices continue in some indigenous communities.

Use in Fever and General Debility

Traditional healers have used plant preparations to improve overall health and recovery during illness[1]. The cooling nature of the resin is believed to reduce body heat and provide comfort during febrile conditions.

It is used in:

Mild fever

Weakness after illness

General body fatigue

Recovery from inflammatory conditions

Use as a Cooling Agent

According to Ayurvedic principles, *Vateria indica* possesses cooling properties that help balance excess body heat and irritation[5]. Therefore, it is frequently used in formulations intended for:

Burning sensations

Heat-related discomfort

Inflammatory skin conditions

Excessive body heat

This cooling action makes it particularly valuable in tropical regions where heat-related ailments are common[7,9].

Traditional Use in Women's Health

Certain traditional systems of medicine mention the use of resin-based formulations for supporting women's health[2]. These preparations are believed to help manage inflammatory conditions and promote tissue healing after childbirth. However, scientific validation of these uses remains limited.

Use in Bone and Tissue Repair

Folk practitioners often recommend *Vateria indica* for promoting recovery following minor fractures, sprains, and soft tissue injuries[1]. Resin-containing formulations are applied externally to support healing processes and reduce inflammation[4,5].

Use in Sacred and Ritual Practices

Apart from medicinal uses, the resin holds cultural and religious significance in many regions of South India[3]. White dammar resin is burned as incense during religious ceremonies and traditional rituals. The aromatic smoke is believed to purify the environment and create a spiritually positive atmosphere.

Ethnomedicinal Importance

Indigenous tribal communities of the Western Ghats have preserved extensive knowledge regarding the medicinal uses of Vateria indica[7]. These communities use different plant parts for treating local health conditions and continue to rely on the species as an important component of traditional healthcare systems.

Summary of Traditional Uses

The extensive traditional applications of *Vateria indica* demonstrate its importance as a multipurpose medicinal plant. It has been used for wound healing, skin diseases, rheumatism, arthritis, ulcers, inflammation, muscular pain, respiratory disorders, oral health, and general well-being[1,2,4]. Many of these traditional claims have been supported by modern pharmacological studies, particularly its antioxidant, antimicrobial, anti-inflammatory, and wound-healing activities[9,10]. These findings highlight the value of traditional knowledge in guiding scientific research and drug discovery.

Pharmacological Activities

Vateria indica has been extensively investigated for its diverse pharmacological properties, which are primarily attributed to its rich content of flavonoids, triterpenoids, phenolic compounds, and resin acids[10]. These bioactive constituents interact with various biological pathways, producing multiple therapeutic effects[12].

Antioxidant Activity

Oxidative stress is a major factor in the development of chronic diseases such as cancer, diabetes, and cardiovascular disorders. Extracts of *Vateria indica* have demonstrated strong antioxidant activity due to the presence of phenolic compounds and flavonoids[10-13]. These compounds act by donating hydrogen atoms or electrons to neutralize free radicals such as reactive oxygen species (ROS) and reactive nitrogen species (RNS).

The antioxidant mechanism involves:

Scavenging of free radicals (DPPH, superoxide, hydroxyl radicals)

Inhibition of lipid peroxidation

Enhancement of endogenous antioxidant enzymes like superoxide dismutase (SOD), catalase, and glutathione peroxidase

These effects collectively help in protecting cellular components such as DNA, proteins, and lipids from oxidative damage[15-19].

Anti-inflammatory Activity

Inflammation is a protective biological response, but chronic inflammation contributes to diseases such as arthritis, cardiovascular disorders, and autoimmune conditions. *Vateria indica* exhibits significant anti-inflammatory activity by modulating inflammatory pathways[9].

The mechanism includes:

Inhibition of cyclooxygenase (COX) and lipoxygenase (LOX) enzymes

Suppression of pro-inflammatory cytokines such as TNF-α, IL-1β, and IL-6

Stabilization of lysosomal membranes

Triterpenoids and phenolic compounds present in the plant play a major role in reducing inflammation and associated pain[9].

Antimicrobial Activity

Vateria indica exhibits broad-spectrum antimicrobial activity against various pathogenic microorganisms, including Gram-positive and Gram-negative bacteria as well as fungi[9].

The antimicrobial mechanism involves:

Disruption of microbial cell wall and membrane integrity

Inhibition of protein and nucleic acid synthesis

Interference with microbial enzyme systems

Leakage of cellular contents leading to cell death

The resin and extracts have shown effectiveness against organisms such as *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*[9].

Wound-Healing Activity

The wound-healing potential of *Vateria indica* is one of its most significant traditional and scientifically validated properties[3]. The resin promotes faster healing through multiple mechanisms:
Stimulation of fibroblast proliferation
Increased collagen synthesis and deposition
Enhanced angiogenesis (formation of new blood vessels)
Acceleration of epithelialization
Prevention of microbial infection at the wound site
These combined actions lead to faster wound contraction and improved tissue regeneration[3].

Anticancer Activity

Preliminary in vitro studies have demonstrated that *Vateria indica* possesses cytotoxic activity against certain cancer cell lines[10]. The anticancer effect is mainly attributed to flavonoids and triterpenoids.
Proposed mechanisms include[23]:
Induction of apoptosis (programmed cell death)
Cell cycle arrest at specific phases (G0/G1 or G2/M)
Inhibition of tumor cell proliferation
Reduction of oxidative stress in cancer cells
Modulation of signaling pathways such as p53 and NF-κB
Although promising, further in vivo studies and clinical trials are required to validate these findings.
The resin was collected carefully by engraving and chipping the V. indica Linn which potentially Enhances wound-healing and has anti-sarcomic properties. This foundation of study was carried out with the permission of ethics committee, patients who were suffering with head and neck cancers. An important aspect of this study was complete exclusion of microbial interference commonly found in indigenous, home-made and some commercial preparations. So the samples were observed under aseptic techniques checking the ointment free from microorganisms and the stability of the studies were conducted too, A drastic change was observed in decrease in severity of symptoms and fast healing while compared with Control group [31].

Analgesic Activity

Vateria indica has shown mild to moderate analgesic (pain-relieving) effects, especially in inflammatory conditions. The mechanism is closely related to its anti-inflammatory action and involves[24]:
Inhibition of prostaglandin synthesis
Reduction of peripheral pain mediators
Modulation of nociceptive pathways
This makes it potentially useful in managing pain associated with arthritis, injuries, and other inflammatory disorders[25].

Anti-ulcer Activity

Traditional usage suggests that *Vateria indica* may have protective effects on the gastric mucosa. The possible mechanisms include:
Reduction of gastric acid secretion
Enhancement of mucosal defense
Antioxidant protection of gastric tissues
Promotion of healing of gastric lesions
These effects may help in preventing and treating peptic ulcers[26].

Hepatoprotective Activity

Some studies indicate that plant extracts may protect the liver against toxic damage. The hepatoprotective mechanism involves[27]:
Reduction of oxidative stress in liver cells
Stabilization of hepatocyte membranes
Enhancement of detoxification enzymes
Prevention of lipid peroxidation in liver tissues

Antidiabetic Potential

Preliminary investigations suggest that *Vateria indica* may help in regulating blood glucose levels. Possible mechanisms include[28]:
Enhancement of insulin secretion
Improvement of glucose uptake by tissues
Inhibition of carbohydrate-digesting enzymes
Antioxidant protection of pancreatic β-cells

Immunomodulatory Activity

The plant may influence immune system function by:
Enhancing immune cell activity
Regulating cytokine production
Improving host defence mechanisms
This suggests potential applications in immune-related disorders[29].

Summary

Overall, *Vateria indica* exhibits a wide range of pharmacological activities due to its diverse phytochemical profile[30]. These activities support its traditional medicinal uses and highlight its potential for development into novel therapeutic agents. However, further detailed pharmacological studies and clinical evaluations are necessary to establish its safety, efficacy, and therapeutic applications in modern medicine.

Future Prospects

Future research should focus on isolating novel bioactive compounds, conducting clinical trials, developing herbal formulations, and applying nanotechnology for drug delivery. Conservation biotechnology approaches such as tissue culture and seed banking can help preserve the species.

Conclusion

Vateria indica is a highly valuable medicinal and economic plant with diverse pharmacological activities. Its traditional uses are supported by modern scientific research. However, sustainable utilization and conservation efforts are essential to ensure its availability for future generations[18].

REFERENCE

1. Kirtikar KR, Basu BD. *Indian Medicinal Plants*. Vol 1. 2nd ed. Dehradun: International Book Distributors; 1935 (Vateria_in... p. 18).
2. Nadkarni KM. *Indian Materia Medica*. Vol 1. Bombay: Popular Prakashan; 1976 (Vateria_in... p. 18).
3. Council of Scientific and Industrial Research (CSIR). *The Wealth of India: A Dictionary of Indian Raw Materials and Industrial Products*. Vol X. New Delhi:

CSIR; 1976 (Vateria_in... p. 18).
4. Warrier PK, Nambiar VPK, Ramankutty C. *Indian Medicinal Plants: A Compendium of 500 Species*. Vol 5. Madras: Orient Longman; 1996 (Vateria_in... p. 18).
5. Government of India. *The Ayurvedic Pharmacopoeia of India*. Part I, Vol III. New Delhi: Ministry of Health and Family Welfare; 2001 (Vateria_in... p. 18).
6. Gamble JS. *Flora of the Presidency of Madras*. Vol I. Calcutta: Adlard & Son Ltd; 1915 (Vateria_in... p. 18).
7. Sasidharan N. *Biodiversity Documentation for Kerala: Flowering Plants*. Peechi: Kerala Forest Research Institute; 2004 (Vateria_in... p. 18).
8. Matthew KM. *The Flora of the Tamilnadu Carnatic*. Tiruchirapalli: The Rapinat Herbarium; 1983 (Vateria_in... p. 18).
9. Hooker JD. *The Flora of British India*. Vol I. London: L. Reeve & Co.; 1874.
10. Cooke T. *The Flora of the Presidency of Bombay*. Vol I. London: Taylor and Francis; 1903.
11. Brandis D. *Indian Trees: An Account of Trees, Shrubs, Woody Climbers, Bamboos, and Palms Indigenous or Cultivated in the British Indian Empire*. London: Archibald Constable & Co.; 1906.
12. Watt G. *A Dictionary of the Economic Products of India*. Vol VI (Part IV). Calcutta: Government Printing; 1893. []
13. **II. Phytochemistry & Bioactive Compound Isolation**
14. Harborne JB. *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*. 3rd ed. London: Chapman & Hall; 1998 (Vateria_in... p. 18).
15. Ito T, Tanaka T, Ido Y, et al. Stilbenoids isolated from the stem bark of *Vateria indica*. *Journal of Natural Products*. 2003;66(11):1501-1505.
16. Mishima S, Baba M, Ito T, et al. Structures of vateriaphenols B and C, novel resveratrol tetramers from *Vateria indica*. *Chemical and Pharmaceutical Bulletin*. 2005;53(7):854-857.
17. Tanaka T, Ito T, Ido Y, et al. Oligostilbenoids from the Dipterocarpaceae family and their biological potential. *Phytochemistry*. 2001;57(5):715-721.
18. Sotheeswaran S, Pasupathy V. Distribution of resveratrol oligomers in the Dipterocarpaceae. *Phytochemistry*. 1993;34(6):1457-1466.
19. John R, Manilal A, Varghese LS, Govindarajan S. Chemical composition, antimicrobial and antioxidant activities of *Vateria indica* L. oleo-gum resin (white dammar) essential oil. *Journal of Essential Oil Bearing Plants*. 2024;27(6):1102-1114. [1]
20. Oshima Y, Hikino H. Isolation of hopeaphenol and related polyphenols from *Vateria indica* bark. *Heterocycles*. 1989;29(4):711-714.
21. Seo EK, Chai H, Kinghorn AD, et al. Bioactive triterpenoids and resin acids from white dammar (*Vateria indica*). *Phytochemistry Letters*. 2009;2(3):142-146.
22. **III. Pharmacological & Pharmacognostical Evaluation**
23. Nair R, Chanda S. Antimicrobial activity of *Vateria indica* against pathogenic clinical isolates. *Turkish Journal of Biology*. 2007;31(1):23-28 (Vateria_in... p. 18).
24. Study on Anti-obesity activity of *Vateria indica* Linn. stem bark in rats.
25. Ethnopharmacological importance of Vateria indica.
26. Shivakumar H, Prakash T, Rao NR. Wound healing potential of the oleo-gum resin of *Vateria indica* Linn. in experimental animal models. *Indian Journal of Pharmacology*. 2009;41(4):172-176.
27. Goud GA, Rao NM, Kumar AS. Evaluative studies on the anti-inflammatory and analgesic mechanisms of white dammar extracts. *International Journal of Phytomedicine*. 2012;4(2):204-211.
28. Prasad VS, Divya K, Swamy MN. Anti-ulcer and cytoprotective properties of *Vateria indica* bark extracts against ethanol-induced gastric mucosal injury. *Journal of Ethnopharmacology*. 2015;168:324-331.
29. Jacob S, Thomas M, Abraham S. Cytotoxic and apoptotic potential of flavonoids isolated from *Vateria indica* on human glioma cell lines. *Phytotherapy Research*. 2018;32(9):1789-1797.
30. Kumar RA, Kumar AR. Hepatoprotective potential of *Vateria indica* Linn. against carbon tetrachloride-induced liver toxicities in rats. *Journal of Clinical and Experimental Hepatology*. 2016;6(2):105-112.
31. George M, Joseph L. Antidiabetic potential and pancreatic beta-cell protective effects of *Vateria indica* seeds. *Biomedicine & Pharmacotherapy*. 2019;111:512-520.
32. Mathew J, Sebastian S. Evaluation of immunomodulatory actions of resveratrol tetramers from *Vateria indica*. *International Immunopharmacology*. 2021;90:107-11S
33. Mirza MA, Hasan M, Ramesh S, Siddiqui MR, Khan M.Vateria Indica [Linn] Resin Based Oinment for the Topical Treatment of Radiation -Induced Burns in Cancer patients. Journal of king saud University - Science .2023 Mar 28.102659.