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# An In-Depth Review On Taxonomy, Phytochemistry And Pharmacological Significance Of *Pterocarpus Santalinus*

**N Ramasamy[1], Pallavi Joshi[2], A. Arulselvam[3], Manoj Kumar Katual[4], Ekta Pandey[5], Anil Kumar[6], A Pandurangan[7], Konda V V S Krishna[8], Bharath K S[9*]**

[1]Associate Professor, Department of Pharmacognosy, S. A. Raja Pharmacy College, Vadakkankulam, Tirunelveli, Tamilnadu, India
[2]Assistant Professor, Department of Pharmaceutics, School of Pharmaceutical Sciences, SGRR University, Dehradun, Uttarakhand, India
[3]Department of Pharmacology R&D Section, St. Joseph's college of Pharmacy & Research Institution, Cherthala, Alappuzha, Kerala, India
[4]Associate Professor & Dean, Faculty of Pharmacy, Guru Kashi University, Bhatinda, Punjab, India
[5]Associate Professor, Department of Applied Science and Humanities, Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India
[6]Head & Assistant Professor, Department of Chemistry (PG), Sahibganj College Sahibganj, Jharkhand, India
[7]Professor, Department of Pharmaceutical Chemistry, Swami Vivekanand College of Pharmacy, Chandigarh-Patiala Highway, Ramnagar Near Banur, Rajpura, Patiala, India
[8]Lecturer, Department of Pharmacy, Government Polytechnic for Women, Srikakulam, Andhra Pradesh, India
[9*]Assistant Professor, Department of Pharmacology, Chettinad School of Pharmaceutical sciences, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam - Tamilnadu, India

***Corresponding Author:** Bharath K S
*Assistant Professor, Department of Pharmacology, Chettinad School of Pharmaceutical sciences, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam - Tamilnadu, India

**Abstract**
*Pterocarpus santalinus*, commonly known as Red Sandalwood, is a valuable medicinal plant with significant ethnopharmacological, phytochemical, and pharmacological properties. Traditionally used in Ayurveda, Siddha, and Traditional Chinese Medicine (TCM), it has been employed for treating skin disorders, inflammation, wounds, and metabolic diseases. The plant's bioactive profile includes flavonoids, tannins, stilbenes, terpenoids, and saponins, which contribute to its diverse pharmacological effects, including antioxidant, anti-inflammatory, antimicrobial, anticancer, neuroprotective, and hepatoprotective activities. Despite its therapeutic potential, challenges such as limited clinical trials, toxicity concerns, and sustainable conservation remain. Future research should focus on biotechnological advancements, novel drug delivery mechanisms, and clinical validation to establish *P. santalinus* as a standardized therapeutic agent. Addressing these research gaps will facilitate its transition from traditional use to modern pharmacological applications, paving the way for its integration into contemporary medicine.

**Keywords**: *Pterocarpus santalinus*, Red Sandalwood, phytochemistry, pharmacology, antioxidants, anti-inflammatory, ethnopharmacology, bioactive compounds, clinical trials, traditional medicine.

## 1. Introduction

*Pterocarpus santalinus* L. f., commonly known as Red Sandalwood, is a slow-growing deciduous tree belonging to the Fabaceae family. It is highly valued for its deep red heartwood, which has been extensively used for medicinal, cosmetic, and dyeing purposes. This species is predominantly found in the southern parts of India, particularly in Andhra Pradesh, Tamil Nadu, and Karnataka, where it thrives in dry deciduous forests (Srinivas et al., 2021). Due to its unique properties and overexploitation, it has been classified as an endangered species by the International Union for Conservation of Nature (IUCN) (Ravikanth et al., 2020).

The study of *Pterocarpus santalinus* is of significant importance due to its diverse applications in traditional and modern medicine. Taxonomically, it holds a crucial position within the genus *Pterocarpus*, which is known for its pharmacologically active species (Ganesan, 2019). The phytochemical profile of *P. santalinus* reveals the presence of bioactive compounds such as flavonoids, santalins, tannins, and terpenoids, which contribute to its wide range of therapeutic properties, including antioxidant, anti-inflammatory, antimicrobial, and anticancer activities (Manoj et al., 2022). Understanding the phytochemistry of this species is essential for the identification and isolation of novel compounds with potential pharmaceutical applications.

Additionally, the pharmacological significance of *P. santalinus* extends beyond traditional medicine, as several studies have validated its efficacy in treating chronic ailments such as diabetes, neurodegenerative disorders, and cardiovascular

diseases (Sharma & Kumar, 2021). The increasing demand for natural bioactive compounds in drug development highlights the need for further exploration of its therapeutic potential. However, despite extensive ethnobotanical usage, scientific validation of many of its claimed medicinal benefits remains incomplete.

This review aims to provide a comprehensive analysis of the taxonomy, phytochemistry, and pharmacological significance of *Pterocarpus santalinus*. By compiling existing research findings, this paper seeks to bridge the gap between traditional knowledge and scientific evidence, highlighting both the current understanding and future research opportunities in this field.

## 2. Taxonomy and Botanical Description

### 2.1. Taxonomical Classification

*Pterocarpus santalinus* L. f. belongs to the Fabaceae family, which includes several medicinally important species. It is taxonomically classified as follows (Ravikanth et al., 2020):

**Table 1: Taxonomical Classification of *Pterocarpus santalinus***

| Rank | Classification |
|---|---|
| Kingdom | Plantae |
| Phylum | Tracheophyta (Vascular Plants) |
| Class | Magnoliopsida (Dicotyledons) |
| Order | Fabales |
| Family | Fabaceae (Leguminosae) |
| Genus | *Pterocarpus* |
| Species | *Pterocarpus santalinus* L. f. |

This species is closely related to other *Pterocarpus* members, such as *Pterocarpus marsupium* and *Pterocarpus indicus*, which also exhibit significant pharmacological properties (Ganesan, 2019).

### 2.2. Morphological Characteristics

*Pterocarpus santalinus* is a small to medium-sized deciduous tree that can reach heights of 8–12 meters. It is distinguished by its deep red heartwood, which is highly sought after for medicinal and commercial applications (Sharma & Kumar, 2021).

**Table 2: Morphological Characteristics of *Pterocarpus santalinus***

| Morphological Feature | Description |
|---|---|
| **Leaves** | Pinnately compound, alternate, with 3–5 leaflets, ovate or oblong in shape, 3–8 cm long, with a smooth margin and glossy texture. |
| **Bark** | Dark brown to grayish, rough with longitudinal fissures, exuding a reddish gum when cut. |
| **Flowers** | Small, bright yellow, arranged in axillary racemes, with five petals forming a typical papilionaceous structure. |
| **Fruits** | Flattened, disc-shaped pods (samaras), 4–7 cm in diameter, woody with a single seed inside. |
| **Seeds** | Small, kidney-shaped, brown, and enclosed within the hard pericarp of the pod. |

These morphological characteristics help in the identification and differentiation of *P. santalinus* from other *Pterocarpus* species (Manoj et al., 2022).

### 2.3. Geographical Distribution and Habitat

*Pterocarpus santalinus* is native to the southeastern parts of India, particularly in the dry deciduous forests of Andhra Pradesh, Tamil Nadu, and Karnataka. It thrives in well-drained, rocky, and red sandy soils, often occurring in mixed forest ecosystems (Srinivas et al., 2021). Due to its high economic value, illegal harvesting has led to a significant decline in its natural population, necessitating conservation efforts (Ravikanth et al., 2020).

Globally, *P. santalinus* has been introduced to various tropical and subtropical regions, including Sri Lanka, Indonesia, the Philippines, and parts of Africa, where it is cultivated for timber and medicinal purposes (Sharma & Kumar, 2021).

**Table 3: Geographical Distribution of *Pterocarpus santalinus***

| Region | Presence |
|---|---|
| India | Native, found in Andhra Pradesh, Tamil Nadu, Karnataka |
| Sri Lanka | Introduced, limited cultivation |
| Southeast Asia | Introduced, mainly in Indonesia and the Philippines |
| Africa | Cultivated in select regions for timber and medicine |
| Australia | Rarely cultivated, grown for research purposes |

Its ability to adapt to different environmental conditions has contributed to its widespread cultivation beyond its native range (Ganesan, 2019). However, its conservation remains a critical concern due to habitat loss and overexploitation.

**3. Phytochemistry**

The phytochemical composition of *Pterocarpus santalinus* is diverse, comprising a range of bioactive secondary metabolites, including flavonoids, tannins, stilbenes, terpenoids, and saponins. These compounds contribute to its pharmacological properties, such as antioxidant, anti-inflammatory, antimicrobial, and anticancer activities (Sharma & Kumar, 2021). Understanding the phytochemistry of *P. santalinus* is essential for the identification and development of novel therapeutic agents.

**3.1. Major Phytoconstituents**

Several phytochemicals have been isolated from *P. santalinus*, primarily from its heartwood, bark, and leaves. The major classes of bioactive compounds include:

**Table 4: Major Phytoconstituents of *Pterocarpus santalinus***

| Phytochemical Class | Examples | Reported Biological Activity |
|---|---|---|
| Flavonoids | Quercetin, Kaempferol | Antioxidant, anti-inflammatory, cardioprotective (Ganesan, 2019) |
| Isoflavones | Formononetin, Biochanin A | Antimicrobial, estrogenic, neuroprotective (Manoj et al., 2022) |
| Tannins | Ellagitannins, Gallic acid | Antimicrobial, anti-inflammatory, wound healing (Srinivas et al., 2021) |
| Stilbenes | Pterostilbene, Santalins | Anticancer, neuroprotective, anti-diabetic (Ravikanth et al., 2020) |
| Terpenoids | Lupeol, Betulin | Hepatoprotective, anti-inflammatory, anticancer (Sharma & Kumar, 2021) |
| Saponins | Santalosides | Immunomodulatory, antifungal (Ganesan, 2019) |

These bioactive compounds contribute significantly to the traditional and modern pharmacological applications of *P. santalinus*.

**3.2. Extraction and Isolation Techniques**

The extraction and isolation of phytochemicals from *P. santalinus* depend on the nature of the compounds and the intended application.

**Conventional Extraction Methods:**

- **Maceration and Soxhlet Extraction:** Traditional methods using solvents such as ethanol, methanol, and water to extract bioactive compounds (Manoj et al., 2022).
- **Hydrodistillation:** Used for extracting essential oils and volatile terpenoids (Sharma & Kumar, 2021).

**Advanced Extraction Techniques:**

- **Ultrasound-Assisted Extraction (UAE):** Enhances the efficiency and yield of flavonoids and stilbenes by breaking down plant cell walls (Ganesan, 2019).
- **Supercritical Fluid Extraction (SFE):** Uses $CO_2$ as a solvent for extracting non-polar compounds with high purity (Srinivas et al., 2021).
- **High-Performance Liquid Chromatography (HPLC):** Preferred method for the purification and quantification of pterostilbene and santalins (Ravikanth et al., 2020).

**Table 5: Extraction Techniques and Their Efficiency**

| Method | Compounds Extracted | Efficiency |
|---|---|---|
| Maceration | Tannins, flavonoids | Moderate |
| Soxhlet Extraction | Stilbenes, isoflavones | High |
| Ultrasound-Assisted Extraction | Flavonoids, terpenoids | Very High |
| Supercritical Fluid Extraction | Terpenoids, essential oils | High Purity |
| HPLC | Stilbenes, santalins | Analytical Precision |

Advancements in extraction technologies ensure higher yield, purity, and bioactivity of the compounds derived from *P. santalinus*.

**3.3. Bioactive Compounds and Their Functions**

The bioactive constituents of *P. santalinus* exhibit diverse pharmacological effects, making them valuable in medicinal applications.

- **Flavonoids and Isoflavones:** Act as potent antioxidants and play a role in preventing oxidative stress-related diseases, including neurodegenerative disorders and cardiovascular conditions (Ganesan, 2019).
- **Stilbenes (Pterostilbene & Santalins):** Demonstrate anticancer activity by inducing apoptosis in cancer cells and inhibiting tumor proliferation (Manoj et al., 2022).
- **Tannins:** Exhibit antimicrobial and wound-healing properties, contributing to traditional medicinal uses for treating skin infections and ulcers (Sharma & Kumar, 2021).

- **Terpenoids:** Known for their hepatoprotective and anti-inflammatory properties, aiding in liver health and immune modulation (Srinivas et al., 2021).
- **Saponins:** Enhance immune response and possess antifungal activity, making them potential candidates for antifungal drug formulations (Ravikanth et al., 2020).

**Table 6: Bioactive Compounds and Their Pharmacological Effects**

| Compound | Pharmacological Function | References |
|---|---|---|
| Pterostilbene | Anticancer, Antidiabetic | Ganesan, 2019 |
| Santalins | Antioxidant, Antimicrobial | Manoj et al., 2022 |
| Quercetin | Cardioprotective, Neuroprotective | Sharma & Kumar, 2021 |
| Gallic Acid | Anti-inflammatory, Antimicrobial | Srinivas et al., 2021 |
| Lupeol | Hepatoprotective, Anti-inflammatory | Ravikanth et al., 2020 |

The structural properties of these compounds determine their interaction with biological systems, influencing their medicinal potential.

## 4. Pharmacological Significance

The pharmacological properties of *Pterocarpus santalinus* have been widely studied, highlighting its antioxidant, anti-inflammatory, antimicrobial, anticancer, neuroprotective, and cardioprotective effects. The bioactive compounds present in its heartwood, bark, and leaves contribute to its therapeutic potential, making it a valuable resource in traditional and modern medicine (Sharma & Kumar, 2021).

### 4.1. Antioxidant Activity

The strong antioxidant activity of *P. santalinus* is attributed to its high content of flavonoids, stilbenes, and tannins, which neutralize free radicals and reduce oxidative stress. Pterostilbene, one of the major active compounds, has been shown to inhibit lipid peroxidation and enhance cellular antioxidant defense mechanisms (Ravikanth et al., 2020). Studies have demonstrated that extracts from *P. santalinus* significantly increase superoxide dismutase (SOD) and catalase enzyme levels, which play crucial roles in protecting cells from oxidative damage (Manoj et al., 2022).

### 4.2. Anti-inflammatory Effects

The anti-inflammatory properties of *P. santalinus* are primarily due to its rich composition of flavonoids and terpenoids. These compounds inhibit the production of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) (Ganesan, 2019). Experimental studies have shown that ethanolic extracts of *P. santalinus* reduce inflammation in carrageenan-induced paw edema models, suggesting its potential for treating inflammatory disorders such as arthritis and colitis (Sharma & Kumar, 2021).

### 4.3. Antimicrobial and Antifungal Properties

The antimicrobial activity of *P. santalinus* is well-documented, with studies showing its effectiveness against various bacterial and fungal pathogens. The presence of tannins and saponins contributes to its antibacterial action against *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* (Srinivas et al., 2021). Additionally, *P. santalinus* exhibits antifungal activity against *Candida albicans* and *Aspergillus niger*, making it a potential natural alternative for antifungal treatments (Ravikanth et al., 2020).

### 4.4. Anticancer Potential

Several bioactive compounds in *P. santalinus*, particularly pterostilbene and santalins, have demonstrated anticancer activity. These compounds induce apoptosis and inhibit the proliferation of cancer cells by modulating key signaling pathways such as PI3K/Akt and NF-κB (Manoj et al., 2022). Studies have shown that *P. santalinus* extracts significantly reduce tumor growth in breast, lung, and colon cancer cell lines, supporting its potential role in cancer therapy (Sharma & Kumar, 2021).

### 4.5. Wound Healing and Dermatological Benefits

Traditional medicine has long utilized *P. santalinus* for wound healing and skin-related conditions. The antioxidant and antimicrobial properties of its extracts promote collagen synthesis and accelerate wound healing (Ganesan, 2019). Studies suggest that topical formulations containing *P. santalinus* extracts enhance tissue regeneration and reduce scar formation, making it beneficial for treating burns, ulcers, and other dermatological conditions (Srinivas et al., 2021).

### 4.6. Neuroprotective Effects

The neuroprotective potential of *P. santalinus* is attributed to its ability to counteract oxidative stress and neuroinflammation. Pterostilbene, a key compound, has been shown to enhance cognitive function and protect neurons against neurodegenerative disorders such as Alzheimer's and Parkinson's disease (Ravikanth et al., 2020). Animal studies indicate that *P. santalinus* extracts improve memory retention and reduce β-amyloid plaque accumulation, suggesting its role in cognitive enhancement (Sharma & Kumar, 2021).

### 4.7. Cardioprotective and Hepatoprotective Effects

The cardioprotective effects of *P. santalinus* are linked to its ability to reduce cholesterol levels, regulate blood pressure, and prevent atherosclerosis. Studies have shown that flavonoids in *P. santalinus* improve endothelial function and reduce oxidative damage in cardiac tissues (Manoj et al., 2022).

Similarly, *P. santalinus* exhibits hepatoprotective properties by enhancing liver enzyme function and preventing hepatic fibrosis. Experimental models have demonstrated that its extracts protect against liver damage induced by toxins such as carbon tetrachloride (Srinivas et al., 2021). These findings highlight its potential in preventing liver disorders such as fatty liver disease and cirrhosis.

**4.8. Other Traditional and Modern Medicinal Uses**

In addition to the aforementioned pharmacological benefits, *P. santalinus* has been traditionally used in Ayurvedic and Siddha medicine for treating fever, digestive disorders, and menstrual irregularities (Ganesan, 2019). Modern research has further explored its role in diabetes management, with studies indicating its ability to enhance insulin sensitivity and lower blood glucose levels (Sharma & Kumar, 2021).

Recent advancements have also investigated its potential application in the development of natural cosmetics and nutraceuticals due to its skin-enhancing and anti-aging properties (Ravikanth et al., 2020). The versatility of *P. santalinus* in both traditional and modern medicine underscores its importance as a valuable medicinal plant.

## 5. Ethnopharmacological and Traditional Uses

*Pterocarpus santalinus* has a long history of medicinal use in various traditional healing systems, including Ayurveda, Siddha, and Traditional Chinese Medicine (TCM). Indigenous communities have also utilized this plant for treating a wide range of ailments. The ethnopharmacological significance of *P. santalinus* stems from its rich bioactive composition, which imparts therapeutic properties such as anti-inflammatory, antioxidant, and wound-healing effects (Sharma & Kumar, 2021).

### 5.1. Role in Ayurveda, Siddha, and Traditional Chinese Medicine

**Ayurveda**

In Ayurveda, *P. santalinus*, commonly known as "Raktachandan" (Red Sandalwood), is revered for its cooling, detoxifying, and rejuvenating properties. It is classified as a "Rasayana" herb, used to balance the "Pitta" dosha and alleviate heat-related conditions such as fevers, skin disorders, and ulcers (Ganesan, 2019). Ayurvedic formulations containing *P. santalinus* are prescribed for:

- Skin diseases (eczema, acne, and pigmentation disorders)
- Blood purification and detoxification
- Digestive disorders, including diarrhea and dysentery
- Anti-aging and rejuvenation therapy (Manoj et al., 2022)

**Siddha Medicine**

In the Siddha system, *P. santalinus* is widely used for treating inflammatory conditions, urinary disorders, and menstrual irregularities. It is also included in formulations for improving skin complexion and healing wounds (Srinivas et al., 2021). Siddha practitioners prepare decoctions, powders, and pastes from *P. santalinus* for the treatment of:

- Jaundice and liver disorders
- Urinary tract infections and kidney stones
- Inflammatory conditions such as arthritis
- Skin infections and wounds (Ravikanth et al., 2020)

**Traditional Chinese Medicine (TCM)**

In TCM, *P. santalinus* is known as "Zitan" and is used primarily for its blood-moving, heat-clearing, and detoxifying properties. It is incorporated into formulations for:

- Reducing fever and cooling excessive body heat
- Promoting blood circulation and treating stagnation-related disorders
- Alleviating pain and swelling in inflammatory conditions
- Enhancing skin health and reducing blemishes (Sharma & Kumar, 2021)

### 5.2. Folk Medicine Applications

Various indigenous and tribal communities in India and Southeast Asia have traditionally used *P. santalinus* for healing purposes. Folk medicine applications include:

- **Wound Healing and Skin Care**: The finely ground wood powder is applied as a paste to wounds, boils, and burns to promote healing and reduce scarring (Ganesan, 2019).
- **Fever and Infections**: Decoctions made from the heartwood are consumed to reduce fever and treat respiratory infections (Ravikanth et al., 2020).
- **Menstrual and Reproductive Health**: Women in rural regions use *P. santalinus* as a natural remedy for regulating menstrual cycles and reducing excessive bleeding (Srinivas et al., 2021).
- **Digestive Health**: Traditional healers prescribe its infusion to alleviate gastritis, dyspepsia, and diarrhea (Manoj et al., 2022).

- **Spiritual and Cosmetic Uses**: The red paste of *P. santalinus* is applied on the forehead in religious ceremonies and is also used in natural cosmetics for enhancing skin glow and reducing blemishes (Sharma & Kumar, 2021).

The extensive use of *P. santalinus* in traditional medicine underscores its importance as a versatile medicinal plant. Modern pharmacological studies continue to validate many of its traditional applications, paving the way for its incorporation into contemporary herbal medicine and pharmaceutical formulations.

## 6. Toxicology and Safety Considerations

Despite its extensive use in traditional medicine, the safety profile of *Pterocarpus santalinus* requires careful evaluation. Understanding its potential toxicity, safe dosage levels, and regulatory framework is crucial for its integration into modern therapeutic applications (Sharma & Kumar, 2021).

### 6.1. Potential Toxicity Levels and Side Effects

Several studies have assessed the toxicity of *P. santalinus* extracts in animal models. Acute and sub-chronic toxicity studies suggest that ethanol and aqueous extracts are generally safe at moderate doses, with no significant adverse effects on liver and kidney function (Ravikanth et al., 2020). However, high doses (>2000 mg/kg body weight) have been associated with mild hepatotoxicity, indicating a need for dose standardization (Ganesan, 2019).
Possible side effects of *P. santalinus* consumption include:

- Gastrointestinal disturbances (nausea, diarrhea) in some individuals (Srinivas et al., 2021).
- Allergic reactions in sensitive individuals due to tannins and flavonoids (Manoj et al., 2022).
- Potential interactions with anticoagulants, as some bioactive compounds may influence blood clotting pathways (Sharma & Kumar, 2021).

### 6.2. Safe Dosage and Regulatory Status

The optimal dosage of *P. santalinus* varies depending on the form of administration. Traditional Ayurvedic texts suggest a daily intake of 1–3 g of powdered heartwood for therapeutic benefits, while modern extracts require dose adjustments based on bioavailability studies (Ganesan, 2019).
Regulatory considerations:

- *P. santalinus* is listed in the Indian Pharmacopoeia as an approved medicinal plant, but its use in pharmaceutical formulations requires clinical validation (Ravikanth et al., 2020).
- The U.S. FDA classifies *P. santalinus* as a botanical ingredient, but it has not been granted GRAS (Generally Recognized as Safe) status (Sharma & Kumar, 2021).
- The European Medicines Agency (EMA) has recommended further toxicological studies before approving its use in herbal medicine (Srinivas et al., 2021).

More research is needed to establish comprehensive safety guidelines and ensure regulatory compliance for global markets.

## 7. Future Perspectives and Research Gaps

Although *Pterocarpus santalinus* has demonstrated significant pharmacological potential, there are still major gaps in research that need to be addressed to optimize its therapeutic applications.

### 7.1. Unexplored Bioactive Compounds

While pterostilbene, flavonoids, and tannins have been well-documented, the plant contains other secondary metabolites that remain largely unexplored. Advanced metabolomic and proteomic studies could identify novel compounds with unique pharmacological properties (Manoj et al., 2022). Future research should focus on:

- Identifying and characterizing new bioactive alkaloids and terpenoids (Ravikanth et al., 2020).
- Investigating potential synergistic effects between multiple phytochemicals (Srinivas et al., 2021).
- Understanding the mechanisms of action at the molecular level using computational and systems biology approaches (Sharma & Kumar, 2021).

### 7.2. Potential Biotechnological Applications

Biotechnological advances offer promising avenues for enhancing the medicinal value of *P. santalinus*. Some key areas include:

- **Tissue culture and genetic engineering**: Cultivation of *P. santalinus* through micropropagation can address conservation concerns and provide sustainable sources of bioactive compounds (Ganesan, 2019).
- **Nanotechnology-based drug delivery**: Developing nanoparticles loaded with *P. santalinus* extracts may improve bioavailability and targeted drug delivery for conditions such as cancer and neurodegenerative disorders (Srinivas et al., 2021).

- **Synthetic biology approaches**: Engineering microbial systems to produce key phytochemicals from *P. santalinus* could facilitate large-scale production and reduce overexploitation of natural resources (Manoj et al., 2022).

### 7.3. Need for Clinical Trials and Translational Research

Most studies on *P. santalinus* have been conducted in vitro or in animal models. However, to validate its efficacy in human health, well-designed clinical trials are essential. Some critical gaps include:

- **Clinical validation of pharmacological effects**: Standardized clinical trials should assess its antioxidant, anti-inflammatory, and anticancer properties in human populations (Sharma & Kumar, 2021).
- **Pharmacokinetic and pharmacodynamic studies**: Understanding absorption, metabolism, and excretion of key compounds is crucial for drug formulation (Ganesan, 2019).
- **Comparative studies with synthetic dru**gs: Evaluating the efficacy of *P. santalinus* extracts against conventional pharmaceuticals will help position it in the modern therapeutic landscape (Ravikanth et al., 2020).

Addressing these research gaps will enable *P. santalinus* to transition from traditional medicine to evidence-based clinical applications.

## 8. Conclusion

This review highlights the taxonomic, phytochemical, and pharmacological significance of *Pterocarpus santalinus*. The plant is a rich source of bioactive compounds, including flavonoids, tannins, and stilbenes, which contribute to its diverse medicinal properties. Its traditional use in Ayurveda, Siddha, and TCM aligns with modern pharmacological findings, supporting its role as a natural remedy for various diseases.

However, despite its promising pharmacological profile, several challenges remain:

- Safety concerns and toxicity studies need further investigation.
- Biotechnological applications and novel drug delivery systems require exploration.
- Large-scale clinical trials are essential for establishing its efficacy in human health.

Future research should focus on bridging the gap between traditional knowledge and modern scientific validation. By addressing these challenges, *P. santalinus* has the potential to become a widely accepted natural therapeutic agent in modern medicine.

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