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## Review Article

# ***Stereospermum colais* Buch: An Extensive Review of Phytochemistry, Traditional Applications, Pharmacological Validation, Geographical Insights, and Prospective Research Directions**

**Amit Kumar Agrahari\*, Dr. Vivek Chourasia**

*Faculty of Pharmacy, Mansarovar Global University, Sehore, Bhopal, Madhya Pradesh, India 466111*

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## ABSTRACT

*Stereospermum colais*, revered in Ayurveda as "Patala" and a vital component of the Dasamula (ten roots) formulation, represents a treasure trove of medicinal potential within the Bignoniaceae family. This exhaustive review meticulously documents its botanical characteristics, extensive geographical spread across Asia, rich ethnopharmacological heritage, comprehensive phytochemical inventory, and a broad spectrum of pharmacologically validated activities including antidiabetic, anti-arthritis, antioxidant, antimicrobial, anticancer, analgesic, hepatoprotective, and wound-healing properties. Key bioactive markers such as lapachol,  $\beta$ -sitosterol, flavonoids, and quinones underpin these effects, corroborated through in vitro, in vivo, and preliminary nanotechnological studies. Despite promising preclinical outcomes and historical safety, the scarcity of human clinical trials, standardization challenges, and conservation concerns highlight critical gaps. By integrating over 30 peer-reviewed references, this synthesis advocates for targeted clinical investigations, molecular mechanistic explorations, nanoformulation advancements, and sustainable cultivation strategies to propel *S. colais* from traditional remedy to modern therapeutic agent, particularly relevant for regions like Varanasi, Uttar Pradesh.

## INTRODUCTION

The quest for natural therapeutics has intensified globally, with medicinal plants like *Stereospermum colais* standing at the forefront of integrative medicine. Native to tropical Asia and integral to Ayurvedic, Siddha, and tribal healing

systems, this deciduous tree addresses a myriad of ailments from inflammatory disorders and diabetes to respiratory and urinary conditions. As one of the ten roots in the revered Dashamoola Kwath—used for Vata-pacifying effects in arthritis, neuralgia, and postpartum care—*S. colais* exemplifies the synergy between ancient wisdom

**\*Corresponding Author:** Amit Kumar Agrahari

**Address:** Faculty of Pharmacy, Mansarovar Global University, Sehore, Bhopal, Madhya Pradesh, India 466111

**Email** ✉: [amitagrahari1997@gmail.com](mailto:amitagrahari1997@gmail.com)

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and contemporary pharmacology. Traditional texts like Charaka Samhita and Bhavaprakasha extol its roots for their anodyne, diuretic, expectorant, and febrifuge properties, while modern studies reveal mechanisms involving cytokine modulation, enzyme inhibition, and radical scavenging. However, fragmented research, variability in plant parts used, extractive methodologies, and limited clinical data impede its mainstream adoption. This comprehensive review systematically collates botanical taxonomy, distributional ecology, ethnomedicinal applications, detailed chemical constituents, exhaustive pharmacological validations via tabulated evidence, toxicity profiles, and forward-looking research imperatives.<sup>[1][2][3][4]</sup>

### Botanical Description

*Stereospermum colais* manifests as a semi-deciduous to deciduous tree, attaining heights of 18-30 meters with a straight, cylindrical bole often buttressed at the base. The bark, pale grey to yellowish-brown, exfoliates in irregular flakes, revealing a reddish inner surface rich in mucilage—key to its traditional decoctions. Leaves emerge in late monsoon, arranged spirally as imparipinnate compound structures bearing 3-5 pairs (occasionally up to 7) of opposite, elliptic to ovate-oblong leaflets measuring 5-20 cm in length and 3-10 cm wide, with acute to acuminate apices and entire margins; the terminal leaflet dominates

in size. Inflorescences form terminal or axillary lax panicles up to 30 cm long, laden with fragrant, tubular, campanulate flowers (4-5 cm) in pale creamy-yellow hues streaked with violet-purple externally, blooming profusely from March to May. Fruits develop as pendulous, linear-oblong capsules, 30-90 cm long and 1-2 cm thick, initially green then turning brown, dehiscent along the sutures to release numerous flat, thin, winged seeds (2-3 cm with 1-2 cm wings) dispersed by wind. Roots, the most medicinally prized part, present as robust, cylindrical taproots with dull brown exteriors, prominent lenticels, and a starchy, bitter interior; transverse sections reveal a wide xylem zone with distinct rays and vessels. Microscopically, stem bark shows abundant stone cells, phloem fibers, and calcium oxalate crystals, while pharmacognostic parameters confirm authenticity via ash values (total 8-10%, acid-insoluble 1-2%) and extractive yields (water-soluble 12-15%, alcohol-soluble 6-8%). This morphological fidelity aids adulteration prevention in herbal trade.<sup>[4][1]</sup>

### Geographical Distribution

*Stereospermum colais* exhibits a pan-Asian distribution, favoring tropical and subtropical deciduous forests, often on moist, well-drained loamy soils at elevations from sea level to 1200 meters. Its adaptability to seasonal monsoons underscores ecological resilience.

| Region                       | Specific Countries/ States                                                                         | Elevation/<br>Habitat                             | Abundance/<br>Threats               | Local Vernacular<br>Names               | Reference |
|------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------------|-----------------------------------------|-----------|
| Western<br>Ghats India       | Kerala (Palakkad, Idukki, Wayanad, Thrissur), Tamil Nadu (Tirunelveli, Coimbatore), Karnataka      | 100-1000 m;<br>Evergreen/<br>deciduous<br>forests | Common;<br>Habitat<br>fragmentation | Pathiri,<br>Poopathiri,<br>Karinthakara | [5]       |
| Central/<br>Eastern<br>India | Maharashtra (Sahyadris, Konkan), Madhya Pradesh, Odisha, Uttar Pradesh (Varanasi plains, Vindhyas) | 200-800 m;<br>Dry<br>deciduous<br>forests         | Moderate;<br>Overharvesting         | Patala, Padala                          | [3]       |



|                     |                                                      |                                  |                         |              |     |
|---------------------|------------------------------------------------------|----------------------------------|-------------------------|--------------|-----|
| Himalayan Foothills | Bihar, Uttar Pradesh, Nepal, Bhutan                  | 300-1200 m; Subtropical forests  | Sporadic; Deforestation | Tamhan       | [3] |
| Indo-China          | Myanmar, Thailand, Vietnam, Laos, Cambodia           | Sea level-600 m; Mixed deciduous | Abundant; Sustainable   | Madhu malati | [2] |
| Sri Lanka/ Malesia  | Sri Lanka (lowlands), Peninsular Malaysia, Singapore | 0-500 m; Riverine woods          | Rare; Urbanization      | Padiri       | [6] |

In India, Kerala hosts the densest populations, while Varanasi's agro-climatic zone supports cultivation trials. IUCN lists it as Least Concern, yet localized threats from logging and medicinal extraction necessitate agroforestry propagation via seeds or root cuttings.

### Traditional and Ethnomedicinal Uses

Ayurveda's Charaka and Sushruta Samhitas prescribe root decoctions (50-100g/day) for Jwara (fever), Kasa (cough), Shwasa (asthma), Mutrakrucho (dysuria), and Prameha (diabetes). Dashamoola formulations like Dashamoolaristam and Dashamoola Kashayam target Vataja

disorders including Sandhivata (rheumatoid arthritis) and post-delivery weakness. Leaves, pounded into paste, heal wounds, earaches, toothaches, and dysentery; flowers mitigate burning micturition, cardiac debility, and emaciation; fruits relieve abdominal colic and pitta-vata imbalances; seeds counter cephalalgia. Siddha texts recommend bark for bone fractures and gonorrhea; Kerala tribals (Paniya, Kuruma) employ leaf juice for malaria and scorpion stings; Maharashtra's Bhil communities use stem bark for dyspepsia. Dosage norms emphasize safety: root powder 3-6g/day, leaf juice 10-20ml. Historical records affirm low toxicity, aligning with LD50 >2000 mg/kg in modern assays<sup>[7]</sup>

| Plant Part | Ayurvedic/ Siddha Use                         | Tribal/ Folk Application  | Dosage/ Form         | Reference |
|------------|-----------------------------------------------|---------------------------|----------------------|-----------|
| Root       | Anti-inflammatory, diuretic, tonic (Dasamula) | Edema, urinary stones     | Decoction 50-100g    | [7]       |
| Leaf       | Dysentery, wounds, rheumatism                 | Earache, malaria          | Paste/ juice 10-20ml | [1]       |
| Flower     | Burning urination, heart tonic                | Debility                  | Infusion             | [3]       |
| Fruit      | Pitta disorders, colic                        | Abdominal pain            | Powder 3g            | [2]       |
| Bark/ Seed | Fracture healing, headache                    | Gonorrhea, scorpion sting | External             | [7]       |

### PHYTOCHEMICAL CONSTITUENTS

Systematic screenings via qualitative (Wagner, FeCl<sub>3</sub> tests) and quantitative (HPTLC, GC-MS, HPLC) methods unveil a diverse metabolome. Roots predominate in naphthoquinones like lapachol (0.5-4% w/w),  $\beta$ -lapachone, dehydro- $\alpha$ -lapachone, and stereospermol; steroids encompass  $\beta$ -sitosterol, stigmasterol, campesterol; fatty

alcohols include n-triacontanol, octacosanol. Flavonoids (quercetin, kaempferol), phenolic acids (gallic, ferulic), tannins (catechin equivalents 45-60 mg/g), and glycosides (dinantin-7- $\beta$ -D-glucuronide) abound. Leaves harbor stilbenes (piceid), coumarins (scopoletin), triterpenoids (ursolic, oleanolic acids); fruits yield lup-20(29)-en-3-one,  $\alpha$ -amyrin. GC-MS profiles



25+ peaks: 5-heptenoic acid (RT 8.2 min), ergosta-7,22-dien-3 $\beta$ -ol (12.5%), siloxanes, and hydrocarbons. Ethanol extracts maximize polar phenolics (TPC 120-150 mg GAE/g), while non-polar fractions concentrate quinones.<sup>[4]</sup>

| Phytoconstituent Class  | Major Compounds                                           | Predominant Plant Part | Extraction Solvent  | Reported Yield/Quantification | Linked Bioactivity                                    | Reference    |
|-------------------------|-----------------------------------------------------------|------------------------|---------------------|-------------------------------|-------------------------------------------------------|--------------|
| Naphthoquinones         | Lapachol, $\beta$ -lapachone, sterequinone-A              | Root/ Bark             | Ethanol, Chloroform | 3.9% w/w lapachol             | Anticancer, Anti-arthritic global research online + 1 | [4][7]       |
| Sterols/ Triterpenoids  | $\beta$ -Sitosterol, stigmasterol, ursolic acid, lupenone | Root/ Fruit/ Leaf      | Methanol, Hexane    | 1.2-2.5%                      | Antidiabetic, Hepatoprotective                        | [8]          |
| Flavonoids/ Polyphenols | Quercetin, kaempferol, gallic acid, catechins             | Leaf/ Root             | Aqueous/ Ethanol    | TPC 145 mg GAE/g              | Antioxidant                                           | [9] [10] [6] |
| Glycosides/ Alcohols    | Dinantin-7-glucuronide, n-triacontanol                    | Root                   | Water               | 0.8-1.5%                      | Anti-peroxidative                                     | [11]         |
| Coumarins/ Stilbenes    | Scopoletin, piceid                                        | Leaf/ Bark             | Methanol            | Trace-0.5%                    | Antimicrobial                                         | [6]          |

HPTLC standardization fingerprints lapachol at Rf 0.65 (UV 254 nm), ensuring quality control.<sup>[4]</sup> In vitro and in vivo validations span diverse models, affirming traditional efficacy with mechanistic insights.

## PHARMACOLOGICAL ACTIVITIES

| Activity       | Experimental Model                                                             | Key Findings/ Mechanisms                                                                                | Effective Extract/ Dose              | Statistical Significance | Reference     |
|----------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------|--------------------------|---------------|
| Antidiabetic   | STZ-induced diabetic rats; $\alpha$ -glucosidase/ $\alpha$ -amylase inhibition | Glucose reduction 28-45%, HbA1c drop, insulin upregulation; IC50 $\alpha$ -glucosidase 61.21 $\mu$ g/mL | Fruit/ root MeOH, 200-400 mg/kg      | p<0.001                  | [8] [12]      |
| Anti-arthritic | CFA adjuvant arthritis in rats                                                 | Paw edema $\downarrow$ 42%, TNF- $\alpha$ /IL-6 $\downarrow$ 35%; lapachol modulates NF- $\kappa$ B     | Root EtOH, 200 mg/kg                 | p<0.01; LD50>2000 mg/kg  | [13]          |
| Antioxidant    | DPPH/ABTS/H2O2 scavenging; lipid peroxidation; XO inhibition                   | 85-92% scavenging at 200 $\mu$ g/mL; oil stabilization                                                  | Leaf/root acetone, 50-200 $\mu$ g/mL | IC50 36-62 $\mu$ g/mL    | [14][12] [15] |
| Antimicrobial  | Agar well diffusion; MIC vs S.aureus, E.coli, Candida                          | Zones 18-25 mm; ethanol leaf superior                                                                   | Leaf EtOH/ChCl3, 100-320 $\mu$ g/mL  | p<0.05                   | [7][15]       |
| Anticancer     | MCF-7 breast cancer cells; Ag/TiO2 NPs                                         | 76% viability inhibition at 320                                                                         | Leaf NPs, 50-320 $\mu$ g/mL          | IC50 120 $\mu$ g/mL      | [15][16]      |

|                  |                                                   |                                                       |                                         |          |                 |
|------------------|---------------------------------------------------|-------------------------------------------------------|-----------------------------------------|----------|-----------------|
|                  |                                                   | µg/mL; apoptosis induction                            |                                         |          |                 |
| Analgesic        | Acetic acid writhing; formalin tail flick in mice | Writhes ↓68%, hot plate latency ↑; central/peripheral | Stem bark MeOH fractions, 100-200 mg/kg | p<0.0001 | [7]             |
| Wound Healing    | Excision/ incision wound in rats                  | 96% contraction by day 15; tensile strength ↑32%      | Leaf ChCl3/EtOH, 5% w/w                 | p<0.01   | [1]             |
| Hepatoprotective | CCl4-induced damage in rats                       | ALT/AST ↓40%, GSH ↑25%; anti-oxidative                | Root acetone, 250 mg/kg                 | p<0.05   | [12]            |
| Hypolipidemic    | STZ-hyperlipidemic rats                           | TC/TG ↓30-50%, HDL ↑; glycogen restoration            | Fruit MeOH, 400 mg/kg                   | p<0.001  | [8][13][12][16] |

Acute/subchronic toxicity affirms safety: no mortality at 2000 mg/kg, no genotoxicity.<sup>[8][13]</sup>

| Toxicity Parameter     | Root EtOH Extract                     | Fruit MeOH Extract         | Reference |
|------------------------|---------------------------------------|----------------------------|-----------|
| Acute Oral LD50 (rats) | >2000 mg/kg                           | >2000 mg/kg                | [13][8]   |
| Subchronic (28 days)   | No hepato/ renal changes at 500 mg/kg | Normal hematology/ biochem | [13]      |
| Genotoxicity (Ames)    | Negative                              | Negative                   | [7]       |

## Future Research Scope

Prospects abound: (1) Clinical Phase II/III trials on Dasamula for RA/diabetes, targeting Varanasi cohorts; (2) Nanoencapsulation of lapachol for bioavailability enhancement—recent Ag/TiO<sub>2</sub> NPs from leaves show 3x potency vs. extracts; (3) Omics-driven discovery: metabolomics for variant-specific markers, transcriptomics for biosynthetic pathways; (4) Synergistic studies with metformin/NSAIDs; (5) Conservation: CRISPR-edited cultivars for high-lapachol lines, GIS mapping for UP/Kerala hotspots; (6) Mechanistics: lapachol's topoisomerase II inhibition, NF-κB suppression via docking simulations; (7) Cosmeceuticals from leaf antioxidants; (8) Standardization: WHO-compliant monographs with HPTLC/MS fingerprints.<sup>[15][16]</sup>

## CONCLUSION

Stereospermum colais epitomizes the untapped pharmacopeial wealth of Ayurvedic flora, with lapachol-led phytochemistry fueling validated bioactivities across therapeutic domains. From geographical ubiquity to preclinical prowess, it beckons clinical advancement, standardization, and eco-sustainable harnessing to benefit global health, especially in India's heartlands like Uttar Pradesh.

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