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Review Article

Pterocarpus santalinus L. f. (Fabaceae): a threatened medicinal tree species of India

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Abstract: *Pterocarpus santalinus* L. (Red Sanders) is an endemic and endangered tree species of southern India, renowned for its valuable heartwood and diverse medicinal properties. Besides its economic importance, the species has attracted considerable scientific attention because of its rich phytochemical composition and broad spectrum of pharmacological activities. The present review summarizes the medicinal uses reported for different plant parts of *P. santalinus* based on published literature. A comprehensive literature survey revealed that the heartwood is the most extensively investigated plant part, exhibiting antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, anticancer, radioprotective, anti-photoaging, anti-adipogenic and wound-healing properties. Seeds have demonstrated antitumour and nephroprotective activities, whereas bark has mainly been investigated for antidiabetic and antidiarrheal properties. In contrast, studies on leaves, flowers, roots, fruits, and other reproductive structures remain scarce. The review highlights the therapeutic significance of this endangered medicinal tree while identifying important research gaps regarding underexplored plant parts and clinical validation of its bioactive compounds.

Keywords: Conservation, pharmacological activities, phytochemicals

Introduction

Pterocarpus santalinus is commonly known as Red Sanders or Red Sandalwood, is an endemic tree species naturally distributed in the dry deciduous forests of the Eastern Ghats of India. Owing to its highly valued heartwood, extensive exploitation and illegal harvesting have considerably reduced its natural populations, resulting in its recognition as an endangered medicinal tree species (Bulle et al., 2016; Dahat et al., 2021). Besides its commercial importance, the species has long been utilized in

traditional systems of medicine for the treatment of inflammation, diabetes, skin diseases, wounds, jaundice, fever, headache, and gastrointestinal disorders (Bulle et al., 2016; Ham et al., 2019; Dahat et al., 2021).

Figure 1: Leaves of *P. santalinus*

Recent pharmacological investigations have demonstrated numerous biological activities including antioxidant, anti-inflammatory, hepatoprotective, antidiabetic, antimicrobial, anticancer, wound-healing, radioprotective, anti-photoaging, anti-obesity, and neuroprotective effects (Kwon et al., 2006; Kumar et al., 2011; Ghali et al., 2018; Gao et al., 2018; El-Badawy et al., 2019; Reddy et al., 2021; Darshani et al., 2024; Zwirchmayr et al., 2023; Nguyen et al., 2024). Most studies have focused on the heartwood because it contains abundant phenolics, flavonoids, lignans, stilbenoids, and other bioactive constituents responsible for these pharmacological properties (Bulle et al., 2016; Dahat et al., 2021). Despite the growing number of scientific investigations, information regarding the medicinal importance of different plant parts remains scattered. Therefore, the present review compiles published reports on the medicinal uses of *P. santalinus* (Figure 1), summarizes plant-part-specific pharmacological activities, and identifies research gaps for future studies.

Methodology

A literature-based review was conducted using peer-reviewed publications available in international scientific journals (Sahu et al., 2026). Relevant articles concerning the medicinal uses and pharmacological properties of *P. santalinus* were collected from the references provided in the present study (Biswas et al., 2004a; 2004b; Bulle et al., 2016a; 2016b). Information on plant parts investigated,

biological activities, and therapeutic applications was extracted, organized, and summarized. Duplicate reports were excluded and emphasis was given to experimentally validated pharmacological studies and comprehensive review articles (Kumar, 2025).

Results and discussion

The literature reviewed indicates that *P. santalinus* possesses a wide range of medicinal properties distributed across different plant parts, although the majority of pharmacological investigations have focused on the heartwood (Table 1). The heartwood exhibited the greatest diversity of biological activities, including antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, hypolipidemic, pancreatic protective, anti-adipogenic, radioprotective, DNA-protective, anti-apoptotic, anti-lipid peroxidation, anti-photoaging, analgesic, wound-healing, anticancer, and potential anti-metabolic syndrome activities. Several studies also demonstrated its insulin-enhancing properties, inhibition of lipid accumulation, and promising drug-likeness based on in vitro and in silico analyses. Compared with the heartwood, relatively fewer investigations have been conducted on other plant parts. Bark has been reported to possess antidiabetic and antidiarrhoeal properties, while seed extracts have demonstrated significant antitumour, antioxidant, anti-inflammatory, hypoglycaemic, hepatoprotective, and nephroprotective activities in experimental studies. Wood powder has primarily been reported as a traditional insect repellent (Table 1). The compiled evidence suggests that although *P. santalinus* is recognized as a valuable medicinal species with diverse pharmacological potential, research has been concentrated largely on heartwood-derived extracts and their phytochemicals.

Table 1: Medicinal uses of plant parts of *P. santalinus*

Parts used	**Medicinal uses**	**Source**
Bark	Antidiabetic	Bulle et al., (2016)
	Diarrhoea	Dahat et al., (2021)
Heartwood	Antioxidant	Bulle et al., (2016)
	Inflammatory disorders	Dahat et al., (2021)
	Headache	Dahat et al., (2021)
	Wound healing	Dahat et al., (2021)
	Anti-inflammatory	El-Badawy et al., (2019)
	Antioxidant	El-Badawy et al., (2019)
	Insulin-enhancing	El-Badawy et al., (2019)
	Hypolipidemic	El-Badawy et al., (2019)
	Pancreatic protective	El-Badawy et al., (2019)
	Hepatoprotective	El-Badawy et al., (2019)
	Anti-adipogenic	Reddy et al., (2021)
	Anti-inflammatory	Reddy et al., (2021)
	Reduction of lipid accumulation	Reddy et al., (2021)
	Potential anti-metabolic syndrome effect	Reddy et al., (2021)

	Radioprotective potential	Ghali et al., (2018)
	DNA protective	Ghali et al., (2018)
	Anti-apoptotic	Ghali et al., (2018)
	Anti-lipid peroxidation	Ghali et al., (2018)
	Thiol-restoring activity	Ghali et al., (2018)
	Antidiabetic potential	Darshani et al., (2024)
	Drug-likeness and ADMET properties	Darshani et al., (2024)
	Anticancer activity	Kwon et al., (2006)
	Analgesic	Dhande et al., (2017)
	Anti-photoaging effects	Gao et al., (2018)
Seeds	Antitumour activity	Akhouri et al., (2020)
	Antioxidant activity	Akhouri et al., (2020)
	Anti-inflammatory activity	Akhouri et al., (2020)
	Hypoglycaemic activity	Akhouri et al., (2020)
	Hepatoprotective activity	Akhouri et al., (2020)
	Nephroprotective activity	Akhouri et al., (2020)
Wood powder	Insect repellent	Dahat et al., (2021)

Conclusion

Pterocarpus santalinus is an endangered medicinal tree species with remarkable therapeutic potential, as evidenced by numerous pharmacological studies. The compiled literature demonstrates that the heartwood is the most extensively investigated plant part, exhibiting diverse biological activities such as antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, anticancer, radioprotective, anti-photoaging, analgesic, and anti-adipogenic effects. In comparison, the bark has received limited attention for its antidiabetic and antidiarrhoeal properties, while seed extracts have shown promising antitumour, antioxidant, hypoglycaemic, hepatoprotective, and nephroprotective activities. However, medicinal investigations on leaves, roots, flowers, fruits, pods, and other renewable plant parts remain extremely limited or absent. The predominance of heartwood-based research raises important conservation concerns because harvesting heartwood requires felling the tree, further threatening natural populations of this endangered species. Therefore, future studies should prioritize the phytochemical and pharmacological evaluation of renewable plant parts such as leaves, bark, flowers, fruits, and seeds to identify alternative sources of bioactive compounds. In addition, comprehensive toxicity studies, standardization of extracts, mechanistic investigations, and well-designed clinical trials are required to validate their therapeutic efficacy and safety. Exploring sustainable utilization strategies alongside conservation measures will not only facilitate the development of novel plant-based therapeutics but also contribute to the long-term preservation of *P. santalinus*.

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