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Review article

Review on utilization of bark of red sanders (*Pterocarpus santalinus* L.): An economically important tree

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Abstract: Wood of *Pterocarpus santalinus* (Red Sanders) has been highly valued since long time for different purposes like: furniture, medicines, pigments and others; however its bark remains underutilized. Bark of any trees generally utilized for fuel purpose in India, however bark can be used for a renewable source of value added chemicals or products because generally they are much richer in both quantity and complexity of extractives. Although the extracts obtained from the bark of *P. santalinus* reported to exhibit several medicinal and therapeutic properties and also used in various ailments in traditional medicines but it is not have high economic values like its wood. Many articles have been published on the different aspects of this tree particularly on wood but no any article dedicated to its bark has been seen. Looking to the high economic potential of the bark of Red Sanders, this article discusses about the various aspects of bark including traditional uses, phytochemistry and biological activities.

Keywords: Red Sanders - Bark - Traditional medicines - Therapeutic properties - Phytochemistry - Biological activities.

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INTRODUCTION

Pterocarpus santalinus L. commonly known as Res Sanders (RS) of family *Fabaceae* is an endemic and endangered timber tree species, endemic to southern India. It grows in approximately 5160 km^2 of fragmented forest landscape of southern Andhra Pradesh, and in a few sporadic patches in Tamil Nadu and Karnataka states (Anonymous 2011, Kukrety *et al.* 2013). It is a deciduous medium-sized tree, up to 11 m in height and are found in the dry hill areas of Palakonda range of Eastern Ghats often on rocky ground and at altitude ranging from 150–900 m (Ramakrishna 1962). *P. santalinus* is highly valued for its heavy, dark claret-red heartwood which yields up to16% of red colouring matter to santalin (Green 1995, Vedavathy 2004, Senthilkumar *et al.* 2015). In recent years, a variant in this species which has wavy-grained wood has driven into sudden prominence because it is highly valued in the export market. Trees with this variant character are rare in nature and they seem to show no apparent morphological differences to differentiate them from the normal-grained trees (Senthilkumar *et al.* 2015). The dye known as santalin extracted from the wood finds its uses in coloring foodstuff and pharmaceutical preparations (Manjunatha 2006a). Although the wood and wood extracts obtained from the tree are known and reported to have several uses like expensive furniture, making musical instruments and medicinal properties, however bark of this tree has not such values. This article discusses the uses and importance of bark of the Red Sanders tree.

TRADITIONAL USES

The bark is rough textured and appears blackish-brown like crocodile skin. When the bark inner part injured or cut, oozes red coloured ‘santalin’ dye. Arunkumar & Joshi (2014) reviewed the various aspects of RS, like its uses, in folklore/tribal medicine; tree improvement in red sanders, studies on wavy grain, studies on vegetative propagation, variability, trade and future of Red Sanders. Soundararajan *et al.* (2016) reviewed the phytochemical, biological and pharmacological activities of Red Sanders. Azamthulla *et al.* (2015) reviewed the

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different aspect and uses of wood and bark of RS. Bark has been reported to have many traditional uses for different therapeutics applications like decoctions of bark and resin have been used traditionally for the treatment of tumours of the gland, urethral discharges and as abortifacient (Kirtikar & Basu 1987). Kandhas tribe in Kandhamal district of Orissa in India use the decoction of fresh stem barks of the tree, *Calamus tenuis* Roxb. root and *Azadirachta indica* A. Juss. to cure piles in empty stomach for 21 days. The extracts obtained from the tree bark and wood are known and reported to have several medicinal properties (Rao *et al.* 2001, Narayan *et al.* 2005, Narayan *et al.* 2007a, b). Along with root of *Piper longum* L. rhizome of lotus and stem of *P. santalinus* is taken with one cup of cow urine in empty stomach for 7 days during intermittent fever and fever due to cold (Behera *et al.* 2006). The stem bark extract is used by a tribal group of Western Ghats in Shimoga region of Karnataka state for treating diabetes, fever, and snakebite and especially for Jaundice (Manjunatha 2006b). Stem bark powder with soft porridge has been used in treating diarrhea and the paste of the wood has been considered as a cooling agent for external application treating inflammations and headache, mental aberrations, and ulcers (Krishnaveni & Rao 2000). Wood and bark brew taken orally relieves chronic dysentery, worms, blood vomiting, weak vision, and hallucination (Arunakumara *et al.* 2011).

PHYTOCHEMISTRY AND BIOLOGICAL ACTIVITIES

The gum kino from the bark of *P. santalinus* provides nonglucosidal tannins, kinotannic acid, kinonin ($C_{28}H_{24}O_{12}$), kinored ($C_{28}H_{22}O_{11}$), pyrocatechin, pyrocatechin acid & small quantities of resin, pectin and gallic acid (Tiwari *et al.* 2015). The synthesized GNPs exhibited antibacterial activity against Gram-positive and Gram-negative bacterial strain (Keshavamurthy *et al.* 2018). Basha *et al.* (2010) evaluated the hypoglycemic activity of aqueous extract of bark of *P. santalinus* on rats. The bark of *P. santalinus* was found to contain β-amyrone, lupenone, epi-lupeol, lupeol, sitosterol and a new lupenediol (Kumar & Seshadri 1975). The heartwood, sapwood and bark of the tree consists of many secondary metabolites like: pterrocarptriol, isipterocarpene, pterocarpdiolone, santalin A and B, isopterocarpolone, acyl olealonic aldehyde, pterocarpol, and acetyloleanolic acid. Kondeti *et al.* (2010) carried out the HPLC analysis of the active fraction which showed 4 peaks. The retention times in minutes (% area) for peaks 1, 2, 3 and 4 were 4.647 (11.225%), 4.940 (20.743%), 7.000 (41.546%) and 9.367 (26.486%), respectively, however, they did not compare the data with wood extracts. A phytochemicals-mediated rapid, stable and eco-friendly synthesis of gold nanoparticles (GNPs) using *P. santalinus* bark extract was reported. The oral administration of aquoues extract at a dosage of 0.7 g kg^{-1} body weight exhibited significant antidiabetic activity in STZ diabetic rats, whereas in normal rats no hypoglycemic activity was observed. Further in a study by Kondeti *et al.* (2010) in which the researchers reported that ethanolic extract of bark of tree, decreases hyperglycemia induced by streptozotocin by increasing glycolysis and decreasing gluconeogenesis. Research on printing on cotton fabrics was attempted using extractive obtained from *Pterocarpus marsupium* (Mahale *et al.* 2016). The barks of *P. santalinus* and *Boswelia ovalifoliolata* Balakr & Henry were screened (Devi & Basha 2012) for amino acid compositions in barks and found the similarities between both and suggested the utilization of *P. santalinus* and *Boswelia ovalifoliolata*, bark extracts in pharmaceutical, cosmetic and food additive products. 70% ethanol extract of the bark of RS was found to posses' strong activity against hepatocellular injury in male Wistar albino rats induced hepatotoxicity in rats by carbon tetrachloride (Manjunatha 2006a). Ethanolic stem bark extract was demonstrated to possess strong antihyperglycemic activity (Rao *et al.* 2001). Out of the three fractions *i.e.*, aqueous, ethanol and hexane; ethanolic fraction tested at the dose of 0.25 g kg^{-1} body weight showed maximum antihyperglycemic activity, but the same dose of 0.25 g kg^{-1} body weight did not cause any hypoglycemic activity in normal rats. The results obtained in the studies were also compared with the diabetic rats treated with glibenclamide and the antihyperglycemic activity of ethanolic extract of *P. santalinus* bark at the dose of 0.25 g kg^{-1} b.w. was found to be more effective than that of glibenclamide (Kameswara *et al.* 2001). 70% methanol extract of the bark was found highly antibacterial activities against the tested pathogens like *Enterobacter aerogenes* Hormaeche & Edwards, *Alcaligenes faecalis* Castellani & Chalmers, *Escherichia coli* Migula, *Pseudomonas aeruginosa* Migula, *Proteus vulgaris* Hauser, *Bacillus cereus* Frankland & Frankland, *Bacillus subtilis* Ehrenberg and *Staphylococcus aureu* Rosenbach (Manjunath 2006b). The acetone, alcohol and benzene extracts of stem bark of *P. santalinus* on vasculogenesis were evaluated using the chick chorioallantoic membrane. It was demonstrated that acetone extracts of bark of *P. santalinus* promotes vasculogenesis in chick CAM (Jaywant *et al.* 2012). The ethanol extract of *P. santalinus* was evaluated for gastroprotection in rats using ibuprofen as the induction model (Narayan *et al.* 2007b).

CONCLUSIONS

The review on the aspects of phytochemistry, traditional uses and biological activities clearly indicate that the bark of *Pterocarpus santalinus* has immense potential for its further utilization and value addition.

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