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REVIEW ARTICLE

# A REVIEW UPDATE ON *SHOREA ROBUSTA* GAERTN F. (SAL)

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**ABSTRACT**

*Shorea robusta* Gaertn. (Sal) has been commonly used in Indian traditional medicine for treatment of various ailments such as circulatory, digestive, endocrine, respiratory and skeletal systems as well as in infectious diseases. This information was collected from available literatures through books, journals and internet. The phytochemical studies have shown the presence of many secondary metabolites belonging to terpenoids, flavonoids, carbohydrate, lignans, phenols and sterols. Crude extracts and isolated compounds from *Shorea robusta* show a wide spectrum of pharmacological activities, such as anti-inflammatory, anti-obesity, antibacterial, wound healing, anti-pyretic & analgesic activities. Many studies have provided evidence for various traditional uses. The present review on its botany, traditional uses, pharmacological activities and phytochemistry which provides preliminary information for further studies for this potential medicinal plant.

**Keywords**: *Shorea robusta*, Phytochemical profile, Pharmacological properties.

## 1. INTRODUCTION

India is a varietal emporium of the medicinal and aromatic plants (MAPs) and we have well-established local healthcare tradition still relevant in indigenous healthcare system[1,2]. As per World Health Organisation (WHO) estimates, almost 80% of the population of developing countries relies on traditional medicines, mostly plant drugs, for their primary health care needs[3-5]. In developed countries, the use of Indian traditional medicines is quite prevalent and also, modern pharmacopoeia still contains at least 25% drugs derived from plants[6]. The use of medicinal plants in the Indian subcontinent can be traced back to the Vedic period. The texts mentioning the uses of different medicinal plants are the Rigveda (written between 4500 and 1600 BC), the Atharveda (2000–1000 BC), the Charaka Samhita (~900 BC) and the Sushruta Samhita (~600 BC); these texts are written in Sanskrit[7-10].

*Shorea robusta* Gaertn. is a tree commonly known as sal or shala tree, belonging to the family Dipterocarpaceae[11]. In addition to the Ayurvedic system of medicine, this tree is widely used in Unani medicine[12]. The present review compiles the fragmented information on the botany, phytochemistry, pharmacology and toxicology of this plant. We hope that this information will highlight the importance of *Shorea robusta* and will provide a new direction for researchers in the future.

### *1.1. Taxonomy and Morphology*

*Shorea robusta* is a large, deciduous tree up to 50 m tall and with a dbh of 5 m; these are exceptional sizes, and under normal conditions *S. robusta* trees attain a height of about 18-32 m and girths of 1.5-2 m; bole is clean, straight and cylindrical, but often bearing epicormic branches; crown is spreading and spherical. Bark dark brown and thick, with longitudinal fissures deep in poles, becoming shallow in mature trees; provides effective protection against fire. The tree develops a long taproot at a very young age. Leaves simple, shiny, glabrous, about 10-25 cm long and broadly oval at the base, with the apex tapering into a long point; new leaves reddish, soon becoming delicate green. Flowers yellowish-white, arranged in large terminal or axillary racemose panicles. Fruit at full size about 1.3-1.5 cm long and 1 cm in diameter; it is surrounded by segments of the calyx enlarged into 5 rather unequal wings about 5-7.5 cm long [13-17]. Some plant parts are given in Figure 1.

**Figure 1:** *Shorea robusta* Gaertn f. plant.

### *1.2. Scientific classification*

Kingdom : Plantae

Unranked : Angiosperms

Unranked : Eudicots

Unranked : Rosids

Order : Malvales

Family : Dipterocarpaceae

Genus : Shorea

Species : *Shorea robusta*

### *1.3. Distribution and Propagation*

*Shorea robusta* is widely distributed in India, Nepal and Bhutan. In India, the species is distributed from Himachal Pradesh to Assam, Tripura, West Bengal, Bihar and Orissa, Eastern districts of Madhya Pradesh extending further to the Eastern Ghats of Andhra Pradesh[18,19]; and it is dominantly distributed on the plains and lower foothills of the Himalayas and also along the valleys[20]. *S. robusta* propogates naturally through seed and coppice. Direct sowing is the cheapest and best method of artificial propagation, although stump plantings, planting out entire plants with balls of earth, and planting out container-grown seedlings are also employed[21].

## 2. Vernacular names and traditional uses

S. robusta is known by various vernacular names in different geographical regions **(see Table 1)**. *Shorea robusta* has been traditionally used for various ailments. The leaves and bark are used to treat wounds, ulcers, leprosy, cough, gonorrhea, earache and headache. The bark is also used to treat diarrhoea, dysentery and vaginal discharges. The fruits are useful in tubercular ulcers, seminal weakness, burning sensation and dermopathy. The oleoresin exuded from the plant has astringent, carminative and stomachic properties. It is useful in vitiated conditions of pitta, wounds, ulcers, neuralgia, burns, fractures, fever, diarrhoea, dysentery, splenomegaly, obesity and burning of the eyes. In Unani medicine, the resin is used for treating menorrhagia, enlargement of spleen and for relieving eye irritation. In Ayurveda, it is used with honey or sugar in treatment of dysentery and bleeding piles. It is also given in gonorrhea and for weak digestion. It is suggested for ulcers, wounds and menopausal disorders by Siddha practitioners[22-26].

**Table 1:** Vernacular names of *Shorea robusta* Gaertn f.

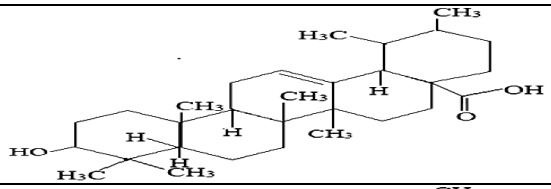
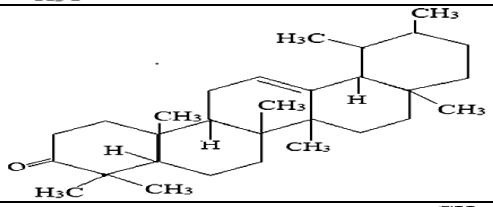
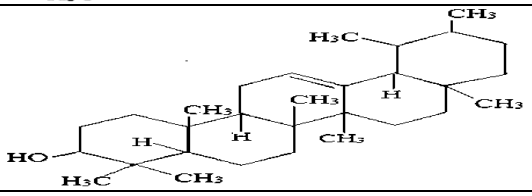
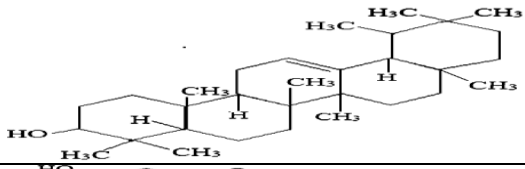
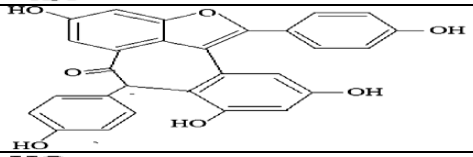
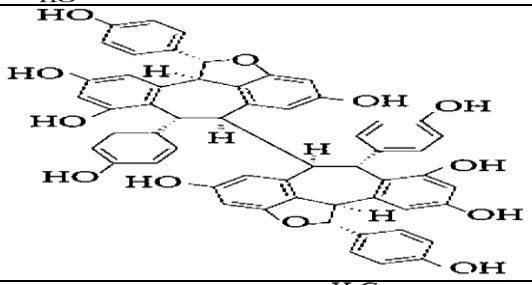
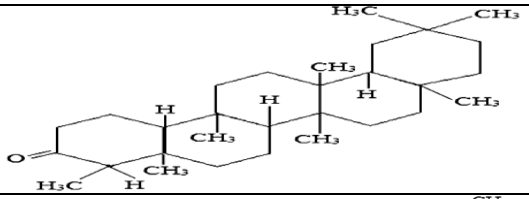
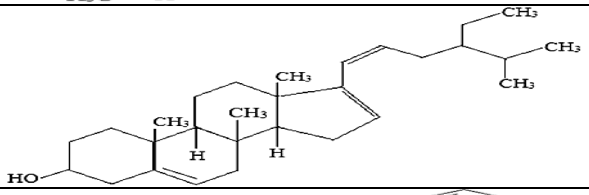
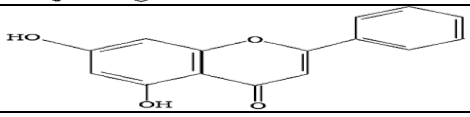
| Vernacular names | Region/language/system of medicine |
|---|---|
| Sakhu, sal, shal, Sakher, Salwa | Bengali |
| Borsal, hal, sakhu, sakhwa, sal, shal | Hindi |
| Kungiliyam, Attam, Shalam | Tamil |
| Salbaum, Salharzbaum | German |
| Agrakh, sakhua, sakwa, sal | Nepali |
| Damar de l'Inde, Arbre à Sal, Balau Jaune, | French |
| Sal | Assamese |
| Enkhyen | Burmese |
| Suo Luo Shuang, Suo Luo Shuang Shu | Chinese |
| Sal Tree, Common Sal, Indian Dammer, Sal Seeds, Saltree, Yellow Balau | English |
| Ral | Gujarati |
| Jall, sal, salwa, shal | India |
| Sara Noki, Serangan Batsuu, Shara Noki | Japanese |
| Bangkirai (Borneo), Damar Laut (Indonesia), Selangan Batu (Sabah), Selangan Batu Kumus | Malay |
| Guggilu, Rala | Marathi |
| Sagua, Sal, Salwa, Sekwa | Oriya |
| Sal, Seral (Resin) | Punjabi |
| Sal, Salovoe Derevo, Shoreia Moshchnaia | Russian |
| Ashvakarna, Chiraparna, Sal, Sala, Sarja | Sanskrit |
| Dammala | Sinhalese |
| Gugal, Guggilamu (Resin), Saluva, Sarjmu | Telugu |
| Raal | Urdu |
| Shala | Ayurveda |

## 3. Phytochemial profile

*S. robusta* contain ursolic acid and *α*-amyrenone; α & β-amyrin[27,28]**;** bark contains ursonic acid and oleanane, Shoreaphenol[29,30]**;** seed contains hopeaphenol, leucoanthocyanidin, and 3,7-dihydroxy-8-methoxyflavone7-*O*-*α*-l-rhamnopyranosyl-(1→4)-*α*-l-rhamnonopyrano- syl(1→6)-*β*-d-glucopyranoside[31]**;** while heartwood contains germacrene-D[24]. The isolation of *β*-amyrin, friedelin, *β*-sitosterol, pheophytin-*α*, and dihydroxyisoflavone from mature leaves was also reported [32]. Some phytochemical Structures were illustrated in the **Table 2.**

**Table 2:** Some structures isolated from *Shorea robusta* Gaertn f.

| Chemical names | Isolated from part | Structures | References |
|---|---|---|---|
| Ursolic acid | Whole plant |  | [27,28] |
| *α*-amyrenone | Whole plant |  | [27,28] |
| α-amyrin | Whole plant |  | [27,28] |
| β-amyrin | Leaves & whole plant |  | [27,28,32] |
| Shoreaphenol | Bark |  | [30] |
| Hopeaphenol | Seed |  | [31] |
| Friedelin | Leaves |  | [32] |
| β-sitosterol | Leaves |  | [32] |
| Dihydroxyisoflavone | leaves |  | [32] |

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## 4. Pharmacological properties

### *4.1. Analgesic activity*

A 70% ethanol extract of the dried powder resin of *Shorea robusta* was investigated for analgesic activity. The extract (30, 100 and 300 mg/kg, i.p.) produced significant central and peripheral analgesic effect, as is evidenced from increase in reaction time in hot plate and tail flick tests. These results demonstrated that the extracts of *S. robusta* possess significant analgesic properties [23]. The methanolic and aqueous leaf extract of *S. robusta* shows analgesic activity with acetic-acid induced writhing and tail flick tests. The dose of both extracts such as methanol and aqueous extract (200 and 400mg/kg i.p.) caused significant reduction of writhing and tail flick method in rats and mice by different ways [12].

### *4.2. Antipyretic activity*

The ethanolic extract (70%) of *S. robusta* resin (SRE) was investigated for its antipyretic activities. The antipyretic activity of SRE was studied using Brewer's yeast-induced pyrexia in rats. The rats were divided into five groups with five animals in each group. Group I was treated with vehicle i.e. 1% v/v Tween-80 and served as control. Groups II to IV were treated with three different doses of SRE (30, 100 and 300 mg/kg orally). Group V was treated with standard drug etoricoxib (10 mg/kg orally). The results of this study demonstrated antipyretic activities of *S. robusta* resin and supported its traditional therapeutic use in fever [36].

### *4.3. Anti-inflammatory activity*

The aqueous extract of leaves of *Shorea robusta* with a dose of 100, 200 & 500 µg/ml, was taken for the activity & compared with the standard Diclofenac doses of 20 & 40 µg/ml, in HRBC membrane stabilization model and same dose of extract was taken for activity & compared with Aspirin 200 µg/ml, using Heat Induced Haemolytic method. The extract of 500 µg/ml showed good result in both models [33]. The methanolic and aqueous leaf extract of *S. robusta* shows anti-inflammatory activity in carraganeen and dextran induced paw method and cotton-pellet-induced granuloma model. The dose of both extracts such as methanol and aqueous extract (200 and 400mg/kg i.p and p.o.) caused significant effect in rats and mice by different ways [12,34,35].

### *4.4. Antinociceptive activity*

A methanol extract of the dried leaves of *Shorea robusta* was investigated for antinociceptive activity. The extract (200 and 400 mg/kg, p.o) produced a dose dependent antinociceptive effect was also observed with hotplate device maintained at 550C, Acetic acid induced writhing, formaline induced paw licking, Tail clip and Tail flick models in mice. Two different dose levels exhibited a significant anti-nociceptive activity in different animal models of pain. In hot plate test, actinociceptive reaction towards thermal stimuli in mice is a well validated model for detection of opiate like analgesic drugs wherein pain response is from spinal origin [34].

### *4.5. Antibacterial activity*

The aqueous extract of floral parts of *Shorea robusta* was prepared with cold water maceration. Well diffusion method was employed to determine the effect of antibacterial potential against Gram positive bacteria viz. *Staphylococcus aureus* and *Bacillus subtilis* and *G*ram negative bacteria viz. *Klebsiella pneumoniae* and *Serratia marcescens.* Aqueous extract of the plant has showed significant inhibitory activity on different bacterial species tested against penicillin as standard antibacterial agent. Furthermore, the preliminary phytochemical analysis revealed that the aqueous extract possesses tannins, flavanoids, cardiac glycosides and steroids, which are involved in antibacterial activity[36].

### *4.6. Anti-Obesity activity*

Anti-obesity effect of hydro-alcoholic extract of *Shorea robusta* (HASR) leaves on monosodium glutamate induced obesity in albino rats. Monosodium glutamate is used to induce obesity for 7 days along with normal diet and obtained obese rats were treated with *Shorea robusta* in a dose of 200, 400 and 600mg/kg p.o for next 41days. Physical parameters such as body weight, various organs and adipose tissue weight and various biochemical parameters like serum glucose, triglyceride, cholesterol, LDL-C, HDL-C, VLDL-C, atherogenic index, SGPT and SGOT were evaluated and compared with both normal control and obesity control groups. From result, it was concluded that hydro-alcoholic *Shorea robusta* leaves extract is a potential drug which can be used for treatment of obesity and favours the correction of disturbed lipid profile [37].

### *4.7. Antiulcer activity*

Gastroprotective potential of *S. robusta* resin (dissolved in water) at two different doses (150 and 300 mg/kg bw p.o.) was studied on ethanol and pyloric ligation (PL) induced gastric ulcer models in rats. Pretreatment with the resin (SRR) produced 62.69% inhibition of gastric mucosal damage in ethanol induced model and 64.55% inhibition in PL-induced model which was comparable to the reference drug omeprazole. The protective effect was associated with normalization of antioxidant markers (superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), glutathione-S-transferase (GST) and lipid peroxidation (LPO)) in ethanol induced model. In PL rats, SRR showed significant ($P<0.001$) decrease in gastric juice volume (65.44%), free acidity (33.06%), total acidity (26.98%) pepsin (44.39%) and protein (23.82%) with subsequent increase in carbohydrate (22.67%) and mucin (41.46%) in gastric juice. Further, the pH of the gastric juice increased from 1.23 to 4.54. This study clearly suggested that *S. robusta* resin possess significant gastroprotective activity, supporting the folk use of resin preparations and contributing for its pharmacological validation [38].

### *4.8. Antimicrobial activity*

The aqueous, methanol, petroleum and benzene extract of oleoresin of *Shorea robusta* were tested. Different extracts inhibited the growth of used microorganisms. Aqueous extracts of *Shorea robusta* exhibits significant activity against *Bacillus coagulans, Escherichia coli, Bacillus cereus* and moderate inhibition on *Salmonella typhi* and

 

*Bacillus subtilis* and less activity against *Proteus vulgaris* and *Pseudomonas fluorescence*. However, ethanolic extracts also exhibited significant activity against *Staphylococcus aureus, S. epidermidis* and *Escherichia coli*, moderate inhibition on *Candida albicans* and *Bacillus coagulans.* The results revealed methanol extract showed more significant activity. The petroleum ether and benzene extracts showed less inhibitory activity when compared with the above two extracts. The Petroleum ether showed activity against *Escherichia coli*, *Aspergillus flavus* and *Candida albicans* and whereas benzene extracts worked against *Bacillus licheniformis, Bacillus cereus* and *Aspergillus flavus.* It may be concluded that *Shorea robusta* resin have a stronger and broader spectrum of antimicrobial activity against a number of pathogenic microorganisms [18].

### *4.9. Immunomodulatory activity*

The ethanolic extract of *Shorea robusta* bark was administered p.o. (orally) to mice at a dose of 100mg and 300mg/kg body weight per day for 14 days. In this study, *Shorea robusta* bark extract administrated rat models at 300mg/kg per day, i.p showed significant effect in stimulating immunomodulatory response, thus *Shorea robusta* bark is an effective natural health product for modulating immune system [39].

### *4.10. Kairomonal activity*

The attractant (kairomonal) property of some compounds isolated from bark of sal (*Shorea robusta*) against its dreaded pest sal borer, *Hoplocerambyx spinicornis*, in laboratory. Extract of the bark and its various isolates were prepared by standard procedure and subjected to bioassay. Behaviour exhibited by the beetles, viz., orientations, walking movement, antennal activity, visits to the test compound treated surface, biting and feeding attempts to the particular compound and number of beetles attracted has been recorded. They showed positive behaviour with regard to the parameters discussed above against the bark extract as well as other isolated compounds. The chemical analysis of the compounds exhibiting the kairomonal property has also been performed [40].

### *4.11. Free radical scavenging and antioxidant activities*

Antioxidants are one of the key players in tumorigenesis, several natural and synthetic antioxidants were shown to have anticancer effects. The aim of the present study is to divulge the preventive nature of *Shorea robusta* bark extract (SRBE) during diethylnitrosamine (DEN)-induced liver cancer in male Wistar albino rats. Administration of DEN to rats resulted in increased serum marker enzymes aspartate transaminase (AST), alanine transaminase (ALT), lactate dehydrogenase (LDH), and gamma glutamyl transpeptidase (GGT). The levels of lipid peroxides elevated with subsequent decrease in the tissue antioxidants like superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH), glutathione peroxidase (GPx), and glutathione reductase (GR). SRBE supplementation (500mg/kg body weight) significantly attenuated these alterations, thereby showing potent anticancer effect in liver cancer. These findings suggest that SRBE prevents lipid peroxidation, hepatic cell damage, and protects the antioxidant system in DEN-induced hepatocellular carcinogenesis [41].

### *4.12. Woundhealing activity*

The ethanolic extract of *S. robusta* (10 and 30 % w/w ) applied locally in excised and incised wounds) produced a dose-dependent acceleration in wound contraction and increased hydroxypyroline content and tensile strength of wound in rats. The result demonstrate wound healing activity of ethanolic extract of *S. robusta* resin [22].

## TOXICITY

There is no any information reported about toxicity on *Shorea robusta* Gaertn f. plant according to literature survey in data and Google, PUBMED, IPSC-INTOX, Scopus, etc[42].

## CONCLUSION

The available scientific research on *S. robusta* has shown that it is an important medicinal plant used in a wide range of medical treatments. The plant has been in use for a long period of time without any documented serious adverse effects. The detailed information presented in this review provides evidence for its phytochemical, pharmacological & traditional uses. The outcomes of such future studies will provide promising sources of phytochemicals that will have huge potential for the pharmaceutical industry.

### Conflict of interest statement

We declare that we have no conflict of interest.

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