

# *Shalmali (Bombax ceiba): Versatility in its therapeutics*

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## Abstract

The medicinal plants are widely used by the traditional medical practitioners for curing various diseases in their day-to-day practice. *Shalmali* is a well-known plant used in the traditional system for treatment of many diseases. The therapeutic activity of *Shalmali* is partly due to the presence of flavonoids, phenolics, sesquiterpenoids, shamimicin, bombamalosides, bombamalones, bombasin, bombasin 4-o-glucoside, and bombalin. In the present review, efforts have been made to recapitulate different aspects of scientific studies on the *Shalmali* such as ethnopharmacology, phytochemistry, and mainly the pharmacological activities. *In vitro* and *in vivo* studies, for various pharmacological activities of the *Shalmali*, for example, antioxidant, antimicrobial, anticarcinogenic, anti-inflammatory, immunomodulatory, hypotensive, hypolipidemic, antihyperglycemic, and analgesic have been demonstrated.

**Key words:** Antimicrobial, antioxidant, *Bombax ceiba*, *Salmaal malabarica*, Semal, *Shalmali*

## INTRODUCTION

*Bombaxmal baricum* DC syn., *Salmaal malabarica* Schott. and Endl., and *Bombax ceiba* Linn. belong to the family *Bombacaceae*. It is known by different names such as red cotton tree, Indian kapok tree (English), *Shalmali* (Sanskrit), semal (Hindi), shimul (Bengali), mullilavu (Malayalam), and kondabrug (Telugu) in different languages.<sup>[1]</sup> It is a deciduous tree attaining a height up to 40 meters and a girth up to 6 meter or more. In India, it is distributed throughout the hotter parts of the country up to 1500 meter or more.<sup>[2]</sup> Its young stem and branches are covered with stout and hard prickles, its leaves are large, spreading, glabrous, and digitate, leaflets are 5-7, lanceolate, and 10-20 cm long, and its flowers are numerous, large, fleshy, bright crimson, yellow, or orange containing many seeds with long, dense, silky hairs.<sup>[3]</sup> It has number of traditional uses, and its medicinal usage has been reported in the Indian traditional systems of medicine. According to Ayurveda, it has stimulant, astringent, hemostatic, aphrodisiac, diuretic, antidiarrheal, cardiotonic, emetic, demulcent, antidiysenteric, and antipyretic properties.<sup>[4,5]</sup>

The root of *Shalmali* is sweet, cooling, stimulant, restorative, astringent, aphrodisiac,

demulcent, emetic, and tonic. It is used in the treatment of diarrhea, dysentery, menorrhagia, and for wounds. The gum is cooling, astringent, stimulant, aphrodisiac, tonic, and demulcent in nature. It is useful in dysentery, hemoptysis and pulmonary tuberculosis, influenza, burning sensation, menorrhagia, and enteritis. Bark is mucilaginous, demulcent, emetic, and tonic. Flowers are astringent and good for skin troubles and hemorrhoids. Seeds are useful in treating gonorrhea and chronic cystitis. A paste made out of prickles is good for restoring skin color, especially applied on the face. Young fruits are useful in calculus affections, chronic inflammations, and ulceration of the bladder and kidney.<sup>[6]</sup>

## MATERIALS AND METHODS

The following are the process and eligibility criteria for the inclusion of data pertaining to this review: Information extracted from various Ayurvedic treatises, text books of

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Ayurvedic and modern pharmaceuticals, pharmacopoeias (Ayurvedic formulary of India, Ayurvedic pharmacopoeia of India), and available dissertations/thesis were also investigated. A search was undertaken in Google scholar, MEDSCAPE, Science Direct, Medline (www.pubmed.com)/pubmed database, SCOPED, and other relevant databases, using keywords like *Bombax malabaricum*, *S. malabarica*, *Bombex ceiba*, *Shalmali*, Semal, etc.

### Traditional Uses

Ayurveda, the traditional Indian medicine, describes the excellence of plants by combining both the pharmacognosy (properties) and pharmacology (action). These traditional parameters reflect not only the quality but also efficacy of the plants. Some of its medicinal uses and formulations as mentioned in Ayurveda are being described here.

#### Charak samhita

Semal has been described among top ten drugs used as styptic, bowel regulator, and tissue regenerator in Ayurveda. Pedicel/petiole of the plant or gum is used as enema in ulcerative colitis and dysentery.<sup>[7,8]</sup>

#### Sushruta samhita

Stem bark is said to be useful in hemorrhagic disorders, wound healing, removing pimples/acne, and have a cooling effect in burning sensations. It is also used in hyperpigmentation, wounds, burns, and stomatitis as a topical therapeutic agent.<sup>[9]</sup>

#### Ashtang hridaya

*Mocharasa* of the plant is widely used in various Ayurvedic formulations for tissue regeneration, wound healing, and antidysenteric effects.<sup>[10]</sup>

#### Bhava prakash

Powder of root (*Semal-musli*) with sugar is considered to be a good aphrodisiac. Root is also considered to possess antiaging, anabolic, and nutritive properties. Paste of leaves is applied in arthritis and on glandular swellings. Flowers of *B. ceiba* with seeds of *Papaver somniferum*, sugar, and milk is prescribed to cure piles. Gum (*Mocharasa*) of the plant is cold in potency, absorbent, demulcent, aphrodisiac, and astringent in taste and cures dysentery, diarrhea, retained undigested food, burning sensation, various menstrual diseases, and diseases of *Kapha*, *Pitta*, and *Rakta*.<sup>[11]</sup>

#### Dravyaguna vijnana

A traditional formulation “*Shalmali ghrita*” prepared with flowers of *B. ceiba* is used as *Pramehagna* and to cure polyurea, spermatorrhea, leucorrhea, and menorrhagia.<sup>[12]</sup>

### Indian Material Medica

In painful micturition, a preparation called *Trinetra rasa* is given with a decoction in milk made of juice of *Cynodon dactylon*, liquorice root, gum of *Bombex Malabaricum*, and *Tribulus terrestris*.<sup>[13]</sup>

### Dose of Different Parts

Ayurveda describes the therapeutic doses of its various parts as follows: 5-10 g (Stem-bark, Root); 1-3 g (Fruit); 10-20 g (Flower); and 1-2 g of Gum.<sup>[14]</sup>

### Panchrasa of shalmali<sup>[11]</sup>

In *Bhava prakash*, there is mention about the *Panchrasa* of *Shalmali* [Table 1].

### Phytochemical Studies

Many chemical compounds have been isolated from different parts of *B. ceiba*. These belong mostly to phenolics, flavonoids, sesquiterpenoids, steroids, naphthoquinones, and neolignans. A total of 16 compounds have been isolated from root, 8 from root bark, 3 from stem bark, 3 from heart wood, 2 from leaves, 78 from flowers, 19 from seeds, and 11 from gum. Many compounds have been isolated from its various parts, out of which the novel ones are shamimicin, bombamalosides, bombamalones, bombasin, bombasin 4-o-glucoside, and bombalin which have been isolated first time from any plant species.<sup>[15]</sup> In a preliminary phytochemical study, roots have shown the presence of flavonoids, tannins, saponins, steroids, cardiac-glycosides, and phenols besides carbohydrates and amino acids.<sup>[16]</sup> The stem-bark contains Shamimicin, a flavanoid which was screened for its

Table 1: *Panchrasa* of *Shalmali*

Parameters	Values	Modern terminology
<i>Rasa</i> (taste)	<i>Madhur</i> <i>Kashayam</i>	Sweet Astringent
<i>Guna</i> (properties)	<i>Laghu</i> <i>Snigdha</i> <i>Picchila</i>	Light Unctuous Sticky
<i>Virya</i> (potency)	<i>Sheeta</i>	Cooling
<i>Vipaka</i> (post digestive effect)	<i>Madhura</i>	Sweet
<i>Karma</i> (action)	<i>Shothahara</i> <i>Kaphavardhak</i> <i>Vedanasthapana</i> <i>Dahaprashamana</i> <i>Grahi</i> <i>Vrishya</i> <i>Rasayani</i> <i>Kashahar</i> <i>Raktarodhak</i>	Anti-inflammatory Expectorant Analgesic Refrigerant Astringent Virility promoter Lymphatics Thirst controller Hemostatic

hypotensive activity in animal model.<sup>[17]</sup> Methanolic extract of leaves has demonstrated presence of steroids, carbohydrates, tannins, triterpenoids, deoxy-sugar, flavonoids, and coumarin glycosides.<sup>[18]</sup> Flowers have been shown to contain the  $\beta$ -D-glucoside of  $\beta$ -sitosterol, free  $\beta$ -sitosterol, hentriacontane, hentriacontanol, traces of an essential oil, kaempferol, and quercetin.<sup>[19]</sup> Gum of *B. ceiba* contains a mixture of various sugars and gallic and tannic acids.<sup>[20,21]</sup>

### Scientific Validation of Traditional Uses

We have tried to collect references of all recent researches which are validating claims of classical trends of therapeutics of *Shalmali*.

### Antimicrobial and Antibacterial Activity

Plant extracts (acetone, methanol, and aqueous) were assayed for their activity against multidrug-resistant *Salmonella typhi*.<sup>[22]</sup> Methanolic and aqueous extract of stem-bark has also shown strong antibacterial activity against multidrug-resistant *S. typhi* strains. Mangiferin isolated from ethanolic extract has antibacterial potential and also inhibited growth of *Candida albicans*.<sup>[23]</sup>

### Antioxidant Activity

Methanolic extract of whole plant material of *B. ceiba* showed 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity with an  $IC_{50}$  of 68  $\mu$ g/ml.<sup>[24]</sup> Total phenolic content of the gum was found to be 5.89 gallic acid equivalent (GAE)/100 g dry weight (DW). Gum has shown 55.38  $\mu$ mol TEAC/100 g DW in 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) assay and 80.12  $\mu$ mol TEAC/100 g DW in DPPH assay, whereas ferric reducing ability of plasma assay has shown value of 9.06  $\mu$ mol TEAC/100 g DW.<sup>[25]</sup> Flowers of *B. malabaricum* have excellent natural antioxidant activities compared with ascorbic/gallic acid.<sup>[26]</sup> Methanolic extract of fresh leaves of *B. ceiba* and tested it with its acetyl group, cinnamoyl group, and methyl derivatives, it was found that methyl derivative of mangiferin was devoid of DPPH radical scavenging activity even at concentration of 200  $\mu$ g/ml suggesting that the presence of methoxy group abolishes the antioxidant activity.<sup>[27]</sup> In another study, methanolic extract of roots of *B. malabaricum* was evaluated using DPPH radical scavenging assay and reducing power assay.<sup>[16]</sup>

### Cancer Cell Growth Inhibition

Flowers of *B. ceiba* showed antioxidant effects and antiproliferative activity against seven human cancer cell lines (Michigan Cancer Foundation-7 [MCF-7]), HeLa Henrietta Lacks), COR-L23, C32, A375, ACHN, and LNCaP cells).<sup>[28]</sup>

### Antiangiogenic Activity

*B. malabaricum* stem bark's methanolic extract was found to exhibit a significant antiangiogenic activity on tube formation of human umbilical venous endothelial cells (HUVEC). Lupeol is a component of fractionated product of the extract showed a marked inhibitory activity on HUVEC tube formation while it did not affect the growth of tumor cell lines such as SK-MEL-2, A549, and B16-F10 melanoma.<sup>[29]</sup>

### Hepatoprotective Activity

In one of the studies, it was proved that the methanolic extract of flowers of *B. ceiba* causes significant decrease in alkaline phosphates, alanine transaminases, aspartate transaminases, and total bilirubin levels but increases in the level of total protein in comparison to control.<sup>[30]</sup>

### Antihyperglycemic and Antihyperlipidemic Activity

N-hexane fraction from hydromethanolic extract of *S. malabarica* significantly decreases in the levels of serum total cholesterol, triglyceride, phospholipids, free fatty acid, low-density lipoprotein-cholesterol (LDL-C) and very LDL-C (VLDL-C) and increases in high-density lipoprotein-cholesterol.<sup>[31]</sup>

### Inhibitory Effects on Fatty Acid Synthesis (FAS)

FAS had been found to be over express and hyperactive in most cancers. Pharmacological inhibitors of FAS activity preferentially repress cancer cell proliferation and induce cancer cell apoptosis without affecting non-malignant fibroblasts. These made FAS an excellent drug target for cancer therapy. The cancer cell A549 was used as a cell model to test the inhibitory effort of flavonoid extracts of *S. malabarica* on FAS.<sup>[32,33]</sup>

### Protective Effect in Inflammatory Bowel Disease

The *Mocha rasa* of *Shalmali* is known to contain large amounts of tannic and gallic acids acting as astringents which precipitate proteins which helpful in restoring the damaged epithelial mucosal lining of the ulcerated mucosa.<sup>[34,35]</sup>

### Aphrodisiac

Young roots of *B. ceiba* also known as Semal-musli are used traditionally in Indian subcontinent as aphrodisiac. Its juice is considered nutritive, restorative, and sexual stimulant. The lyophilized aqueous extract of roots on sexual behavior, spermatogenesis, and anabolic effects in male albino rats in presence of female rats. A gain in body weight was achieved and significant improvement in mount, intromission, and ejaculation frequencies. Seminal fructose content and epididymal sperm counts were also significantly improved.<sup>[36]</sup>

## Anti-obesity

The extract of stem bark of *B. ceiba* has significant anti-obesity potential against high-fat diet-induced experimental obesity, possibly due to modulation of FAS and PTP-1B signaling in Wistar rats due to the presence of active flavanoids and lupeol, respectively.<sup>[37]</sup>

## Analgesic Effect

Methanolic extract of *B. ceiba* leaves, its fractions, and mangiferin induced a significant and dose-dependent analgesic effect in acetic acid writhing and hot plate test.<sup>[38]</sup>

## Anti-acne Effect

Thorn of *Salamalia malabarica* Schott. and Endl has been employed to treat acne of the face. The alcoholic extract of bark and thorns posses very good anti-acne potential against *Propionibacterium acne* with minimum inhibitory concentration (MIC) of 250 µg/ml while MIC value of leaf was 500 µg/ml which was better as compared to MIC of standard clindamycin. All three extracts have been reduced *P. acne*-induced granulomatous inflammation on rats.<sup>[39]</sup> The thorns of *S. malabarica* are an important ingredient of Himalaya, “Acne-N-Pimple Cream” is a polyherbal formulation recommended for the management of *acne vulgaris*. The study on cream observed significant reduction in the number of blackheads and whiteheads, in number of inflamed pustules and overall inflammation. “Acne-N-Pimple Cream” is clinically effective and safe in the management of *acne vulgaris*.<sup>[40]</sup>

## Cardioprotective Effect

Root powder of this plant i.e., *B. ceiba* significantly modifies the coronary risk factors such as atherogenic lipids, fibrinogen, and oxidative stress in patients with ischemic heart disease. Moreover it has been reported with its antioxidant activity due to high amounts of phenolics and tannins.<sup>[41,42]</sup>

## DISCUSSION

*B. ceiba*, the Indian red kapok tree, is an important multipurpose tree species and has been proved to be a nature's boon for human welfare. Every part of this plant is use for many purposes in classics. On *B. ceiba*, many research works were carried out that resulted in exploration of many novel chemical compounds as well as validation of its traditional uses in many diseases. Phytochemically, it is enriched with flavonoids, phenolics, and sesquiterpenoids, but some novel compounds have been isolated from it such as bombamaloside, bombamalones, bombasin, bombalin, and shamimicin These phytochemical is responsible for pharmacological action such

as hypolipidemic, hypoglycemic, antioxidant, anabolic and fibrinolysis enhancing activities, and many others. Different parts of *B. ceiba* have shown to possess many biological properties predominantly antioxidant, antimicrobial, anti-inflammatory, analgesic, anabolic, hepatoprotective, hypotensive, and hypoglycemic activities. The antidiabetic efficacy of the plant extract may be explained in two ways. One is the indirect pathway through which the phytomolecule may stimulate the existing  $\beta$  cell or regenerate the  $\beta$  cell for the recovery in serum insulin along with protection of oxidative injury. Another is the direct way where the phytoingredients present that there may inhibit enzymes such as  $\alpha$  glycosidase that may interfere with the glucose production in the gastro intestinal tract from complex carbohydrates.<sup>[43]</sup> However, there is some need of future development and there is need of further validation in large-scale, placebo-controlled, double-blind, multi-centered, cross-over studies with a large number of patients for long duration should be carried out to establish its biological activities. There is also need of standardization, quality control, and their implementation for preserving. Extracts prepared from its various parts should be standardized with the help of modern techniques for quality assurance and control. The plant is used for so many purposes which may threaten future sustainability of the plant. Therefore, there is urgent need to develop conservation techniques and the implementation for preserving this important plant species.

## CONCLUSION

On the basis of all available classical and contemporary references, we may conclude that all medicinal values of *Shalmali* are true in nature. The pharmacological studies had validated potency of this plant against diseases. The presence of potent active chemical constituents indicates that *Shalmali* could serve as “lead compound” for development of novel medicines.

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