



Bombax Ceiba Linn: An Ethnopharmacological Update

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Abstract

Bombax ceiba linn comes from genus *bombax* also known as cotton tree or red silk cotton tree. More specifically it is also known as silk Malabar tree. It is a flowering tree with a height of up to 40 meters and found in tropical and subtropical Asia as well as northern Asia Australia. It has been chosen as the "city flower" of the cities of Kaohsiung and Guangzhou for its large, showy flowers with thick, waxy, red petals that densely clothe leafless branch tips in late winter and early spring. *B. ceiba* is a source of food, fodder, fiber, fuel, medicine, and many other valuable goods for natives of many Asian countries. For example, its fruits are good sources of silk-cotton for making mattresses, cushions, and pillows. *Bombax ceiba* is a famous plant used extensively in traditional medicine for various diseases. They are used in the treatment of cholera, tubercular fistula, coughs, urinary complaints, nocturnal pollution, abdominal pain due to dysentery, and impotency. The gum is astringent, demulcent and tonic. It is used in the treatment of dysentery, haemoptysis in pulmonary tuberculosis, influenza and menorrhagia. The leaves are hypotensive and hypoglycaemic. They are combined with *Vitis* spp. (part not specified) to treat carbuncle; and with *Terminalia alata* to treat haematuria. The knots or the stem are used on bleeding gums (cooked in mustard oil with the bark of *Zyzyphus rugosa* and *Ichnocarpus frutescens* and then eaten. The bark is reputedly used against cholera (usually combined with many other plants), pleurisy, and stings and as a diuretic. It is used in bandages for lasting fractures or given in infusion for toothache before visiting the dentist. It is reported to contain important phytoconstituents such as naphthol, naphthoquinones, polysaccharides, anthocyanins, shamimin and lupeol.

Keywords: *Bombax ceiba* linn; Hypoglycaemic; Antipyretic activity; Haematuria; Phytoconstituent; Pulmonary tuberculosis; Influenza and menorrhagia

Introduction

The different medicinal plant, such as arid zone plants, herbal plants and some shrubs have the potential role in the prevention and treatment of human diseases. The arid zone plants are also known as wild plants as they do not need special care and maintenance. Such plants have some medicinal property thus used in prevention and treatment of various health ailments. They contain a variety of different nutrients and therapeutic constituents: vitamins, minerals, trace elements as well as active ingredients with a variety of medicinal actions. This tree is rich in various phytochemicals. Extracts have confirmed the presence of alkaloids, flavonoids, glycosides, coumarins, proteins and amino acids. *Bombax ceiba* has numerous documented effects, some of which are anti-inflammatory, aphrodisiac, antimicrobial, hepatoprotective, anti-diabetic, anti-aging and hypotensive. Evaluation at the CNS level, however, is limited [1]. Free radicals have been implicated in the etiology of several degenerative disorders including cancer, diabetes, rheumatoid arthritis, atherosclerosis, liver cirrhosis, Alzheimer's disease and other neurodegenerative disorders. Antioxidants, the compounds that can scavenge free radicals play a significant role as they prevent damage of cell proteins, lipids, carbohydrates, nucleic acids as well as biomembranes caused by reactive oxygen species [2] It was found that the young roots of *B. ceiba* have hypoglycemic, hypolipidemic, and hepatoprotective activities and confirm the traditional uses of this plant to manage diabetes and its associated liver toxicity. In addition, the male rat treated with young root extracts of this plant has improved sexual performances and behaviors [3]. The methanolic flower extract of *B. ceiba* has the protective effects against cytotoxicity in the cell line [4]. Some parts of this plant are edible that is famous in the Northern part Thailand. People use flowers (Figure 1) to cook as curry soup, called "Nam Ngiao" served with rice noodles [5]. The interest in free radicals and their role in the tumor micro environment have recently increased. Cancer and several inflammatory processes that lead to cancer and

autoimmune diseases have been related to the direct and/or indirect effects of oxidative stress induced by free radicals. In normal conditions, reactive oxygen species (ROS) have an important role in normal cells in signal transduction and gene transcription. Nevertheless, ROS may act as a trigger for carcinogenesis. There are several anticancer drug candidates with antioxidant capacity [6]. Reports have shown the presence of glycosides and tannins in roots, stem and leaf. In the stem some alkaloids and in roots, proteins are identified. The stem bark and root contains mangiferin, lupeol and β -sitosterol. The root bark

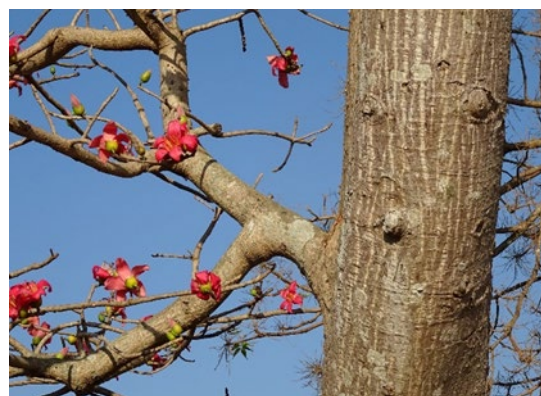


Figure 1: Flower of *Bombax Ceiba*.

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has 3 naphthalene derivatives related to gossypol (toxic principle of cotton seed) and called as 'semigossypol'. Flowers contain β -sitosterol, traces of essential oil, kaempferol and quercetin. On hydrolysis gums yields arabinose, galactose, galacturonic acid and rhamnose [7]. This tropical tree has a straight tall trunk and its leaves are deciduous in winter. Red flowers with five petals appear in the spring before the new foliage. It produces a capsule which, when ripe, contains white fibers like cotton. Its trunk bears spikes to deter attacks by animals [8]. Considering its medicinal importance to the traditional healers the plant was chosen for the investigation of bioactivities. The roots of *B. ceiba* were subjected to different bioassays to determine its biological activities with the aim of establishing the pharmacological basis for its folkloric use against different diseases. Despite the traditional use of this plant in the treatment of jaundice and splenic enlargement, very few scientific studies have been carried out to delineate its influence on experimentally induced hepatotoxicity. A recent study has reported hepatoprotective effect of the *Bombax ceiba* flowers (Figure 2) in anti-tubercular drugs-induced toxicity [9]. There is no side effect reported since the medical uses are started.

Taxonomical Classification

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Malvales

Family: Bombacaceae

Genus: Bombax

Species: Ceiba

Binomial name: *Bombaxceiba* L.; *Bombaxmalabaricum* D.C; *Salmalia*; *Malabarica* (D.C) [10]

Morphology of *Bombax Ceiba*

Bark: Grey brown or silver grey colored with hard sharp conicles prickles.

Leaves: Leaves are large, spreading, glabrous, leaflets lanceolate, 3-7 and margin entire.

Flowers: Flowers are red numerous, appearing when the tree is bare of leaves, stamens many arranged in five bundles of 9-12 each and an inner bundle of 15.

Fruits: The fruits are brown capsule-like upto 15 mm long, filled with numerous black seeds.

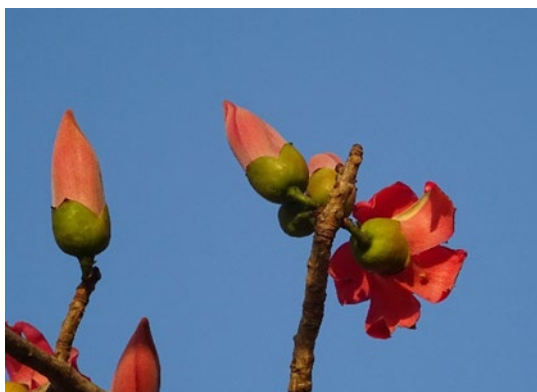


Figure 2: Mature *Bombax Ceiba*.

Seeds: Seeds are smooth, black or grey embedded in long white wool, which are irregular obovoid in shape, smooth and oily with dense silky hair.

Gum: Light brown to opaque or dark brown called as semul gum [11].

Species of *Bombax Ceiba*

- *Bombaxalbidum* Gagnep.
- *Bombax anceps* Pierre (syn. *B. kerrii* & *B. valetonii*).
- *Bombaxblancoanum* A.Robyns.
- *Bombaxbuonopozense* P. Beauv.
- *Bombaxcambodiense* Pierre.
- *Bombaxceiba* L. (syn. *B. thorelii* Gagnep).
- *Bombaxcostatum* Pellegr. & Vuill.
- *Bombax insigne* Wall. (syn. *B. scopulorum*) [12]

Description of Plant

Bombax ceiba grows to an average of 20 meters, with old trees up to 60 meters in wet tropical regions. The trunk and limb bear numerous conical spines particularly when young, but get eroded when older. The leaves are palmate with about 6 leaflets radiating from a central point (tip of petiole), an average of 7–10 centimetres (2+5/6–4 in) wide, and 13–15 centimetres (5+1/6–5+5/6 in) in length. The leaf's long flexible petiole is up to 20 centimetres (8 in) long. Huge Red Cotton Tree at Kodungallur, India Cup-shaped flowers solitary or clustered, axillary or sub-terminal, fascicles at or near the ends of the branches, when the tree is bare of leaves, an average of 7–11 centimetres (2+5/6–4+1/3 in) wide, 14 centimeters (5+1/2 in) in width, petals up to 12 centimetres (4+2/3 in) in length, calyx is cup-shaped usually 3 lobed, an average of 3–5 centimeters (1+1/6–2 in) in diameter. Staminal tube is short, more than 60 in 5 bundles. Stigma is light red, up to 9 centimeters (3+1/2 in) in length; ovary is pink, 1.5–2 centimeters (2/3–5/6 in) in length, with the skin of the ovary covered in white silky hair at 1mm long. Seeds are numerous, long, ovoid, black or gray in colour and packed in white cotton [12-20].

Other Names

Kapok Tree, *Bombax ceiba*. Other common names include red silk cotton tree and silk cotton tree. Boichu, Bombax, Booruga, Boorunga, Bouro, Bula, Buroh, Edelsong, Illavam, Kaanti-senbal, Kantakadruma, Kantesavar, Katesawar, Kempu-booruga, Leptan, Malabulak, Mu mian, Mullilavu, Mulletlava, Mullila-pula, Mullilavau, Mullilavu, Mullubooruga, Neibie, Nglo, Nuoliu, Pagun, Pan-ya, Panchu, Phakong, Pula-maram, Pulai, Rakta-pushpa, Red Silk Cotton tree, Roktosimul, Salmali, Samar, Sanar, Saur, Savar, Savri, Sawar, SŽmul, Senur, Shembal, Shemolo, Shevari, Shevri, Shimla, Shimul cotton, Simal, Simalo, Simalu, Simla, Simlo, Simolu, Singi.

Traditional Uses of *Bombax Ceiba*

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.

Medicinal Uses of *Bombax Ceiba*

The flowers are astringent and refrigerant. They are used to treat

cutaneous troubles. The young roots are diuretic and tonic. They are used in the treatment of cholera, tubercular fistula, coughs, urinary complaints, nocturnal pollution, abdominal pain due to dysentery, and impotency. The gum is astringent, demulcent and tonic. It is used in the treatment of dysentery, haemoptysis in pulmonary tuberculosis, influenza and menorrhagia. The leaves are hypotensive and hypoglycaemic. A decoction of the shoots has reputedly been used to treat ulcers of the palate, syphilis, leprosy and spider or snake bites. Combined with the roots of *Moghania macrophylla*, the fruit of *Terminalia chebula* and borax, they are used to treat enlarged spleen; they are combined with *Capparis zeylanica* and *Carissa carandas* to treat oedema; and with fenugreek to treat corns on the foot. The seedlings have reputed antipyretic activity (when ground with a few leaves of fistula and *Semecarpus anacardium*). They are combined with *Vitis* spp. (part not specified) to treat carbuncle; and with *Terminalia alata* to treat haematuria. The knots or the stem are used on bleeding gums (cooked in mustard oil with the bark of *Zyzyphus rugosa* and *Ichnocarpus frutescens* and then eaten. The bark is reputedly used against cholera (usually combined with many other plants), pleurisy, stings and as a diuretic. It is used in bandages for lasting fractures or given in infusion for toothache before visiting the dentist [13].

Cultivation Details

Bombax Ceiba is a plant found in tropical, humid low lands. It grows best in areas where annual daytime temperatures are within the range 28 - 42°C, though it can tolerate 5 - 49°C. It can resist occasional light frosts, with new growth being killed at -1°C, but dormant growth being tolerant down to -3°C. It prefers a mean annual rainfall of 750 - 4,000 mm, tolerating 500 - 5,000mm and preferring a distinct dry season. Grows best in a sunny position. Prefers a deep, rich, well-drained soil, but tolerating a wide range of conditions. Established plants are drought tolerant (Barwick. M et al), and can also withstand occasional inundation of the soil. Prefers a pH in the range 5.5 - 6.5, tolerating 4.9 - 7.2. It is a fast-growing plant, especially when young. The plant can commence flowering when around 8 - 10 years old from seed [13].

Propagation

Seed - sown fresh, without pre-treatment, they have a high germination rate. Some reports suggest germination rates can be improved by pre-soaking the seeds for 12 hours prior to sowing, this is likely to refer to seeds that have dried somewhat. Seeds can be sown in a sunny position, either in situ or in nursery beds. Sprouting takes place in 10 - 25 days. Transplant 5cm tall seedlings to individual containers and plant out 12 months later (Table 1-4) [13-17]

Phyto-Chemical Analysis of *Bombax Ceiba*

The preliminary phytochemical investigation on *Bombax ceiba* extracts revealed that the presence of various secondary metabolites such as carbohydrates, flavones and flavanones, tannins and phenolic compounds, saponins, sterols, and tri-terpenoids in all the extracts (Table 1).

Phytoconstituent

The most common phytochemicals in food include polyphenols, carotenoids, flavonoids, coumarins, indoles, isoflavones, lignans, organosulfures, catechins, phenolic acids, stilbenoids, isothiocyanates, saponins, procyanidins, phenylpropanoids, anthraquinones, ginsenosides, and so on [18].

Table 1: Phyto-Chemical Analysis of *Boombax Ceiba* Leaves [14].

Name of the chemical Tests	Chloroform	Ethyl Acetate	Ethanol	Aqueous
Alkaloids	-	-	-	-
Glycosides	-	-	+	+
Fat/Fixed oil	-	-	-	-
Flavonoids	-	-	+	+
Saponins	-	-	-	+
Tannins	-	-	+	+
Carbohydrate	-	-	+	+
Protein	-	-	+	-

Table 2: Phytoconstituent of *Bombax Ceiba* Stem Bark [15].

Name of the chemical Tests	Petroleum ether extract	Chloroform extract	Methanol extract	Distill water extract
Alkaloids	-	-	+	+
Glycosides	+	+	+	+
Steroid	+	+	-	-
Flavonoids	+	-	+	+
Saponins	+	-	+	+
Tannins	-	-	+	+
Terpenoids	-	+	-	+
Pytosterols	-	+	+	+

Phytoconstituent present in leaves

The various tests for Glycoside, Phenol, Flavanoid, Saponin, Crbohydrate and protein are found positive [19]. Leaves of *Bombax Ceiba* linn contain a flavonol C glycoside shamimin [20-23]. From the dried leaves of *B. malabaricum* in the same year, mangiferin, a xanthone was separated by repeated column chromatography of the n- BuOH fraction [24]. Eleven compounds were isolated and identified as taraxeryl acetate, squalene, taraxerone, beta-sitosterol palmitate, taraxerol, 4-methyl stigmast-7-en-3-ol, 1H-indole-3-carboxylic acid, 6-O-palmitoylsitosteryl-D-glucoside, 12beta-hydroxyl-pregnane-4, 16-diene-3, 20-dione, lolilide and 5-(hydroxymethyl) furfural [25-35 (Table 2).

Phytoconstituent present in stem bark

Shamimicin, (3, 4- dihydroxyphenyl)-3, 4-dihydro-3, 7-dihydroxy-5-O - xylopyranosyloxy- 2H-1- benzopyran along with lupeol were isolated [21]. Bark contains lupeol, saponins, tannins, gums and 4, 5, 7- trihydroxyflavone-3-O-β-D-glucopyranosyl (1- 4)-α rhamnopyranoside [22]. Isolation and characterization resulted in the identification of two compounds from the extracts of stem barks of *B. ceiba*. These were lup-20 (29) en-3b-ol, named BC-1 and 2-hexyl-7, 8-dimethyl-1, 4-naph-thaquinone, named ceiba naphthaquinone.

Phyto-constituent present in flower

Polysaccharide isolated from flowers-had a continuous backbone of 4(1-4)- βlinked D-galactopyranose and 2 (1-3)- β-linked Larabinopyranose units with β-linked D- galactose and α-linked L rhamnose and L-arabinose units as end groups [22]. *B. ceiba* Flowers have been shown to contain the β-D' glucoside of β-sitosterol, free β-sitosterol, hentriacontane, hentriacontanol, traces of an essential oil, kaempferol and quercetin [20].

Phytoconstituent present in seed

Nhexacosanol and palmitic acid isolated from seeds [22]. N-hexacosanol and palmitic acid was isolated from seeds. [29]. The seed oil contains phytosterol, palmitic acid, stearic acid, oleic acid and

Table 3: Phytoconstituent of *Bombax Ceiba* Flower [16].

Phytochemical	Pet. ether	Chloroform	Ethyl Acetate	Acetene	Ethanol	Methanol	Water
Alkaloids	+	+	+	+	+	+	+
Glycosides	-	-	-	-	+	+	-
Carbohydrates	+	+	+	+	+	+	+
Flavonoids	-	-	+	+	+	+	-
Phenols	-	-	+	+	+	+	-
Phlobatannins	-	-	-	+	-	+	-
Proteins	-	-	-	-	+	+	+
Saponins	+	+	+	+	+	+	+
Sterols	-	-	-	-	-	+	-
Tannins	+	+	+	+	+	+	+
Terpenoids	+	-	-	+	+	+	+
Quinones	-	-	-	+	+	+	+
Oxalates	-	-	-	-	-	-	-

Table 4: Phytoconstituent of *Bombax Ceiba* Seed [16].

Name of the chemical Tests	Petroleum ether extract	Chloroform extract	Methanol extract	Distill water extract
Alkaloids	+	-	+	+
Glycosides	+	-	+	+
Steroid	+	+	-	+
Flavonoids	+	-	+	+
Saponins	-	-	+	+
Tannins	+	-	-	+
Terpenoids	-	+	-	+
Pytosterols	-	-	+	-

linoleic acid and lipase like enzyme. [30] Seed oil was glyceridic mixture of myristic, palmitic, arachidic, behinic and linoleic acid along with carotenoids, α -tocopherol and various amino acids and sugars.[31] Seeds contain essential amino acids like threonine, valine, methionine, isoleucine, leucine, phenylalanine, lysine, histidine, arginine and tryptophan [26].

Phytoconstituent present in root bark

Lactone isolated from root bark [22]. Hemigossypol-6-methyl ether was isolated from the root bark (Table 5) of *B. malabaricum* along with isohemigossypol-1-methyl ether [23]. A sesquiterpene lactone isolated from the roots of a plant species identified as *Salmaliamalbaricum* (syn *Bombax ceiba*) was previously identified as hemigossylic acid lactone-7- methyl ether. 2D NMR experiments have shown that this was a new compound, isohemigossylic acid lactone-2-methyl ether [27-31].

Phytoconstituent of bombax ceiba gum

Hydrolysis of gum yields arabinose, galactose, galacturonic acid, rhamnose and partial hydrolysis yields 6- o-(β -D-galactopyranosyl-uronic acid)-D galacto pyranose; 2, 3, 4, 6-tetra-, 2, 6-di and 2, 4-di-o-methyl-D-galactose and 2, 3, 5- tri and 2, 5-di-o-methyl-L-arabinose. [32] *Bombax ceiba* gum can be substituted for gum tragacanth [32]. Indigenous substituted for imported drugs. Methylated *Bombax ceiba* gum on hydrolysis has been found to yield 2, 3, 4, 6-tetra-, 2, 6-di-, and 2, 4-di-o-methyl-D-galactose and 2, 3, 5-tri and 2, 5-di-o-methyl-L-arabinose [33] (Table 3).

Pharmacological Activity

Analgesic activity

Mangiferin, 2-beta-D-glucopyranosyl-1,3,6,7-tetrahydroxy-9H-xanthen- 9-one, obtained directly from methanolic extracts of *B.*

Table 5: Phytoconstituent of *Bombax Ceiba* Root Bark [17].

Name of the chemical Tests	Petroleum ether extract	Chloroform extract	Methanol extract	Water extract
Carbohydrates	-	-	+	+
Protein and amino acid	-	-	+	+
Fat and Oils	+	-	-	-
Steroids	+	+	-	-
Cardiac Glycoside	-	-	-	-
Anthraquinone	-	-	+	+
Saponin	-	-	+	+
Flavonoids	-	-	+	+
Alkaloids	-	-	+	+
Tannins and Phenolic compounds	-	-	+	+

ceiba leaves demonstrated strong antioxidant activity (EC₅₀) 5.8 (+/-) 0.96 μ g/ml) using DPPH assay. The acetyl and cinnamoyl derivatives were found to be less active than mangiferin whereas methyl and 3, 6, 7-trimethylether tetraacetate derivatives were inactive implying that for antioxidant activity, free hydroxyl groups and catechol moiety are essential. Moreover, mangiferin showed hepatoprotective activity against carbon tetrachloride induced liver injury further supporting the free radical scavenging property in the in vivo system. Additionally, crude plant extracts and purified mangiferin failed to exhibit acute anti-inflammatory activity whereas, extracts displayed significant analgesic effect in acetic acid- induced writhing and hot plate tests in mice. Using naloxone, it was revealed that plant extract induced analgesia was independent of the opioid receptor; whereas, mangiferin demonstrated significant interaction with the receptor at a peripheral site, with a slight contribution at the neuronal level [34].

Anti-Inflammatory activity

In-vitro anti-inflammatory activity of extracts of *Bombax ceiba* (Table 4) was assessed by human red blood corpuscles membrane stabilizing method with slight modifications [34]. In-vitro anti-inflammatory activity of extracts of *B. ceiba* was assessed by Human Red Blood Corpuscles (HRBC) membrane stabilizing method with slight modifications. The blood was collected from healthy human volunteer who had not taken any anti-inflammatory drugs for 2 weeks prior to the experiment and transferred to the heparinized centrifuge tubes and centrifuged at 3,000 rpm. The packed cells were washed with isosaline and a 10% suspension in normal saline was made. Diclofenac potassium (50 mcg/ml) was used as standard. The reaction mixture (4-5

ml) consisted 2 ml of hypotonic saline (0.25% w/v NaCl), 1 ml of 0.15 M phosphate buffer (pH 7.4), and 1 ml of test solution (1000 mcg/ml) in normal saline and 0.5 ml of 10% HRBC in normal saline. For control, 1 ml of isotonic saline was used instead of test solution. The mixtures were incubated at 56°C for 30 min. and cooled at running tap water, centrifuge at 3000 rpm for 20 min. The absorbance of supernatant was read at 560 nm using visible Spectrophotometer. The experiment was performed in triplicates. The control represents 100% lyses [35].

Hepatoprotective activity

Several Researchers reported that the methanol extract of flowers of *B. ceiba* (MEBC) investigated and it was found that MEBC significantly decreased the level of TBARS and elevated the level of GSH at all doses as compared to control. The biochemical parameters and histopathological studies results shown that the MEBC were not able to completely revert the hepatic injury induced by INH and RIF, but it could limit the effect of INH and RIF to the extent of necrosis [34]. The hepatoprotective activity of a methanolic extract of flowers of *B. ceiba* (MEBC) was investigated against hepatotoxicity produced by administering a combination of two anti-tubercular drugs isoniazid (INH) and rifampicin (RIF) for 10 and 21 days by intraperitoneal route in rats. MEBC were administered at three graded dose i.e. 150, 300 and 450 mg/kg i.p. 45 min prior to anti-tubercular challenge for 10 and 21 days. MEBC was evident in all doses as there was a significant decrease in alkaline phosphatase (ALP), alanine transaminases (ALT), aspartate transaminases (AST) and total bilirubin levels, but increase in the level of total protein in comparison to control. MEBC significantly decreased the level of TBARS (thiobarbituric acid reactive substances) and elevated the level of GSH (reduced glutathione) at all doses as compared to control. The results obtained from the analysis of biochemical parameters and histopathological studies, resulted in the conclusion that the MEBC were not able to completely revert the hepatic injury induced by INH and RIF, but it could limit the effect of INH and RIF to the extent of necrosis [36].

Antimicrobial or antibacterial activity

Plant extracts (methanol and aqueous) were assayed for their activity against multi-drug resistant *Salmonella typhi*. Strong antibacterial activity was shown by the methanol extracts of *Salmaliamalabarica* [36, 37]. Plant or plant parts were collected, dried, homogenized and extracted in two organic solvents viz. methanol and acetone. The antibacterial activity against *Klebsiella pneumoniae* was done by agar disc diffusion method. The activity was compared with standard antimicrobials Amikacin and Piperacillin [38].

Antioxidant

The antioxidant activity of a methanolic extract of *B. ceiba* was evaluated using several antioxidant assays, in terms of its: (i) ability to scavenge DPPH (1, 1-diphenyl-2-picrylhydrazyl) and hydroxyl free radicals; (ii) action against lipid peroxidation (in rat liver microsomes and soy bean phosphatidylcholine liposomes), induced by ascorbyl radicals and per-oxynitrite; and (iii) effect on myeloperoxidase activity. The cytotoxic-activity was monitored through the mitochondrial activity in the Vero cell line. The extract showed antioxidant activity in all assays. The EC50 for DPPH was 87 µg/ml; lipid peroxidation of microsomes and soy bean liposomes induced by ascorbyl radicals were 141 µg/ml and 105 µg/ml, respectively and by peroxynitrite were 115 µg/ml and 77 µg/ml, respectively. The K (0.5) value for myeloperoxidase activity inhibition by the extract was 264 µg/ml. The extract showed very low toxicity toward Vero cells [39]. The antioxidant activity of a root extract of *B. ceiba* was evaluated using several antioxidant assays,

in terms of its: ability to scavenge DPPH and reducing power assay. Methanolic extract of the roots has showed a high amount of phenolics (30.95% w/w) and tannins (15.45% w/w) and a very good DPPH radical scavenging activity in a dose dependent manner [53-60]. A study was undertaken to evaluate the in vitro antioxidant potential of bark of *Bombaxceiba* (Bombacaceae). Aqueous and ethanolic extracts of the bark were subjected to *in vitro* antioxidant activity screening models [40].

Cytotoxicity

Aqueous extracts of the plants were screened for their cytotoxicity using present study supports that brine shrimp bioassay is simple reliable and convenient method for assessment of bioactivity of medicinal plants and lends support for their use in traditional medicine. Aqueous extracts of the plants were screened for their cytotoxicity using the brine shrimp lethality test. The present study supports that brine shrimp bioassay is simple reliable and convenient method for assessment of bioactivity of medicinal plants and lends support for their use in traditional medicinesignificant improvement in mount, intromission and ejaculation frequencies. Seminal fructose content and epididymal sperm counts were also significantly improved [42]. Cytotoxicity of different concentrations of each extract was identified using the brine shrimp lethality bioassay [43]. Aqueous extracts of the plants were screened for their cytotoxicity using the brine shrimp lethality test. The present study supports that brine shrimp bioassay is simple reliable and convenient method for assessment of bioactivity of medicinal plants and lends support for their use in traditional medicine [44-47].

Hypotensive activity

Shamimin along with lupeol [lup-20 (29) en-3b-ol], which possesses potent hypotensive activity, have been isolated from *B. ceiba* stem bark. BCBMM [Filtrate from BCBM (Methanolic extract of defatted stem bark)] one of the most active fractions has revealed its adverse effects on heart, liver and kidneys of mice at the dose of 1000 mg/ kg/d [46].

Diuretic activity

The study reported on diuretic effects of aqueous and crude ethanol extracts of *Bombax ceiba* L. fruits using acute model in rats, indicated that the aqueous and ethanol extracts of *B. ceiba* fruit (200 mg/kg and 400 mg/kg, p.o.), was significantly increased the urine output in higher doses. These effects will demonstrate a possible diuretic action of *B. ceiba* fruit extracts and support its folklore use in various urinary ailments [46].

Antiangiogenic activity

Methanol extract of the stem barks of *B. ceiba* was reported to have a significant antiangiogenic activity on in vitro tube formation of human umbilical venous endothelial cells. The result indicated bioactivity guided fractionation and isolation was also carried out on this extract [45-61]. Hypotensive, hypoglycaemic activity. In this study it has been reported that shamimin, a Cflavonol glucoside isolated from *Bombax ceiba* leaves showed potency as a hypotensive agent at the doses of 15 mg/kg, 3 mg/kg, 1 mg/kg and significant hypoglycaemic activity at 500 mg/kg in SpragueDawley rats [48]. Analgesic activity of bombax ceiba obtained Mangiferin, 2-Beta-Dglucopyranosyl-1, 3, 6, 7tetrahydroxy- 9H-xanthen-9- one, directly from methanolic extracts of *B. ceiba* leaves demonstrated strong antioxidant activity using DPPH assay [34]. Additionally, crude plant extracts and purified mangiferin have failed to exhibit acute anti-inflammatory activity whereas, these extracts displayed significant analgesic effect in acetic acid- induced

writhing and hot plate tests in mice [35].

Antipyretic activity

A group of workers have reported that the methanol extract of *Bombax malabaricum* leaves (MEBM) was evaluated for the antipyretic activity in rats. The MEBM has possessed a significant antipyretic activity in Baker's yeast induced pyrexia [47-50].

Aphrodisiac activity

The aphrodisiac activity of *B. ceiba* root extract was investigated. The extract (400 mg/kg body wt/day) was administered orally by gavage for 28 days. Mount latency (ML), intromission latency (IL), ejaculation

latency (EL), mounting frequency (MF), intromission frequency (IF), ejaculation frequency (EF) and post-ejaculatory interval (PEI) were the parameters observed before and during the sexual behavior study at day 0, 7, 14, 21 and 28 days. The extract reduced significantly ML, IL, EL and PEI ($p < 0.05$). The extract also increased significantly MF, IF and EF ($p < 0.05$). These effects were observed in sexually active and inactive male mice [51].

Cancer cell growth inhibition

Flowers of *B. ceiba* showed antioxidant effects and anti-proliferative activity against seven human cancer cell lines (Michigan Cancer Foundation-7 [MCF-7], HeLa Henrietta Lacks), COR-L23, C32, A375,

Table 6: Summary of Pharmacological Activities Reported In Different Parts Of *Bombax Ceiba* Linn.

S. No.	Researcher	Pharmacological Activity	Key findings	Reference No.
1.	Diab KA et al. (2022)	Genotoxic Activity	Ethanol extract from <i>B. ceiba</i> flower is considered a genotoxic agent toward cancer cells at its cytotoxic concentrations. This extract exerted moderate cytotoxic activity via induction of DNA damage in liver cancer Huh7 cells.	[60]
2.	Sirohi et al. (2021)	CNS Activity	Hydroalcoholic extract of <i>Bombax ceiba</i> induce act as hypnotic, also decrease anxiety, means act as anxiolytic agent due to hypnosis.	[59]
3.	Panwar A et al. (2020)	Nutritional Activity or value	The immature calyx known as Semargulla is eaten as a vegetable in Uttar Pradesh. The paste of its petals is mixed with breast milk and applied externally to heal the red eyes and from the root of <i>B. Ceiba</i> tonic is extracted for healing of waist pain.	[58]
4.	Sinha S et al. (2019)	Neuroprotective Activity.	It was observed that the ethanolic and hexane extracts from <i>B. ceiba</i> inhibit the activity of both <i>acetylcholinesterase</i> (43.32–69.94%), which is comparable to donepezil (50 µg/ml). The ethanolic extracts of <i>B. ceiba</i> exhibited potent <i>acetylcholinesterase</i> activity (IC50 36.14 ± 1.21 µg/ml)	[56]
5.	Chaudhary et al. (2018)	Aphrodisiac activity	Studied in sexually active and inactive male mice and the extract have shown aphrodisiac effect.	[54]
6.	Shah S et al. (2017)	Anthelmintic Activity	The anthelmintic activity was found to be moderate in ethanolic leaves extract. Polyphenolic compounds possess anthelmintic activity	[55]
7.	Rani et al. (2016)	Antileprotic Activity	Seeds and roots of <i>Bombax ceiba</i> were used by traditional practitioners and religious healers of Bangladesh in the treatment of leprosy	[54]
8.	Digge S et al. (2015)	Antibacterial activity	The aqueous bark extracts of the <i>Bombax ceiba</i> has been shown better activity due the presence of tannins and tannins are responsible for anthelmintic activity.	[53]
9.	Tundis et al. (2014)	Cancer Cell Growth Inhibition	Flowers of <i>B. ceiba</i> showed antioxidant effects and antiproliferative activity against seven human cancer cell lines [MCF-7], HeLa Henrietta Lacks), COR-L23, C32, A375, ACHN and LNCaP cells.	[48]
10.	Ananda et al. (2013)	Hepatoprotective Activity	The methanol extract of flowers of <i>B. ceiba</i> (MEBC) investigated and it was found that MEBC significantly decreased the level of TBARS and elevated the level of GSH	[35]
11.	Ananda et al. (2013)	Anti-inflammatory Activity	Extracts of <i>B. ceiba</i> was assessed by Human Red Blood Corpuscles (HRBC) to see anti-inflammatory effect.	[35]
12.	Yang et al. (2013)	Antiangiogenic activity	Strong antioxidant is extracted from leaves which are Mangiferin, 2-Beta-Dglucopyranosyl-1, 3, 6, 7-tetrahydroxy- 9H-xanthen-9- one, directly from methanolic extracts of <i>B. ceiba</i> leaves.	[28]
13.	Gupta et al. (2013)	Anti-obesity	The extract of stem bark of <i>B. ceiba</i> has significant anti-obesity due to FAS and PTP-1B signaling.	[50]
14.	Jagtap et al. (2011)	Protective effect in inflammatory Bowel disease	Tannin and gallic acids act as astringents which is helpful in restoring damage	[49]
15.	Hossain et al. (2011)	Antipyretic activity	Methanol extract of <i>Bombax malabaricum</i> leaves (MEBM) was evaluated for the antipyretic activity in rats.	[47]
16.	Phullan R et al. (2009)	Antimicrobial or Antibacterial activity	When Plant extracts (methanol and aqueous) were assayed strong antibacterial activity was observed.	[37]
17.	Vieira et al. (2009)	Antioxidant	The phyto-constituent responsible for antioxidant activity are DPPH (1, 1-diphenyl-2-picrylhydrazyl) and hydroxyl free radicals; phosphatidylcholine liposomes), induced by ascorbyl radicals and per-oxy nitrite.	[39]
18.	Jain et al. (2009)	Cardio-protective Effect.	Root powder of <i>B. ceiba</i> significantly modifies the coronary risk factors such as atherogenic lipids, fibrinogen and oxidative stress in patients with ischemic heart disease.	[53]
19.	Dara A et al. (2005)	Analgesic Activity	Phyto-constituent Mangiferin and 2-beta-D-glucopyranosyl-1, 3, 6, 7-tetrahydroxy-9H-xanthen- 9-one displayed significant analgesic effect.	[34]
20.	Alluri V et al. (2005)	Cytotoxicity	Aqueous extracts of the plants were screened for their cytotoxicity using the brine shrimp lethality test.	[43]
21.	Dara et al. (2005)	Diuretic activity	Aqueous and ethanol extracts of <i>B. ceiba</i> fruit (200 mg/kg and 400 mg/kg, p.o.), was significantly increased the urine output in higher doses.	[34]
22.	Ravichandran et al. (2004)	Anti-acne Effect	Alcoholic extract of bark and thorns possess very good anti-acne	[52]
23.	Saleem et al. (1999)	Hypotensive activity	Shamimin along with lupeol [lup-20 en-3b-ol], possesses potent hypotensive activity.	[46]

ACHN and LNCaP cells. The anticancer activity of BCM extract was determined *in vitro* using HL-60 cell line. Cell density was adjusted to 1.5×10^6 cells/mL and cells were treated with BCM at 1, 10, 25, 50 and 100 $\mu\text{g/mL}$ for different time periods [48].

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. [48, 49].

Anti-obesity

The extract of stem bark of *B. ceibahas* 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 [50].

Anti-acne effect

Thorn of *Salmaliamalabarica* Schott. And End has been employed to treat acne of the face. The alcoholic extract of bark and thorns possess very good anti-acne potential against *Propionibacterium* acne with minimum inhibitory concentration (MIC) of 250 $\mu\text{g/ml}$ while MIC value of leaf was 500 $\mu\text{g/ml}$ which was better as compared to MIC of standard clindamycin. All three extracts have been reduced *P. acne*-induced granulomatous inflammation on rats. The thorns of *S. malabarica* are an important ingredient of Himalaya, "Acne-N-Pimple Cream" is a polyherbal formulation recommended for the management [51] 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 [52].

Cardio-protective 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 [53-61] (Table-6).

Conclusion

Bombax ceiba linn is one such tree which has many qualities. In this review article, we have taken a closer look at those features and qualities. We first got to know the taxonomical classification, morphology, species, description and other names of this tree better. The traditional and medicinal uses of this tree are very high and it is used in large quantities. We tried to understand those traditional and medicinal uses in a detailed way. In this research paper we shortly studied about cultivation and propagation of this tree. Parts (Leaves, Stem bark, Flower, Seed and Root bark) of this plant contain many important phyto-constituents which we studied in a detailed way because of their medicinal uses. This review article contains important tables, which shows different chemical analysis done on this tree parts. *Bombax ceiba* linn tree is a tree with more than one pharmacological studies which are Analgesic Activity, Hepatoprotective Activity, Antimicrobial or Antibacterial activity, Antioxidant Cytotoxicity, Hypotensive activity, Diuretic activity Anti angiogenic activity, Antipyretic activity, Aphrodisiac activity, Cancer Cell Growth Inhibition, Protective Effect in Inflammatory Bowel Disease, Anti-obesity, Anti-acne Effect and Cardio-protective Effect. This plant is a miracle because of its vast pharmacological activities, phyto-constituents and effectiveness. But

there is lot work of work still remain to do because this potential.

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