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Review Article

BOMBAX CEIBA LINN: A CRITICAL REVIEW ON PHYTOCHEMISTRY, TRADITIONAL USES, PHARMACOLOGY, AND TOXICITY FROM PHYTOPHARMACEUTICAL PERSPECTIVE

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ABSTRACT

Traditional medicines are becoming crucial and decisive role in the prevention and cure of diseases and disorders. Traditional medicines have various pharmacological activities which important for human health. *Bombax Ceiba* widely used from past decades for the treatment of diseases and disorders. *Bombax ceiba* is usually referred to as kapok tree and moca, which belongs to *Bombacaceae*. Moca is a crucial medicative, plant widely found in a tropical and subtropical Asian country like India, Pakistan. Various scientific studies or medicative usage has been reported within the traditional systems of drugs like Ayurveda, Siddha and Unani. Owing to this widespread attention about traditional medicines, scientific validations of medicinal plants have become a thrust area of research. In this paper, the scientific validation of *Bombax ceiba* for various biological activities has been reviewed with its chemical constituents present in the whole plant and with its traditional and contemporary uses. This manuscript also provides deep inside of recent patents associated with *Bombax ceiba* in the past decade.

Keywords: *Bombax ceiba*, Medicinal plant, *Bombacaceae*, Validation, Pharmacological activity

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INTRODUCTION

Traditional medicines are being used more and more in the treatment of ailments [1]. Because of the widespread use of ethno-medicine, the WHO and many research-oriented enterprises have invested heavily in traditional herbal medicine investigation. Out of the 1562 certified medications (from 1994 to 2014) 654 were natural product derivatives, while the remaining 76 were either unchanged natural products or botanicals [2]. Scientific validations of medicinal plants became a thrust field of research as a result of this growing attention to traditional medicine. The scientific validity of the red silk-cotton tree (for diverse biological activities) has been reviewed in the research [3]. *Bombax ceiba* is usually known with different type of names like as Kapok tree, Moca and Semal which belong to family *Bombacaceae*. Its diverse medicinal uses have been stated within the Indian traditional systems of pharmaceuticals such as Ayurveda, Siddha, and Unani after various scientific researches. It is richly available and commonly found in Asia, tropical Asia, Africa, and Australia. It is mostly found in India at altitudes of up to 1500 meters. *Bombax ceiba* lives in a different environmental climate, including arid deciduous forests, humid deciduous forests, and along with rivers. The red Kapok tree (*Bombax ceiba*) is "a stunning presence in any scenery. It occurs, especially during the long periods of December, when it loses its leaves and in January, it bursts into red blossoms on the bare branches, look like a complete red tree. After creating the earth, 'Pitamaha' reposed under the tree 'Salmali' according to the Hindu 'Mahabharata.' It is referenced in the 'Yajnavalkya' with the trees of the nether realms. Astringent, aphrodisiac and alternative qualities have been discovered in the roots of relatively young trees over time. The gum is utilized as an astringent in several countries, such as Holland. In Madras, the immature fruits are dried and utilized as a demulcent and astringent, and the gum is utilized to treat diarrhea and dysentery.

Phytochemistry

Whole plant of *Bombax ceiba* has various chemical constituents which are responsible for pharmacological activity. These are given in below table 1 along plant part and Category of Phytoconsitiutes.

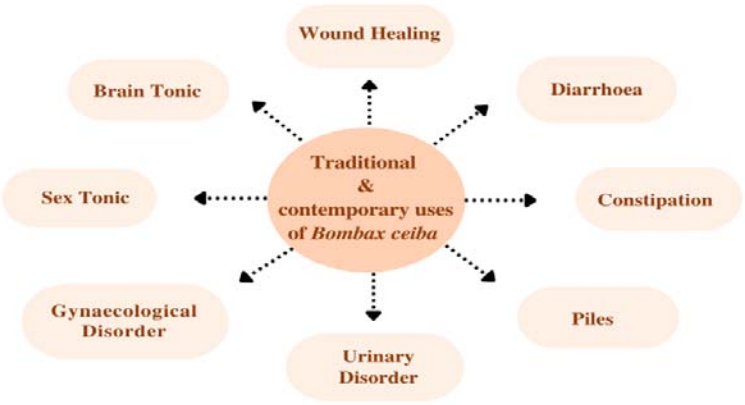

Fig. 1: Various traditional and contemporary uses of *Bombax ceiba*

Table 1: Constituent of roots, Bark, Flowers, Stem, Spines, Seeds of *Bombax Ceiba*

Constituent of roots of *Bombax ceiba*			
Plant part	**Category of phytoconsitiutes**	**Chemical constituents**	**Reference**
Roots of *b. Malabaricum*	Glycosides	3', 4', 5, 7-tetra hydroxyl-6-methoxy flavan-3-o-β-D glucopyranosyl-α-D-xylopyranoside, tracontanol and β-sitosterol. 1, 6-dihydroxy-3-methyl-5-isopropyl-7-methoxy-8-naphthalene carboxylic acid lactone	[32]
	Polysaccharides	(L-arabinose, D-xylose, with traces of L-rhamnose, uronic acid) along with 2, 3, 4, 6-tetra–o-methyl glucose and 2, 3, 6-tri-o-methyl glucose, 2-o-methyl glucose and 3-0-methyl glucose	
	9 cadinanesesqui terpenoids (5 new compounds and 4 known compounds)	New {(Bombamalones A-D, I-IV) and bombamaloside V} known (isohemigossypol-1-Me ester, 2-omethylisohemigossylic acid lactone, bombaxquinone B, lacinilene C	[44]
	Sesquiterpene lactone	hemigossylic acid lactone-7-methyl ether	[35]
Constituent of barks of *Bombax ceiba*			
Root bark of *b. Ceiba*	4 new aromatic sesquiterpenoid	Lupeol, β-sitosterol, naphthaquinone and potassium nitrate	[43]
Petroleum ether extract of root bark	Pentacyclic triterpenoid	lupeol, β-sitosterol, naphtha oquinone	[38]
	Organic molecules	Isohemigossypol-1, 2-dimethyl ether, 8-formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1, 4-naphthaquinone, 7-hydroxycadalene.	[37]
Constituent of flowers of *Bombax ceiba*			
Isolated from flower	3 new biosides	(24β-ethyl cholest-5-en-3β-o-α-Larabinopyranosyl (16)-β-D glucopyranoside, 3, 5 dihydroxy-4'-methoxy flavones-7-o-α-L-rhamnopyranosyl-(16)-β-D-glucopyranoside and 4, 5, 7-trihydroxy-flavone-3-o-β-Dglucopyranosyl (14)-α-L rhamnopyranoside. Anthocyanin-A and B	[37, 43]
	Phytosterols	β-D-glucoside of β-sitosterol, free β-sitosterol, hetriacontane, hetriacontanol, kaempferol, quercetin and traces of essential oil.	[28]
Ethyl acetate fractions of alcoholic extract of flower	Phytosterols	46 compounds were identified like palmitic acid, ethyl palmitate, β-sitosterol etc	[41]
	Bombalin derivative	2 unusual 9'-norneolignans i.e. bombasin and bombasin 4-o-β-glucoside and a novel Dgulono-γ-lactone derivative bombalin	[42]
		3 known compounds. Dihydrodehydro di-coniferyl alcohol 4-o-β-d-glucopyranoside, trans-3-(p-coumaroyl) quinic acid and neochlorogenic acid	[42]
	A novel glycoside	Quercetagetin	[30]
	2 new flavanoid compounds were isolated from petals of flowers	Pelargonidin-5-β-glucopyranoside and cyaniding-7-methyl ether 3-β-glucopyranoside.	[31]
N-hexane extract of flower	14 compounds	Cholesterol, stigmasterol, campesterol, α-amyrin and 10 were hydrocarbons.	[27]
Constituent of spines of *Bombax ceiba*			
Spines of stem bark	A new ferulic ester	A new ferulic ester, trans-triacontyl-4-acetoxy-3-methoxy cinnamate, along with known ferulates and triterpenes	[40]
Constituent of seed of *Bombax ceiba*			
Methanolic extract of *Bombax ceiba* of seed	7 flavones	Vicenin 2, linarin, saponarin, cosmetin, isovitexin, xanthomicrol, apigenin	[27]
	Amino acids	lysine, arginine, alanine, glutamic acid, glycocol, leucine, lysine,	[33]
	Sugars	Fructose, glucose, galactose, sucrose, lactose, arabinose.32 N-hexacosanol and palmitic acid	[32]
	Fatty acid	N-hexacosanol and palmitic acid	[43]
Seed oil	Enzyme	Phytosterol, palmitic acid, stearic acid, oleic acid and linoleic acid and lipase derivative	[25]
	Fatty acids	Glyceridic mixture of myristic, palmitic, arachidic, behinic and linoleic acid along with carotenoids, α-tocopherol and various amino acids and sugars	[34]
	Essential amino acids	threonine, valine, methionine, isoleucine, leucine, phenylalanine, lysine, histidine, arginine and tryptophan	[39]
Hydrolysis of gum	Carbohydates	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-methylo-D-galactose and 2, 3, 5-tri and 2, 5-di-o-methyl-L-arabinose	[32]
Methylated *Bombax ceiba* gum on hydrolysis	Monosaccharides	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	[23]

Bombax ceiba gum can be substituted for gum tragacanth.

Beneficial uses of *Bombax ceiba* plant treat for various aliment, those make plant as a silent doctor [45].

Stimulant, astringent, haemostatic, aphrodisiac, diuretic, antidiarrheal, cardiotonic, emetic, demulcent, antidysenteric, alterative, and antipyretic characteristics are among the plant's traditional applications. Because of its wide range of pharmacological effects, the plant's extracts have been utilized in a variety of traditional remedies [52-55].

Pharmacological activities

Only a few researches have been published to support the traditional use of *Bombax ceiba*. The plant's promise in the treatment of many ailments has been demonstrated *in vitro* and *in vivo* research.

Table 2: Medicinal use of *Bombax ceiba*

***Bombax ceiba* parts+ingredients**	**Uses**	**Reference**
Red silk cotton tree root powder+vidari (Ipomoea digitata) root+shatawar, and misri	It is used for ejaculation and sperm-related issues. Consume this combination with milk 2 times a day.	[1-3]
Bombax ceiba leaves+water+strain	Beneficial for blood purification.	[3, 10]
Red silk cotton tree root powder+water	Help in leucorrhea	[56]
Bombax ceiba root powder (100 gm)+mulethi powder (50 gm)+swarngeru (25 gm)	Useful in a variety of issues, including excessive bleeding during menstruation Consume this combination with milk or water 2 times a day.	[1-3, 56]
Thorny part of the stem of the *Bombax ceiba* tree or make a thorn paste+water	Apply to the affected area, help dermis problems in, including acne, blemishes, and hyperpigmentation	[10]
Bark paste	Beneficial in lightening scars caused by boils, acne vulgaris, and burns.	[56]
Clean and dry the *Bombax ceiba* root, then crush it into a powder.	Boost or enhance breast milk. Consume this combination with milk or water 2 times a day.	[56]
Bombax ceiba root powder+black pepper+ginger powder	To treat a cold or cough, take a tiny dose.	[56]

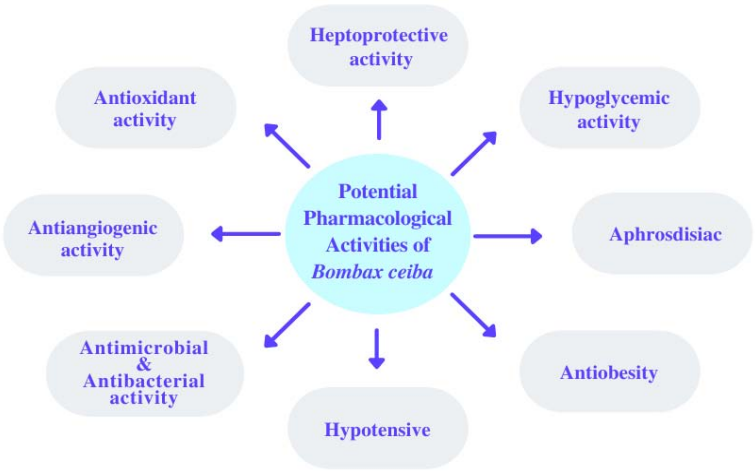

Fig. 2: Various potential pharmacological activites of *Bombax ceiba*

Table 3: Hepatoprotective activity of *Bombax ceiba*

S. No.	**Plant part used in extraction with solvent**	**Activity performed**	**Method used in activity**	**Observation**	**Reference**
01	Part-*Bombax ceiba* leaves Solvent-Methanol	Hepatoprotective	Hepatotoxicity produce by a mixture of two anti-tubercular drugs isoniazid (INH) and rifampicin (RIF) administered for 10 and 21 d by intraperitoneal route in rats.	The results obtained from the analysis of biochemical parameters and histopathological studies, enabled to conclude that the MEBC were not able to revert completely hepatic injury induced by INH+RIF, but it could limit the effect of INH+RIF to the extent of necrosis.	[6]
02	Part-*Bombax ceiba* leaves Solvent–Ethanol	Hepatoprotective	DPPH scavenging activity	*Bombax ceiba* plant shows the hepatoprotective activity as well as they are traditionally used in the treatment of diabetes.	[10]
03	Part-*Bombax ceiba* flowers Solvent–Water	Hepatoprotective	Carbon tetrachloride (CCl_4) treatment was given to the rats for hepatotoxicity induced, at the same time, vehicle or aqueous extract of flowers of *Bombax ceiba* (250 or 500 mg/kg) or silymarin (25 mg/kg) were administered daily by oral route for seven days.	The outcome indicated that the aqueous extract of flowers of *Bombax ceiba* showed a hepatoprotective effect against CCl_4-induced hepatotoxicity and exhibited *in vitro* antioxidant effects.	[20]
04	Part-*Bombax ceiba* young root Solvent-Ehtanol	Hepatoprotective	Diabetes and hepatic toxicity in Alloxan-Induced Diabetic Mice.	The results showed that the young roots of *Bombax ceiba* have potential hypoglycemic, hypolipidemic and hepatoprotective activities and confirm the traditional uses of this plant to manage diabetes and its associated liver toxicity.	7

Table 4: Antioxidant, analgesic, Immunomodulatory, antibacterial. Antidiabetic activity of *Bombax ceiba*

S. No.	Plant part used in extraction with solvent	Activity performed	Method used in activity	Observation	Reference
01	Part-*Bombax ceiba* leaves Solvent–Methanol	Antioxidant and analgesic	DPPH Free Radical Scavenging Assay	On the basis of the current investigation, found that B. ceiba leaves extract and mangiferin from *B. ceiba* possess antioxidant and analgesic properties.	[46]
02	Part-*Bombax ceiba* bark Solvent–Methanol	Antioxidant and Immunomodulatory Activity	*In vivo* immunomodulatory and antioxidant activity of *Bombax ceiba* methanol extract was evaluated by assessing its effect on Hemagglutinating antibody (HA) titer, delayed type of hypersensitivity (DTH) response, hematological profile (Hb, WBC, RBC), lipid per oxidation (LPO), reduced glutathione (GSH), superoxide dismutase (SOD), catalase (CAT) and cytokine release.	These findings suggested that the methanol extract of *Bombax ceiba* possessed promising immunostimulant properties, which could be ascribed, in part, to its anti-oxidant capacity.	[19]
03	Part-*Bombax ceiba* flower Solvent–Methanol	Antioxidant	The antioxidant activity (AA) was evaluated using DPPH method.	The results suggest that the Bombax ceiba flowers are rich in alkaloid, phenolics, tannins, amino acids and proteins. It is a potential source of antibacterial, and antioxidant molecules.	[49]
04	Part-*Bombax ceiba* flower Solvent–Methanol, diethyl ether	Antioxidant	1,1-diphenyl-2-picryl-hydrazyl (DPPH) scavenging activity	The antioxidative effect of the plant extract is possibly due to the presence of phenolic components. The methanolic extract of *B. ceiba* showed significant antioxidant potential.	[48]
05	Part-*Bombax ceiba* leaf and flower Solvent–ethanol, water	Antioxidant and antidiabetic	2, 2‐diphenyl‐1‐picrylhydrazyl (DPPH) radical scavenging assay, 2, 2‐azino‐bis-(3‐ethylbenzothaizoline‐6‐sulphonate (ABTS) assay, and ferric reducing antioxidant power (FRAP) assay were used to investigate the *in vitro* antioxidant and antidiabetic activities of the extracts.	The crude extracts from *B. ceiba* showed the potent *in vitro* antioxidant and antidiabetic activities, especially the flower extracts.	[50]
07	Part-*Bombax ceiba* stem bark Solvent–methanol	antibacterial and antioxidant	The antioxidant capacity was determined by DPPH, Nitric Oxide scavenging and reducing power activity. For antibacterial activity, Gram-negative (Escherichia coli, Pseudomonas aeruginosa and Salmonella typhi) and Gram-positive bacteria (Bacillus subtilis, Staphylococcus aureus) were used.	This study revealed that *Bombax ceiba* of local origin has good antibacterial activity against various microorganisms and it can also provide defense against oxidative stress.	[8]

Aphrodisiac activity of *Bombax ceiba*

(Pankaj H. Chaudhary) examined the aphrodisiac activity of *Bombax ceiba* Linn. (Bombacaceae) root extract was examined. For 28 d, the extract (400 mg/kg body weight/day) was given orally via tube feeding. At days 0, 7, 14, 21, and 28, the parameters of mounting, intromission, ejaculation latency and frequency, with post-ejaculatory duration, were measured before and during the sexual behavior research. Mount delay, intromission latency, ejaculation latency, and post-ejaculatory interval were all considerably shortened by the extract (p 0.05). Mounting, intromission, and ejaculation frequency were all considerably raised by the extract (p 0.05). Both sexually active and passive male mice showed these effects [4].

In vitro* anti-inflammatory activity of *Bombax ceiba

Human Red Blood Corpuscles membrane stabilizing technique with modest changes was used to investigate the *in vitro* anti-inflammatory efficacy of extracts of *Bombax ceiba.* Choose a healthy human volunteer who has not used any anti-inflammatory drugs for 14 d prior to the experiment, draw blood, and homogenize it at 3,000 rpm in heparinized centrifuge tubes. The blood cells were washed in isosaline, and a tenth suspension was prepared in saline solution. The standard utilized was cataflam (50 mcg/ml). 2 ml hypotonic saline (0.25 percent w/v NaCl), 1 ml 0.15 M phosphate buffer (pH 7.4), 1 ml test solution (1000 mcg/ml) in saline solution, and 0.5 ml of 10 percent HRBC in saline solution made up the rate of reaction of the mixture (4-5 ml). Instead of the test solution, 1 ml of isotonic saline was used as a control. The mixtures were incubated at 56 °C for 30 min, chilled under cold tap water, and then homogenized for 20 min at 3000 rpm. Using a visible Spectrophotometer, the absorbance of the sample was measured at 560 nm. The control group is made up entirely of lyses [2].

Anti-obesity activity of *Bombax ceiba*

Because it includes Lupeol, which inhibits PTP-1B, adipogenesis, TG production, and lipid deposition in adipocytes and adipokines, *Bombax ceiba* has a strong mitigative ability, while flavonoids extracted from *B. ceiba* have FAS suppressive effect. In this investigation, male Wistar albino rats weighing 180-220 g were used. Obesity was produced in the lab by feeding a high-fat diet for ten weeks. The standard treatment was Gemfibrozil 50 mg/kg and the methanolic extract of *B. ceiba* extract 100, 200, and 400 mg/kg were given orally from the seventh to the tenth week. Introduction with the HFD for 10 w resulted in a huge (p 0.05) rise in percent weight gain, BMI, and LEE index values; serum glucose, triglyceride, LDL, VLDL, cholesterol, free fatty acid, ALT, AST; tissue TBARS, nitrate/nitrite levels; different fat pads and relative liver weight; and a massive reduction in food consumption (g and kcal), serum HDL, and tissue gluta. When compared to the HFD control, treatment with

Bombax ceiba extract and Gemfibrozil dramatically reduced these HFD-induced alterations. In compared to Gemfibrozil, the effect of B. ceiba 200 and 400 mg/kg was more prominent. Because of the presence of flavonoids and lupeol, these researchers determined that the methanolic extract of *Bombax ceiba* stem bark had strong mitigative ability against HFD-induced overweight in rats, probably via modification of FAS and PTP-1B signaling.

(Chauhan *et al.*, 2018)*B. ceiba* extracts were also found to have considerable osteoblast cell division and alkaline phosphatase activity in UMR-106 cell lines. In histopathology, surgical excision of the ovaries resulted in a massive (p 0.05) decrease in bone mineral mass, bone-crunching ability, serum ALP, calcium, phosphorus, and estradiol contents, as well as evident bone tissue degradation. In comparison to the OVX control, the application of petroleum ether and methanolic extract for 28 d substantially (p0.05) alleviated the effects of ovariectomy-induced bone porosity and regained bone development. The presence of lupeol, gallic acid, and β-sitosterol contents of *B. ceiba:* stem bark mitigated the state of fracture risk, probably due to estrogenic regulation, as demonstrated by *in vitro* osteogenic activity [14].

Table 5: Antiangiogenic activity of *Bombax ceiba*

S. No.	Plant part used in extraction with solvent	Activity performed	Method used in an activity	Observation	Reference
01	Part-Flowers of *Bombax ceiba* Solvent-Diethyl ether (DE) and light petroleum (PE)	Antiproliferative and antioxidant	Sulforhodamine B (SRB) assay against MCF-7, HeLa, COR-L23, C32, A375, ACHN, and LNCaP cells in comparison with a human normal cell line, 142BR.	The presence of β-sitosterol and some fatty acids may also play an important contribute to the bioactivity of *B. ceiba* flower extracts.	[18]
02	Part-Not specified, Solvent-(Hexane, Ethyl Acetate, Methanol and Ethanol (70%)	Antiproliferative	The anticancer activity of Bombax ceiba extract by human leukemia cell lines using SRB assay using HL_{60} cell lines.	The results support the folkloric usage of the studied plant and confirmed that the studied plant possesses constituents with cytotoxic properties that can be useful for developing anticancer agents.	[51]
03	Part-The stem barks of *Bombax ceiba* Solvent-Methanol	Antiangiogenic	Methanolic extract of the stem barks of Bombax ceiba found to exhibit a significant antiangiogenic activity on *in vitro* tube formation of human umbilical venous endothelial cells (HUVEC).	Lupeol 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.	[9]
04	Part-Stem wood of *Bombax ceiba* Solvent-chloroform (CH), n-hexane (NH), ethyl acetate (EA), chloroform: methanol (CH: M), chloroform: ethanol (CH: E), acetone: ethyl acetate (AC: EA), methanol: ethyl acetate (M: EA), ethanol: ethyl acetate (E: EA), (E: EA), acetone (AC), methanol (M), ethanol (E), acetone: distilled water (AC: W), methanol: distilled water (M: W) and distilled water (W).	Antiproliferative	Extract evaluated by antiproliferative activity against THP-1 human leukemia cell line.	The present findings revealed that chloroform and n-hexane extracts of stem wood as well as root wood part as an enriched source of phytochemicals possessing cytotoxic potential.	[22]

Table 6: Antimicrobial and antibacterial activity of *Bombax ceiba*

S. No.	Plant part used in extraction with solvent	Activity performed	Method used in activity	Observation	Reference
01	Part-Stem of *Bombax ceiba* Solvent-Methanol, ethanol, and aqueous	Antimicrobial activity	The antimicrobial activity was measured by disc diffusion method. Antimicrobial activity of crude extracts of *B. ceiba* against five bacterial strains (Gram positive and Gram negative) and one fungal strain.	Methanol-extracted samples showed good activity against P. aeruginosa and C. albicans but ethanol extract showed tremendous activity against X. maltophilia.	[16]
02	Part-Young Fruits, leaves and Spikes inoculated with different bacteria, six wells are of *Bombax ceiba pentandra* solvent-Aqueous, methanol, ethyl acetate, chloroform, and hexane	Antimicrobial activity	Antimicrobial activity investigated against five bacterial species namely *Escherichia coli, Bacillus Subtilis, Staphylococcus aureus, Pseudomonas aerogenosa* and *Shigella flexnerri*.	The antimicrobial effect of methanolic extract of *Bombax ceiba pentandra* fruit could be endorsed the presence of wide spectrum of bioactive molecules, including polyphenols, flavonoids and tannins.	[12]

Cytotoxic of *Bombax ceiba*

The goal of this study was to use a variety of *in vitro* assays to look into the cytotoxicity activity of *Bombax ceiba* L. The chloroform (CH) extract from stem wood was highly hazardous (LC50 42.41±3.40 g/ml), followed by the acetone: ethyl acetate (AC: EA) extract with an LC_{50} value of 72.92±4.41 ug/ml in a brine shrimp mortality assay. At a concentration of 20 g/ml, n-Hexane (NH) extract of root wood portion inhibited THP-1 cell line by 70.95±1.77 percent (IC50 15±0.56 ug/ml). In a protein kinase suppression experiment with 21±1.2 and 29±1 mm

bald ZOI (MIC= 50 ug/disc), NH and CH extracts of stem wood component exhibited excellent results. The results of this investigation show that CH and NH extracts of stem and root wood are good sources of phytoconstituents with cytotoxic capability [21].

Table 7: Hypoglycemic activity of *Bombax ceiba*

S. No.	Plant part used in extraction with solvent	Activity performed	Method used in an activity	Observation	Reference
01	Part-Bark of *Bombax ceiba* Solvent-petroleum ether (60 °-80 °), ethyl acetate and ethanol	Hypoglycemic and hypolipidemic	Hypoglycemic and hypolipidemic evaluated through normal and streptozotocin-induced diabetic rats administered with graded oral doses (200, 400, 600 mg/kg/day)	Phytochemical and GC-MS studies confirmed the presence of triterpenoid compounds in the extract, which may account for its significant hypoglycemic activity.	[1]
02	Part-Leaves of *Bombax ceiba* Solvent-Ethyl acetate, n-butanol, hydro-alcoholic (70-30%)	Hypoglycemic activity	Hypoglycemic activity of *Bombax ceiba* extract examined on Normoglycemic Rats model and Oral Glucose Tolerance Test model.	These studies concluded that the leaves of *Bombax ceiba* L have potential to lower the blood glucose level in experimental animals. *Bombax* has proved that anti-diabetic potential on normal rats, possibly due to regenerate β cells.	[17]

Table 8: Miscellaneous pharmacological activity of *Bombax ceiba*

S. No.	Plant part used in extraction with solvent	Activity performed	Method used in an activity	Observation	Reference
01	Part-Stem bark of *Bombax ceiba* Solvent-petroleum ether	Hypotensive	Hypotensive Activity Normotensive Sprague–Dawley rats were anaesthetized with pen-tothal® sodium (50 mg/kg i. p.). The trachea was exposed and cannulated to facilitate spontaneous respiration. Drugs were injected (vol. 0.2—0.25 ml) through a polyethylene cannula inserted into the external jugular vein followed by a saline flush (0.2 ml).	Lupeol and fraction BCBMM have emerged as potent hypotensive constituents of Bombax ceiba stem bark while new dimeric glycoside shamimicin was found devoid of any activity at the dose of 15 mg/kg.	[15]
02	Part-Stem bark of *Bombax ceiba* Solvent-petroleum ether	Anti-obesity	The present study was designed to investigate the antiobesity effect of *Bombax ceiba* Linn on high-fat diet-induced obesity. Male Wistar albino rats weighing 170-230 g were employed in present study. Experimental obesity was induced by treatment with high fat diet for 10 w. *B. ceiba* extract 100, 200 and 400 mg/kg and gemfibrozil 50 mg/kg as standard drug were administered orally from 7th to 10th weeks.	It concluded that the methanolic extract of stem bark of Bombax ceiba Linn has significant anti-obesity potential against High Fat Diet-induced obesity, possibly due to modulation of FAS and PTP-1B signalling in rat.	[4]
03	Part-*Bombax ceiba* root Solvent–Methanol	Antioxidant, brine shrimp lethality, thrombolytic, antidiarrheal, hypoglycemic, central and peripheral analgesic activities.	Root extract was evaluated by various method like free radical scavenging assay by DPPH method, brine shrimp lethality bioassay.	B. ceiba was found to be a potential plant for the further chemical investigation, since it has significant antioxidant, brine shrimp lethality, thrombolytic, antidiarrheal, hypoglycemic, central and peripheral analgesic activities	[13]
04	Part-*Bombax ceiba* stem bark Solvent–Ethanol	antioxidant, anti-inflammatory, anthelmintic	The *in vitro* anti-inflammatory activity was performed by human red blood cells stabilization method, *in vitro* anthelmintic activity by Pheretimaposthuma method, *in vitro* antioxidant activity by DPPH scavenging method, and anti-microbial studies by agar streak dilution method against *bacteria E. coli, B. subtilis, K. pneumonia*, and *fungi C. albicans* and *A. niger*.	The study also revealed the possession of various potentials like anti-inflammatory, antioxidant, anthelmintic, and antimicrobial activity against nosocomial infections opens new future perspectives of these thorns, which in early literature were considered hard structures.	[5]

Table 9: Patents associated with *Bombax ceiba*

S. No.	Patent number and year	Country	Patent title
1	US 7,749,544 B2 and 2010	United States Patent	Composition for treating aids and associated conditions
2	WO 2012/131652 Al and 2012	World Intellectual Property Organization	Herbal Compositions For Treatment or Prevention of Neurological Disorders
3	CN104521947A and 2016	China	Preparation method of *Bombax ceiba* three-dimensional dried flowers
4	304196 and 2018	India	Isolation of Phytoconstituent From *Bombax ceiba*
5	201821019083 A and 2018	India	A Herbal Composition Or Decoction For The Management Of Abnormal Menstruation

CONCLUSION

Bombax ceiba whole plant very useful; barks, roots, flowers and seed have lots of chemical constituents. Practical aspects show that *Bombax ceiba* is king of herbs. *Bombax ceiba* plant has been broadly used in Unani system of medicine as well as particular ethno-medicines afterward antiquity. The phytochemicals showed the presence of alkaloids, tannins, glycosides, reducing sugar, saponins, and terpenoids, while anthraquinone, flavonoids, steroids, anthocyanin and Proteins and amino acids and cardiac glycosides also present in *Bombax ceiba*various parts. Different parts of *Bombax ceiba* is well used as antidiarrheal, siccative, blood purifier, anti-asthmatic, avaricious, to increase consistency of semen, semen procreator, uterine tonic, amenorrhoea, abortifacient, antileucorrhoic etc. Despite its wide usage, in a variety of ailments, there have been little scientific validation investigations on the plant. The plant's potential antioxidant and anti-inflammatory effect is responsible for the majority of its bioactivities. Major pharmacological activity like anticancer, heproprotective, antimicrobial and antibacterial activity make the plants very impotant for improve health and treat diseases. Marked phytochemicals like lupeol, β-siterol and mangiferin shows various pharmacological activity *in vitro.* Various climatic circumstances have a serious impact on the phytochemicals compounds of the plant, as evidenced by variation in bioactivities of the plant taken from different areas. Still there is a further need to identify and isolate the pharmacologically active molecules from different parts of this plant so as it can be improved employed. There is a lot of room for more research and understanding of the mode of action of the bioactivities shown.

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AUTHORS CONTRIBUTIONS

Niraj Gupta, Devender Sharma and Rekha Rani were responsible for the conception, experiments, and writing and revising the manuscript.

CONFLICT OF INTERESTS

Declared none

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