Chapter 4

Bombax ceiba L.: The Malabar silk-cotton Tree

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Abstract: *Bombax ceiba* L., commonly known as the Malabar silk-cotton tree, is a fast-growing, deciduous tree belonging to the Malvaceae family. Native to South and Southeast Asia, it is widely distributed across tropical and subtropical regions. Ecologically, *B. ceiba* plays a vital role in supporting biodiversity. The tree holds immense cultural, medicinal, and economic significance. In traditional medicine, various parts of the tree like bark, roots, flowers, and gum-are used to treat ailments such as diarrhoea, wounds, and respiratory issues due to their anti-inflammatory, antioxidant, and antimicrobial properties. Despite of its ecological and economic importance, *B. ceiba* faces threats from habitat loss and overexploitation. This chapter highlights the significance of *B. ceiba* in various aspects.

Keywords: Malabar silk-cotton tree, traditional medicine, ecological importance, cultural significance, economic value

Introduction

Under the family Malvaceae, *Bombax ceiba* L., holds significant importance as a medicinal plant. It is commonly known by different names, such as Semar,

Semul, and Semal in Hindi, and Red Silk Cotton Tree in English (Somvanshi and Saboo, 2020; Gupta *et al.,* 2022). This tall deciduous tree exhibits a straight buttressed trunk and expansive branches. It is a large deciduous tree found throughout India, tropical and sub-tropical regions of Asia, Africa, and Australia (Kamble *et al.,* 2017). In India, this tree is located at elevations up to 1500 meters. It flourishes in both dry and moist deciduous forests, as well as near rivers, particularly in the peninsular region. The tree prefers deep, sandy loam derived from granite but shows maximum development in deep, alluvial soil of the valleys and is recognized as a fast-growing species requiring abundant sunlight (Jaffar *et al.,* 2023). The medicinal applications of this substance have been documented in traditional medical systems, including Ayurveda, Siddha, and Unani. Its potential has been emphasized for addressing a variety of health issues, such as inflammation, microbial infections, pain, liver toxicity, high blood pressure, angiogenesis, HIV, fever, dysentery, respiratory conditions, bladder ulcers, acne, gynecological disorders, hemorrhoids, and urinary infections (Chaudhary and Khadabadi, 2012; Hossain *et al.,* 2013a; Kamble *et al.,* 2017). This tree is abundant in a variety of phytochemicals. Extracts have verified the existence of alkaloids, flavonoids, glycosides, coumarins, proteins, and amino acids (Hossain *et al.,* 2011). *B. ceiba* has a wide range of documented pharmacological activities, including anti-inflammatory, aphrodisiac, antimicrobial, hepatoprotective, anti-diabetic, anti-aging, and hypotensive properties (Sen *et al.,* 2022).

Morphology

B. ceiba is referred to as the Kings of the Forest owing to its impressive size and striking flowers. This species is a large deciduous tree characterized by a straight, cylindrical trunk and branches that spread horizontally in whorls. The distinctive features that set this species apart in the forest include its whorled

branching system, considerable dimensions, and the buttresses at its base (Plate 1 & 2).

Bark: The bark of the tree displays a grey-brown or silver-grey color and is adorned with sharp conical prickles (Nayak and Kumar, 2023).

Leaf: The leaves are green, palmately compound, broad, spreading, glabrous, lanceolate 5-7 leaflets on short stalks of their own radiating from the end of a long common leaf stalk, petiolate, petiole- 10-15 cm long, pulvinus at base, leaflets 7-9 cm long, 4-6 cm wide, ovate-lanceolate, acuminate apex, entire margins, unicostate reticulate venation, prominent midrib. Generally, the leaflets found in the centre are longer as in the fingers in palm (Shah, 2022; Jaffar *et al.,* 2023).

Flower: The flowers are large, vibrant, and appear from January to March when the tree is leafless, creating a striking sight in winter and spring. Flowers are numerous, measuring 10–12.5 cm across, and cluster towards the branch ends. Flowers are fleshy with a bright crimson color, though yellow or orange variants are rare. Sepals 5, thick, fleshy, cup-shaped, gamosepalous, with free ends. Green and smooth on the outside, white silky on the inside. Valvate aestivation and inferior in position. Petals 5, polypetalous, oblong, recurved above, and fleshy. 7.5-15 cm in length. Bright crimson, rarely yellow or orange. Imbricate aestivation and inferior. Stamens are numerous, distinct, and united at the base to form a staminal tube. Carpels 2, connate in a superior, 5-loculed ovary. Each locule contains two or more anatropous ovules with axile placentation. Style is single, ending in a 5-lobed, pentafid stigma, united at the base. Ovary is superior. Birds are attracted to the bright red flowers, aiding in pollination. Post-blooming, the flowers form a scarlet carpet on the ground (Verma *et al.,* 2015; Panwar *et al.,* 2020).

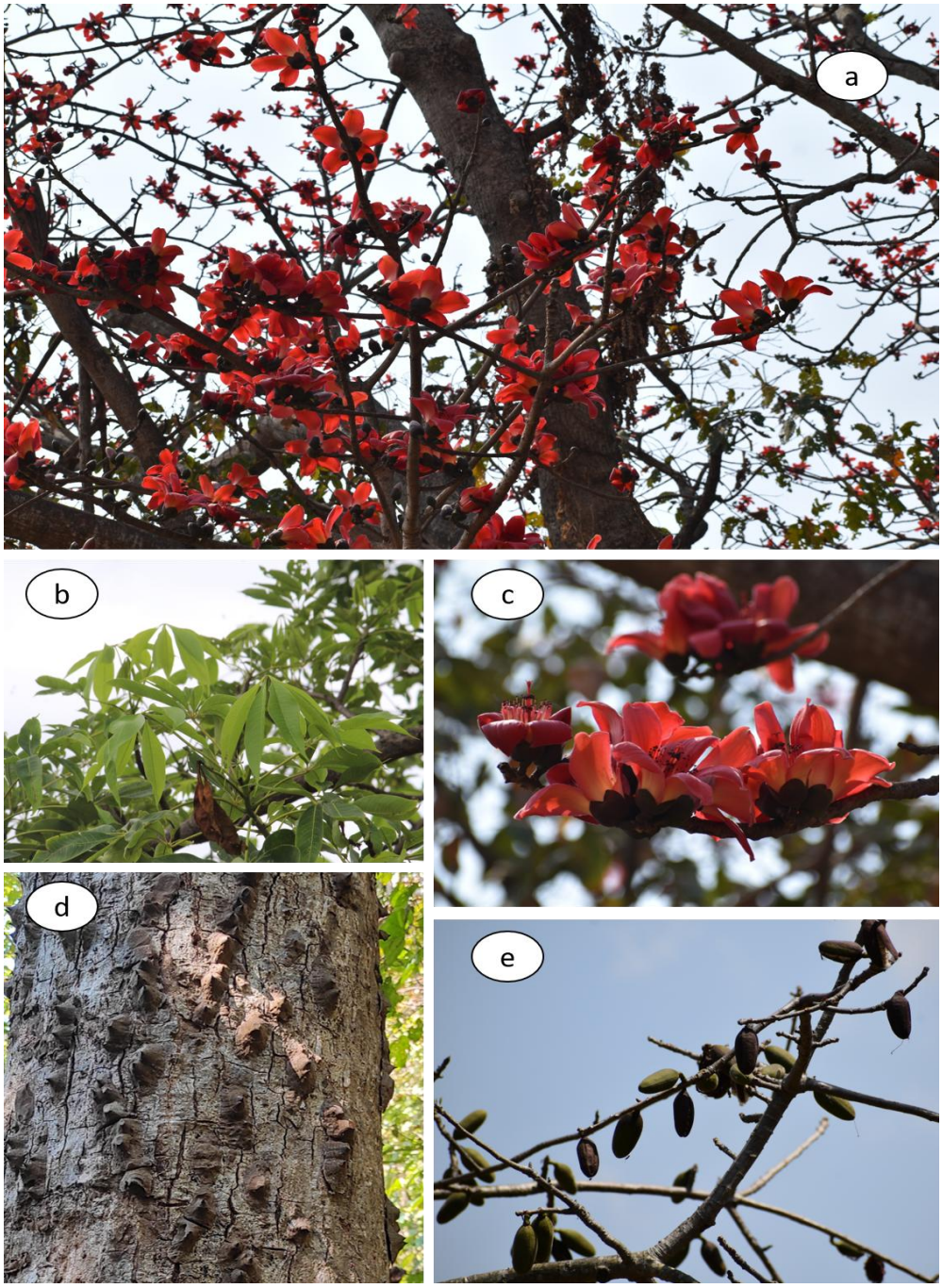

Plate 1: Vegetative parts of *B. ceiba* a) Canopy, b) leaves, c) flowers, d) bark, e) fruits

Plate 2: Whole plant of *B. ceiba* in wild

Fruit: The fruit is characterized as a black-brown capsule with an egg-like shape, measuring approximately 10 - 15 cm in length and 3 to 5 cm in thickness. It comprises five robust woody valves that contain numerous irregularly obovoid, smooth, oily black seeds, each adorned with dense silky hairs. The pulp of the fruit is sweet and edible. Upon reaching maturity, the valves open, allowing the seeds, which are equipped with silky hairs, to detach from the fruit (Kumar *et al.,* 2022; Nayak and Kumar, 2023).

Seed: Seeds are small, either brown or black, smooth, and measure between 6 to 9 mm in length. Their oily nature, combined with a thick layer of long silky hairs, facilitates their dispersal by the wind (Chaudhary and Tawar, 2019; Shukla *et al.,* 2020).

Gum: The gum of *B. ceiba* is light brown to opaque or dark brown (Jaffar *et al.,* 2023).

Traditional medicinal uses

B. ceiba holds significant ethnomedicinal value among various tribal communities. Different parts of the tree, such as bark, seeds, roots, flowers, fruits, and stem pulp, are utilized for treating various ailments.

Bark: Decoction of the bark is consumed on an empty stomach to cure diarrhea and dysentery. Bark paste applied to affected areas is useful for curing cuts and wounds (Nayak and Kumar, 2023). Infusion of bark is used to treat toothache.

Leaves: Leaves are used in blood purification (Raut *et al.,* 2017).

Flowers: Flowers are astringent and refrigerant. It is used to treat cutaneous troubles. Decoction of flowers treats ulcers of the palate, syphilis, and leprosy (Chaudhary and Khadabadi, 2012).

Fruits: Dried tender fruits are utilized in the treatment of calculi-related conditions, as well as chronic inflammation and ulceration affecting the bladder and kidneys, including strangury and various types of dysuria (Raut *et al.,* 2017).

Seed: Paste of seeds and roots applied externally to treat various skin diseases (Gupta *et al.,* 2023).

Stem pulp: Stem pulp is used as a cooling agent, and provides relief in conditions requiring cooling therapy (Sen *et al.,* 2022).

Roots: They are diuretic and tonic. Used in the treatment of cholera, tubercular fistula, and coughs. Useful in urinary complaints and nocturnal pollution. It helps to relieve abdominal pain due to dysentery and improves impotency (Sen *et al.,* 2022). Root is also used in excess bleeding in menstruation (Raut *et al.,* 2017).

Gum: It acts as an Astringent, demulcent, and tonic. Used to treat dysentery and haemoptysis in pulmonary tuberculosis. Effective for influenza and menorrhagia (Gupta *et al.,* 2023).

Pharmacological potential

The pharmacological potential of *B. ceiba* lies in its broad spectrum of bioactive compounds, such as flavonoids, phenolics, alkaloids, saponins, and tannins. These compounds make the plant effective for diverse pharmacological potentials.

Antimicrobial activity: Plant extracts, including those derived from acetone, methanol, and aqueous solutions, have demonstrated activity against multidrug-resistant *Salmonella typhi*. Both methanolic and aqueous extracts from the stembark have exhibited significant antibacterial effects against

strains of multidrug-resistant *Salmonella typhi*. Additionally, mangiferin, which is isolated from the ethanolic extract, possesses antibacterial properties and is effective in inhibiting the growth of *Candida albicans* (Rani and Khullar, 2004; Vaghasiya and Chanda, 2009; Hossain *et al.,* 2012).

Ant-obesity: The extract derived from the stem bark of *Bombax ceiba* Linn. exhibits considerable anti-obesity properties in the context of high-fat diet-induced experimental obesity. This effect may be attributed to the modulation of fatty acid synthase (FAS) and protein tyrosine phosphatase 1B (PTP-1B) signalling pathways in Wistar rats, facilitated by the presence of active flavonoids and lupeol (Gupta *et al.,* 2013).

Antidiabetic activity: Compounds like isoorientin, vitexin and isomangiferin, nigricanside may contribute to the antidiabetic effects of the *B. ceiba* leaf extract. A study investigated the potential therapeutic benefits of *B. ceiba* extract on rats with type 2 diabetes mellitus (T2DM), documenting its effects. The administration of BCE resulted in a significant reduction in fasting blood glucose levels and enhanced oral glucose tolerance in the T2DM rats (Xu *et al.,* 2017).

Hypoglycemic and hypotensive activity: Shamimin, a C-flavonol glucoside derived from the leaves of *B. ceiba*, demonstrated considerable effectiveness as a hypotensive agent at doses of 15 mg/kg, 3 mg/kg, and 1 mg/kg. Additionally, it exhibited significant hypoglycaemic activity at a dosage of 500 mg/kg in Sprague Dawley rats (Chaudhary and Tawar, 2019).

Anticancer potential: Preliminary studies suggest that extracts from *B. ceiba* may exhibit cytotoxic activity against certain cancer cell lines. Tundis *et al.,* (2014) demonstrated the flowers of *B. ceiba* having antioxidant properties and exhibited antiproliferative activity against seven human cancer cell lines, specifically Michigan Cancer Foundation-7 (MCF-7), HeLa (Henrietta

Lacks), COR-L23, C32, A375, ACHN, and LNCaP cells (Meena and Chaudhary, 2017).

Antioxidant activity: The antioxidant properties associated with isoorientin, vitexin, isomangiferin, quercetin, hexoside, mangiferin isovitexin, and nigricanside. High levels of phenolic and flavonoid compounds scavenge free radicals, reducing oxidative stress, results in the prevention of degenerative diseases like cancer and cardiovascular disorders (Vieira *et al.,* 2009).

Anti-inflammatory and analgesic activity: A study revealed that the ethanol extract of *B. ceiba* exhibited the highest anti-inflammatory activity, which was highly significant ($p<0.001$) compared to the aqueous extract ($p<0.01$) and petroleum ether extract ($p<0.05$). This notable anti-inflammatory potential is attributed to the presence of bioactive compounds such as tannins, flavones and flavanones, phenolic compounds, saponins, sterols, and triterpenoids in the extracts (Hossain *et al.,* 2012; Anandarajagopal *et al.,* 2013b).

Gastrointestinal effects: The methanolic extract of *B. ceiba* leaves was investigated for its antidiarrheal activity in rats. The extract significantly reduced diarrhoea, dysentery, and intestinal motility, indicating its effectiveness (Savalia *et al.,* 2019).

Ecological significance

B. ceiba is a very large and tall tree it has become the favourite roosting and resting sites for large birds especially the vultures, eagles, and bats (Jain *et al.,* 2011). The attractive nectar-rich flowers attract numerous pollinators such as bees, butterflies, and various bird species. Fruit and Seed Provision: The capsules of B. ceiba contain seeds surrounded by silky fibres, which are a food source for various animals. Additionally, the flowers and leaves may be consumed by certain herbivorous species, contributing to their dietary needs

(Figure 2). It also plays a role in mitigating climate change by sequestering carbon dioxide from the atmosphere. The roots of *B. ceiba* engage in symbiotic relationships with mycorrhizal fungi, which assist in nutrient uptake. Support for insect populations: The tree provides habitat and food for various insect species, some of which may play roles in pest control or serve as pollinators for other plants. *B. ceiba* contributes to the structural diversity of forests.

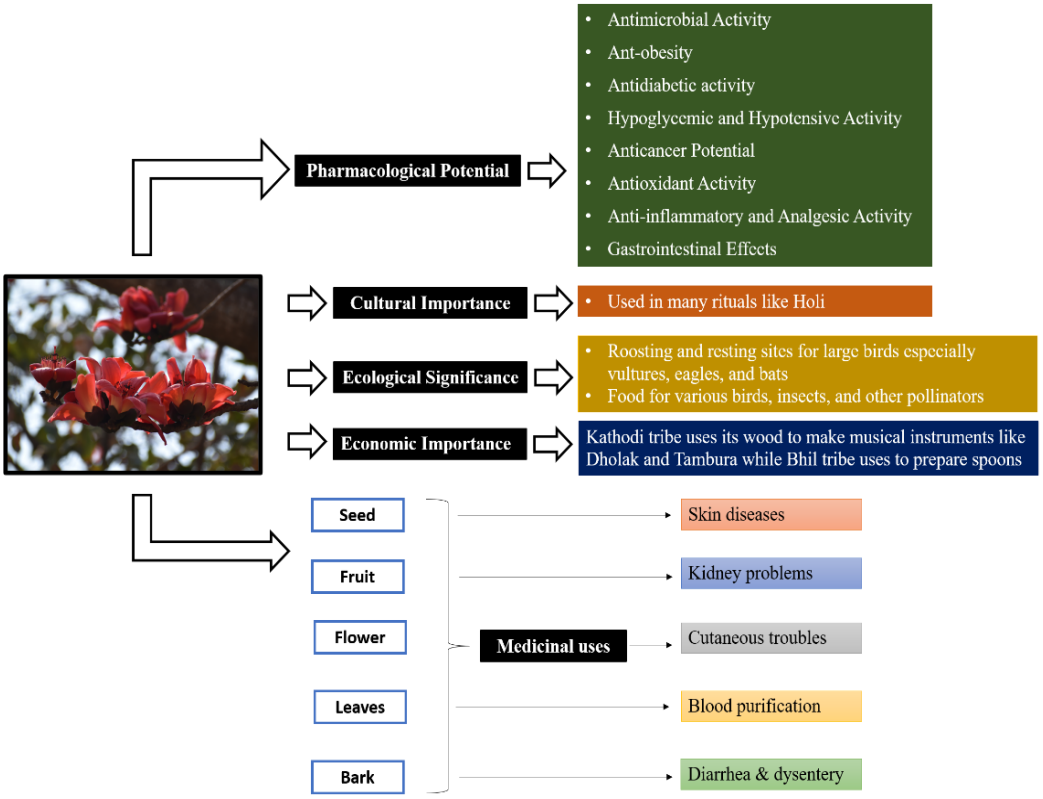

Figure 1: Significance of *B. ceiba*

This diversity is crucial for resilient ecosystems capable of withstanding environmental changes and disturbances. It may play a role in ecological succession, often being one of the pioneer species that establish in disturbed areas, thereby facilitating the establishment of other plant species.

Figure 2: Pollination in *Bombax ceiba* by birds

Cultural and economic importance

B. ceiba, apart from its immense medicinal potential, has been widely used for various commercial and industrial purposes. Deeply rooted in myths, customs, and traditions, this ancient tree holds cultural significance that has been passed down through generations and continues to influence urban and rural communities. While many traditions promote sustainable use and preservation of this beneficial species, certain practices, such as the ritualistic burning of *B. ceiba* during Holi cause significant harm to its survival. This issue is particularly pronounced in Udaipur district, Rajasthan, which has the highest tribal population in the state. Major tribes in the region include the Bhil, Garasia, Kathodi, Meena, and Damor communities (Jain *et al.,* 2009). In Rajasthan Kathodi tribe uses its wood to make musical instruments like Dholak and Tambura while Bhil tribe uses to prepare spoons. The cotton-like

fiber extracted from the fruits, known as kapok, is utilized in making mattresses, cushions, and insulation (Raut *et al.,* 2017).

Conclusion

In addition to its medicinal properties, this plant serves as a significant source of timber and fibre. Nevertheless, additional research is required to thoroughly explore its medicinal capabilities. It is anticipated that forthcoming scientific investigations will identify valuable plant-based active compounds from this tree that can be utilized effectively and safely in the treatment of various contemporary diseases. The over-exploitation of this species in certain regions has raised concerns regarding its conservation, necessitating immediate action. The study highlights the urgent need for sustainable conservation strategies to protect *Bombax ceiba*, ensuring its medicinal, ecological, cultural, and economic benefits are preserved for future generations.

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