Butea monosperma - Botanical, Pharmacological, and Conservation: An Overview

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ABSTRACT

Butea monosperma, commonly known as the flame of the forest, is a medium-sized deciduous tree of the Fabaceae family, renowned for its vibrant orange-red flowers. Native to the Indian subcontinent and Southeast Asia, it thrives in various habitats, including dry deciduous forests and degraded lands. This tree holds significant medicinal, cultural, and ecological value. Its phytochemical constituents, such as flavonoids, tannins, and glycosides, exhibit diverse pharmacological activities, including anti-inflammatory, antimicrobial, and hepatoprotective effects. Despite its ecological importance, *Butea monosperma* faces threats from habitat destruction and overexploitation. Conservation efforts focusing on habitat protection, sustainable harvesting, and community involvement are crucial for its preservation. This monograph provides a comprehensive scientific overview of *Butea monosperma,* encompassing its taxonomy, morphology, distribution, traditional uses, phytochemistry, pharmacology, and conservation status.

INTRODUCTION

Butea monosperma,commonly known as the flame of the forest, palash, dhak, or tesu, is a medium-sized deciduous tree belonging to the family Fabaceae. It is renowned for its vibrant orange-red flowers that appear in the dry season, transforming the landscape into a visual spectacle. This tree is native to the Indian subcontinent and Southeast Asia, where it holds significant cultural, medicinal, and ecological importance. This monograph provides a comprehensive scientific overview of *Butea monosperma*, encompassing its taxonomy, morphology, distribution, ecology, traditional uses, phytochemistry, pharmacology, and conservation status. (Somayaji, A., *et.al.*, 2016)

Taxonomy and Nomenclature

Kingdom: Plantae

Clade: Angiosperms

Clade: Eudicots

Clade: Rosids

Order: Fabales

Family: Fabaceae

Subfamily: Faboideae

Genus: Butea

Species: *Butea monosperma*

The genus name "Butea" honors John Stuart, the third Earl of Bute, a patron of botany. The species epithet "monosperma" refers to the characteristic single seed of the plant's pods.

Morphology

Leaves: The leaves of *Butea monosperma* are pinnate and trifoliate, comprising three leaflets. The leaflets are broadly ovate, measuring 10-20 cm in length and 8-15 cm in width, with a velvety texture on the underside. The petiole is long, supporting the leaflets on a common stalk.

Flowers: The flowers are the most striking feature of *Butea monosperma*. They are bright orange-red, borne in dense racemes at the end of leafless branches. Each flower has a corolla that is papilionaceous, with a large standard petal, two wings, and a keel. The flowering season typically spans from January to April, depending on the geographical location.

Fruits: The fruit is a flat, woody pod, 10-20 cm long and 3-5 cm wide, containing a single seed. The pod is indehiscent, meaning it does not split open to release the seed when mature.

Bark and Stem: The bark is grayish-brown, rough, and fissured, often exuding a reddish resin known as "Butea gum." The stem is sturdy and branches out extensively, contributing to the tree's expansive canopy. (Jain, S., *et.al.*, 2023)

Distribution and Habitat

Butea monosperma is widely distributed across the Indian subcontinent, including India, Nepal, Bangladesh, and Myanmar. It thrives in a variety of habitats, from dry deciduous forests to open grasslands and riverbanks. The tree is tolerant of poor soil conditions and can often be found in degraded lands, making it an important species for reforestation and soil conservation efforts. (Lahori, P., *et.al.*, 2020)

Ecological Adaptations: *Butea monosperma* is well adapted to withstand drought conditions due to its deep root system, which allows it to access groundwater. Its deciduous nature helps conserve water during the dry season, shedding leaves to reduce transpiration.

Traditional Uses

Medicinal Uses: *Butea monosperma* has a long history of use in traditional medicine systems like Ayurveda and Unani. Various

parts of the tree, including the flowers, leaves, bark, seeds, and gum, are utilized for their therapeutic properties.

Flowers: Used as an astringent, tonic, and diuretic. They are also employed in the treatment of various skin diseases, ulcers, and as a febrifuge.

Leaves: Known for their anti-inflammatory and analgesic properties. They are used to treat conditions like rheumatism and joint pain.

Bark: Used as a tonic and anthelmintic. It is also applied externally for wounds and ulcers.

Seeds: Have anthelmintic and antimicrobial properties. They are used to treat intestinal worms and infections.

Gum: Known as "Butea gum" or "Bengal kino," it is used as an astringent and in the treatment of diarrhea and dysentery.

Cultural Uses: *Butea monosperma* holds cultural significance in many regions. The flowers are used in religious rituals and festivals, particularly during the Hindu festival of Holi, where they are used to make natural dyes. The wood is used for making agricultural implements, and the leaves are used as plates and fodder for livestock.

Phytochemistry

The phytochemistry of *Butea monosperma* reveals a rich array of bioactive compounds with diverse therapeutic potentials. Flavonoids, isoflavones, terpenoids, glycosides, phenolic compounds, and steroids present in this plant contribute to its anti-inflammatory, antioxidant, anti-cancer, antimicrobial, hepatoprotective, anti-diabetic, and anti-diarrheal activities. Continued research into these phytochemicals and their mechanisms of action will further elucidate the medicinal value of *Butea monosperma*, paving the way for the development of novel therapeutic agents derived from this remarkable plant. (Somayaji, A., *et.al.*, 2016)

Key Phytochemicals

Flavonoids

- **Butrin:** Butrin is a significant flavonoid glycoside found in *Butea monosperma* flowers. It has demonstrated various pharmacological activities, including anti-inflammatory and antioxidant properties.
- **Coreopsin**: Another important flavonoid glycoside, coreopsin, is present in the flowers. It exhibits antimicrobial and hepatoprotective effects. (Somayaji, A., *et.al.*, 2016)
- **Isobutrin:** Isobutrin is a structural isomer of butrin, also found in the flowers, contributing to the plant's anti-inflammatory and analgesic properties.

Isoflavones

- **Butein:** Butein, an isoflavone, is one of the most studied compounds in *Butea monosperma.* It has been shown to possess anti-cancer, anti-diabetic, and anti-inflammatory activities. Butein inhibits various enzymes, such as tyrosinase and xanthine oxidase, which are linked to its therapeutic potential.
- **Sulphurein:** Sulphurein, another isoflavone, exhibits significant antioxidant activity, protecting cells from oxidative stress (Somayaji *et.al.*, 2016).

Terpenoids

- Lupenone: Lupenone is a triterpenoid present in the leaves and stems of *Butea monosperma*. It has demonstrated anti-inflammatory and anti-tumor activities.

- Lupeol: Lupeol, another triterpenoid, is known for its anti-inflammatory, anti-cancer, and hepatoprotective properties.

Glycosides

- Palasitrin: Palasitrin is a glycoside isolated from the bark and flowers of *Butea monosperma*. It has shown promise in anti-fungal and anti-bacterial applications.

- Palastrin: This glycoside is known for its anti-diarrheal properties and is traditionally used in treating gastrointestinal disorders.

Phenolic Compounds

- Chalcones: Chalcones, such as butein and isoliquiritigenin, are phenolic compounds with significant anti-inflammatory and antioxidant activities.

- Tannins: Tannins present in the bark contribute to the astringent properties of *Butea monosperma*, making it useful in treating diarrhea and dysentery.

Steroids

- β-Sitosterol: β-Sitosterol is a phytosterol found in the seeds and leaves. It exhibits anti-inflammatory, anti-cancer, and cholesterol-lowering effects.

Biological Activities

Anti-inflammatory Activity

The anti-inflammatory potential of *Butea monosperma* is primarily attributed to its flavonoids and isoflavones. Butein, in particular, inhibits the release of pro-inflammatory cytokines and reduces the expression of cyclooxygenase-2 (COX-2), thereby mitigating inflammation.

Antioxidant Activity

The antioxidant activity of *Butea monosperma* is significant, with flavonoids such as butrin and isobutrin playing a crucial role. These compounds scavenge free radicals, reduce oxidative stress, and protect cellular structures from damage (Jain *et.al.*, 2023).

Anti-cancer Activity

Butein has been extensively studied for its anti-cancer properties. It induces apoptosis in various cancer cell lines, inhibits angiogenesis, and suppresses metastasis. The anti-cancer mechanism involves the modulation of multiple signaling pathways, including the inhibition of nuclear factor-kappa B (NF-κB) and the activation of the p53 pathway (Lahori *et.al.*, 2020).

Antimicrobial Activity

Butea monosperma exhibits broad-spectrum antimicrobial activity against bacteria, fungi, and viruses. Compounds such as coreopsin and palasitrin disrupt microbial cell walls and inhibit the growth and proliferation of pathogens.

Hepatoprotective Activity

The hepatoprotective effects of *Butea monosperma* are attributed to its isoflavones and terpenoids. These compounds protect hepatocytes from damage caused by toxins and oxidative stress, enhance liver function, and promote the regeneration of liver tissues.

Anti-diabetic Activity

Butea monosperma shows promise in managing diabetes mellitus. Butein and other flavonoids improve insulin sensitivity, enhance glucose uptake, and inhibit enzymes involved in carbohydrate digestion, thereby reducing postprandial blood glucose levels.

Anti-diarrheal Activity

The astringent properties of tannins and glycosides in *Butea monosperma* are effective in treating diarrhea. These compounds reduce

intestinal motility, enhance water absorption, and provide relief from gastrointestinal discomfort. (Lahori *et.al.*, 2020)

Pharmacological Activities

Research has validated many traditional uses of *Butea monosperma*, demonstrating a variety of pharmacological activities:

Anti-inflammatory and Analgesic: Extracts from the leaves, flowers, and bark have shown significant anti-inflammatory and analgesic effects, supporting their traditional use in treating pain and inflammation.

Antimicrobial: The seeds, leaves, and bark exhibit antimicrobial activity against a range of bacterial and fungal pathogens, making them useful in treating infections.

Antioxidant: The presence of flavonoids and other polyphenols contributes to the potent antioxidant activity of *Butea monosperma*, helping in neutralizing free radicals and reducing oxidative stress.

Antidiabetic: Studies have shown that extracts from the leaves and flowers can lower blood glucose levels, indicating potential benefits in managing diabetes.

Hepatoprotective: The glycosides and flavonoids in *Butea monosperma* have been found to protect liver cells from damage induced by toxins, supporting its traditional use in liver disorders.

Anthelmintic: The seeds and bark exhibit significant anthelmintic activity, validating their use in treating intestinal worm infections.

Conservation and Management

Despite its wide distribution and ecological significance, *Butea monosperma* faces threats from habitat destruction, overexploitation, and changing land use patterns. Conservation efforts are necessary to ensure the sustainability of this valuable species. Strategies for conservation and management include:

Habitat Protection: Preserving natural habitats where *Butea monosperma* grows and promoting reforestation in degraded areas.

Sustainable Harvesting: Implementing guidelines for the sustainable collection of medicinal and other plant parts to prevent overexploitation. (Lahori *et.al.*, 2020)

Ex Situ Conservation: Establishing seed banks and botanical gardens to conserve genetic diversity and facilitate research on propagation techniques.

Community Involvement: Engaging local communities in conservation efforts, providing education on sustainable practices, and promoting the cultural and economic value of *Butea monosperma*.

CONCLUSION

Butea monosperma, with its striking floral display and rich medicinal properties, is a vital species in both ecological and cultural contexts. Its ability to thrive in diverse and challenging environments underscores its ecological significance, while its phytochemical richness affirms its medicinal value. Despite its widespread distribution, the species faces significant conservation challenges due to habitat loss and overexploitation. Effective conservation strategies, including habitat protection, sustainable harvesting, ex situ conservation, and community engagement, are essential to ensure the sustainable use and preservation of Butea monosperma. Continued research and conservation efforts will help maintain its ecological balance and medicinal utility for future generations.

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