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Comprehensive Exploration of Butea monosperma: A Valuable Medicinal Resource

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Abstract:

Butea monosperma, a moderate-sized deciduous tree belonging to the Fabaceae family, is abundantly distributed across India, Burma, and Ceylon, recognized colloquially as 'dhak' or 'palas,' and commonly referred to as the 'Flame of the forest.' Within the vast Fabaceae family comprising 630 genera and 18,000 species, Butea monosperma stands out for its multifaceted utility, encompassing both medicinal and commercial applications. Each component of this tree serves a distinct purpose, contributing to its extensive use.

Traditionally, Butea monosperma has been attributed with a range of beneficial properties, including astringent, bitter, alterative, aphrodisiac, anthelmintic, antibacterial, and anti-asthmatic attributes. The tree's bark is renowned for yielding a vibrant red juice known as 'Butea gum' or 'Bengalkino.' Pharmacologically, this versatile plant exhibits a wide spectrum of effects, such as anthelmintic, anticonceptive, anticonvulsive, antidiabetic, antidiarrheal, antiestrogenic, antifertility, antimicrobial, antifungal, antibacterial, antistress, chemopreventive, hemagglutinating, hepatoprotective, radical scavenging, thyroid inhibitory, antiperoxidative, hypoglycemic, and wound healing activities.

Furthermore, Butea monosperma's seeds possess notable anthelmintic properties, particularly effective against roundworms and tapeworms. The plant's vibrant flowers yield a striking yellow coloring substance attributed to the presence of chalcones. The use of such herbal medicines derived from Butea monosperma holds promise, offering potential benefits in comparison to conventional synthetic drugs, often with fewer or negligible side effects. This comprehensive review highlights the diverse range of biological activities associated with Butea monosperma, underlining its significance as a valuable medicinal resource.

Keywords : *Butea monosperma*, Butin, Palash, dhak.

Introduction :

Butea monosperma, commonly referred to as the "Flame of the forest" and a member of the Fabaceae family, is deeply entrenched in the cultural and botanical landscape of India, Burma, and Ceylon. Known by various vernacular names such as palas, palash, mutthuga, bijasneha, dhak, khakara, Bastard Teak, Bengal Kino, and Nourouc, this tree's presence spans the vast regions of these countries, except for the most arid areas.

The significance of Butea monosperma extends beyond its botanical taxonomy, as it plays a pivotal role in the local ecosystems and traditional knowledge systems. The collection of its pods, strategically timed before the onset of monsoon rains, is a practice deeply ingrained in the region. Additionally, the plant readily produces root suckers, facilitating its vegetative propagation, thereby sustaining its presence and utility.

Within the genus Butea, which includes Butea monosperma parviflora, Butea minor, and Butea superba, Butea monosperma stands as a distinguished member, cherished for its versatile flowers. These blossoms find extensive use in treating hepatic disorders, viral hepatitis, diarrhea, and as depuratives and tonics. Rich in flavonoids, the flowers are a valuable source of compounds such as Butein, Butrin, Isobutrin, Plastron, Coreipsin, and Isocoreipsin, each contributing to its medicinal properties.

Furthermore, the plant's therapeutic repertoire extends to the isolation of medicarpin, an antifungal agent, from various parts of the plant, including the flowers. The complex chemistry of Butea monosperma has also revealed the presence of flavonoids like Butin, Butein, Butrin, Isobutrin, Palasitrin, Coreopsin, Isocoreopsin, Sulphuresin, Monospermoside, Isomonospermoside, and 7,3,4-trihydroxyflavone, showcasing the plant's diverse bioactive constituents.

Moreover, the stem of this remarkable species yields valuable compounds such as the Euphane triterpenoid 3a-hydroxyeuph-25-ene and the alcohol 2, 14-dihydroxy-11, 12-dimethyl-8-oxo-octadec-11-enylcyclohexane, further expanding the potential applications of Butea monosperma.

Intriguingly, the pods of this plant species have yielded palasimide, an imide with unique properties. Additionally, studies on antioxidant status following ulceration have hinted at the role of free radicals in conditions such as pylorus ligation and ethanol-induced ulceration in rats, shedding light on potential therapeutic implications.

This comprehensive introduction sets the stage for a detailed exploration of the multifaceted attributes and potential medicinal applications of Butea monosperma, emphasizing its significance in both traditional practices and modern pharmacological research.

Botanical Description

Morphological Characteristics

Butea monosperma presents itself as an upright, moderately-sized deciduous tree, typically reaching a height of 12-15 meters. Its growth pattern is characterized by a gracefully twisted trunk and irregularly branching limbs. The tree exhibits a gradual rate of growth, eventually achieving a mature stature of approximately 5 to 8 meters in height and a diameter ranging from 20 to 40 centimeters after approximately five decades of growth.

The wood of this tree possesses a distinctive greenish-white hue and maintains a soft texture, with a weight averaging around 14 to 15 kilograms per cubic foot. The bark of Butea monosperma takes on an ashen appearance, contributing to its unique visual characteristics.

Leaves

Butea monosperma boasts compound leaves comprising three distinct leaflets. These leaves exhibit remarkable features, with petioles measuring 10-15 centimeters in length and stipules. The leaflets themselves are sizeable and tripartite, measuring approximately 10-15 centimeters long. They display an obtuse shape and a smooth, hairless upper surface, while the underside reveals a finely silky texture and prominent reticulate veining, converging towards a cunnate or deltoid base.

Flower

The blossoms of Butea monosperma make their graceful debut in the month of February and continue to grace the tree until late April. These flowers boast a diameter ranging from approximately 2 to 4 centimeters and exhibit a striking tendency to cluster densely along the branches adorned with leaflets. When viewed from afar, the profusion of these blossoms on the upper reaches of the tree conjures an image reminiscent of a distant, vibrant flame.

Fruits

The fruit of the palas tree takes the form of a flat legume, characterized by stalks measuring 12.5-20 centimeters in length and 2.5-5 centimeters in width. These pods are distinguished by their pronounced thickening along the sutures. Young pods are covered in a dense layer of fine hair, giving them a velvety appearance, while mature pods gracefully hang downward.

Seeds

The seeds of Butea monosperma present themselves as flat, measuring between 25 to 40 millimeters in length, 15 to 25 millimeters in width, and with a thickness of 1.5 to 2 millimeters. Encased within a reddish-brown, glossy, and wrinkled seed coat, these seeds contain two substantial, leafy, yellowish cotyledons[1].

Distribution

Butea monosperma exhibits a widespread presence, with its habitat extending across a significant expanse of both India and Burma. It can be found at altitudes of up to 1000 meters, and in the outer Himalayan regions, it can even be encountered at higher elevations. In specific locales such as Khandesh Akrani, it reaches elevations of up to 1200 meters, while in the hills of South India, it thrives at altitudes of up to 1300 meters.

Fig. 1(a) Butea monosperma tree

Fig. 1(b) Butea monosperma flower

Fig. 1© Butea Monosperma leaves

Fig. 1(d) Butea monosperma seeds

Vernacular Names in India

In India, Butea monosperma goes by various vernacular names, reflecting its cultural diversity:

Sanskrit: Palasa
Hindi: Dhak, Palas
English: Bastard Teak
Bengali: Mal & Mar

Gujarati: Khakharo
Marathi: Kakracha
Telugu: Mooduga, Palasamu
Tamil: Parasa
Kannada: Muttuga
Malayalam: Brahmavriksham, Kimshukam
Punjabi: Chichra, Dhak, Palas[2,3]

Phytochemical Constituents of Butea monosperma

The flower of Butea monosperma primarily contains butrin (1.5%), along with butein (0.37%) and butin (0.04%). Additionally, the flowers contain flavonoids and steroids. In addition to these compounds, the flowers also feature coreopsin, isocoreopsin, sulphurein (a glycoside), as well as two compounds with monospermoside and isomonospermoside structures. The roots contain glucose, glycine, glucosides, and aromatic compounds. Gum and stem bark yield tetramers of leucocynidin, while the seeds contain oil. The vibrant color of the flowers can be attributed to the presence of chalcones and aurones[3,4,5].

Medicinal Uses of Butea monosperma

Butea monosperma plays a significant role in Ayurveda, Unani, Homeopathic medicine, and modern medicine, making it a focal point of interest in the medical field. Plants within this genus are renowned for their coloring properties. Butea monosperma is commonly employed as a tonic, astringent, aphrodisiac, and diuretic.

The **roots** are valuable for treating filariasis, night blindness, helminthiasis, piles, ulcers, and tumors. They are also reported to exhibit antifertility, aphrodisiac, and analgesic activities.

The **flowers** find utility in addressing conditions like diarrhea, serving as an astringent, diuretic, depurative, and tonic. They are also used in the treatment of leprosy, skin diseases, gout, and conditions involving thirst and burning sensations.

The **stem bark** serves indigenous medicine by addressing dyspepsia, diarrhea, dysentery, ulcers, sore throat, and snakebites. Beyond its medicinal applications, Butea monosperma has economic value.

Its **leaves** are utilized in crafting platters, cups, and bowls, while the bark fibers are employed for making cordage.

Wood from the Butea monosperma tree finds practical application in constructing well curbs and crafting water scoops, making it a cost-effective choice for such purposes. Additionally, this wood pulp proves suitable for the production of newsprint, further enhancing its economic value.

Notably, Butea monosperma also plays host to the Lac insect, which is responsible for producing natural lacquer. In traditional medicine, various parts of the plant are employed to address diverse health issues. For instance, the root is utilized in treating conditions like night blindness, elephantiasis, impotency, and snakebites. It is even known to induce temporary sterility in women and is applied in cases of sprue, piles, ulcers, tumors, and dropsy.

The **seeds** of Butea monosperma serve medicinal purposes, particularly in addressing inflammation, skin and eye diseases, bleeding piles, urinary stones, abdominal troubles, intestinal worms, and tumors. When these seeds are crushed and combined with lemon juice, they act as a rubefacient when applied to the skin[6,7,8].

Experimental trial on animal models, conducted by different laboratories and authors

Antimicrobial Properties

A novel bioactive flavone glycoside was extracted from the methanol-soluble fraction of Butea monosperma's flowers. This compound, identified as 5,7-dihydroxy-3,6,4'-trimethoxyflavone-7-Oα-L-xylopyranosyl-(1→3)-O-α-L-arabinopyranosyl-(1→4)-O-β-D-galactopyranoside through various color reactions, chemical degradations, and spectral analysis, displayed potent antimicrobial effects against a range of fungal species.

In another study, the in vitro antimicrobial efficacy of Butea monosperma seed oil was assessed using the filter paper disk method. The results revealed that the oil exhibited significant bactericidal and fungicidal properties, making it effective against various pathogenic bacteria and fungi commonly associated with human health issues[9,10].

Antifungal Activity

Fungal endophytes were isolated from the inner bark segments of the ethnopharmaceutically significant Butea monosperma tree. Extracts obtained from the stem bark of B. monosperma using petroleum ether and ethyl acetate displayed notable antifungal effects against Cladosporium cladosporioides. The active compound, which possessed low polarity, was identified as (-)-medicarpin through a process involving bioassay-monitored chromatographic fractionation and physical data comparison. Interestingly, (-)-medicarpin exhibited superior antifungal activity compared to Benlate, a standard fungicide, while (-)-medicarpin acetate also demonstrated significant effectiveness against C. cladosporioides[11,12].

Chemopreventive Activity

The potential chemopreventive properties of B. monosperma extract were investigated concerning hepatic carcinogenesis and markers induced by tumor promoters, as well as oxidative stress in male Wistar rats. The administration of 2-AAF intraperitoneally to male Wistar rats over five consecutive days induced significant hepatic toxicity, oxidative stress, and hyperproliferation. However, pretreatment with B. monosperma extract at doses of 100 and 200 mg/kg body weight effectively countered oxidative stress by restoring antioxidant enzyme levels and mitigating toxicity at both doses[13].

Anthelmintic Activity

In a study involving naturally infected sheep with mixed species of gastrointestinal nematodes, B. monosperma seeds administered as a crude powder exhibited a dose-dependent and time-dependent anthelmintic effect. The highest reduction, reaching 78.4% in eggs per gram of feces (EPG), was observed ten days after treatment with 3 g/kg of the seeds. Levamisole, a standard anthelmintic agent, displayed a more substantial 99.1% reduction in EPG when compared. Additionally, the methanol extract of B. monosperma seeds demonstrated significant anthelmintic activity in vitro[14].

Antihyperglycemic Activity

The antihyperglycemic potential of the ethanolic extract of B. monosperma was assessed in glucose-loaded and alloxan-induced diabetic rats. A single dose of the ethanolic extract at 200 mg/kg significantly improved glucose tolerance and reduced blood glucose levels in alloxan-induced diabetic rats. Repeated oral treatment with the extract at 200 mg/kg/day over two weeks led to a significant decrease in blood glucose levels, serum cholesterol, and an improvement in HDL-cholesterol and albumin levels, compared to the diabetic control group[15].

Antidiarrheal Activity

The ethanolic extract of B. monosperma stem bark was evaluated for its antidiarrheal potential using various experimental models in Wistar albino rats. The extract effectively inhibited castor oil-induced diarrhea and PGE2-induced enteropooling in rats. Furthermore, it reduced gastrointestinal motility following charcoal meal administration. These results support the efficacy of this herbal remedy as a non-specific treatment for diarrhea, aligning with its traditional use in folk medicine[16].

Antiviral Activity

From the seeds of Butea monosperma, a potential antiviral flavone glycoside has been successfully isolated. Its chemical structure has been elucidated as 5,2'-dihydroxy-3,6,7-trimethoxyflavone-5-O-β-D-xylopyranosyl-(1→4)-O-β-D-glucopyranoside through meticulous analysis using various spectral techniques and chemical degradations. This compound shows promise for its antiviral activity, particularly against certain strains of viruses[17].

Anticonvulsant Activity

Researchers conducted a bioassay-guided fractionation of dried Butea monosperma flowers to isolate the active component responsible for its anticonvulsant properties. The petroleum ether extract underwent fractionation using solvents of differing polarities, including n-hexane, n-hexane:ethyl acetate, ethyl acetate,

and methanol. This exploration led to the discovery of a triterpene compound (TBM) in the n-hexane:ethyl acetate (1:1) fraction of the petroleum ether extract, showcasing anticonvulsant activity against seizures induced by maximum electroshock (MES). Additionally, TBM displayed effectiveness against seizures induced by pentylenetetrazol (PTZ), electrical kindling, and the combination of lithium sulfate and pilocarpine nitrate (Li-Pilo). However, TBM did not prove effective against seizures induced by strychnine and picrotoxin. Notably, TBM exhibited a depressant effect on the central nervous system. Upon repeated use for seven days, the PD50 (MES) of TBM increased, indicating a potential role in the treatment of epilepsy[18].

Anti-Giardial and Immuno-Stimulatory Activity

Pippali rasayana, an Ayurvedic herbal remedy prepared from Piper longum and Butea monosperma, traditionally used for the treatment of chronic dysentery and worm infestations, was examined for its anti-giardial and immunostimulatory effects in mice infected with Giardia lamblia trophozoites. The rasayana exhibited remarkable results, with up to a 98% recovery rate from the infection. Interestingly, it did not exert a direct killing effect on the parasite in vitro. Instead, it induced significant activation of macrophages, as evidenced by increased macrophage migration index (MMI) and heightened phagocytic activity. This enhancement of host resistance likely played a crucial role in the animals' recovery from giardial infection[19].

Anti-Implantation Activity

Butin, isolated from Butea monosperma seeds and administered orally to adult female rats at doses of 5, 10, and 20 mg/kg from the first day to the fifth day of pregnancy, exhibited anti-implantation activity. The treatment led to a dose-dependent termination of pregnancy and a reduction in the number of implantation sites, with 90% of treated animals experiencing termination at the highest dose. Additionally, in ovariectomized young female rats, butin demonstrated estrogenic activity at doses comparable to those exerting anticonceptive effects but lacked antiestrogenic properties. Notably, butin displayed a weak estrogenic effect, as even at 1/20th of the anticonceptive dose, it induced a significant uterotrophic effect[20].

Antihepatotoxic Activity

An extract derived from Butea monosperma flowers, a plant traditionally used in India for treating liver disorders, exhibited significant antihepatotoxic activity in various models of liver damage. The extract was subjected to fractionation via solvent partitioning and HPLC. The antihepatotoxic principles identified included two known flavonoids: isobutrin (3, 4, 2', 4'-tetrahydroxychalcone-3, 4'-diglucoside) and the less active butrin (7, 3', 4'-trihydroxyflavanone-7, 3'-diglucoside). A dedicated HPLC system was developed for the qualitative and quantitative analysis of isobutrin and butrin in Butea monosperma flower extracts. These compounds hold promise for their potential use in treating liver-related ailments[21].

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