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Ethnobotany and Ethanopharmacology of Butea Monosperma (Lam) Kuntze- A Compressive Review

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ABSTRACT

In traditional medicine, there are many natural crude drugs that have the potential to treat many disease and disorders, one of them is *Butea monosperma* (Lam.) Taub (Syn. *Butea frondosa*; Family Fabaceae) popularly known as 'palas', and commonly known as 'Flame of forest'. *Butea monosperma* is a tree of tropical and subtropical climate found throughout the drier parts of India, often gregarious in forests, open grasslands and wastelands. It grows on a wide variety of soils including shallow, gravelly sites, black cotton soil, clay loams, and even saline or waterlogged soils. It is an erect, medium sized tree of 12-15 m high, with a crooked trunk and irregular branches. There are various species of Butea monosperma available over the world. The leaves 3 foliate, large and stipulate. Number of constituents belonging to imides, lactones, flavonoids, sterols, and alkaloids has been reported from various species of *Butea*. *Butea monosperma* is considered as a good source for products such as fodder, fuel, fibre, timber, gum or resin, dyestuff and traditionally in number of ailments. Pharmacologically *Butea monosperma* has been reported for various activities such as anthelmintic, anticonceptive, anticonvulsive, antidiabetic, antidiarrhoeal, antiestrogenic and antifertility, antiinflammatory, antimicrobial, antifungal, antibacterial, antistress, chemopreventive, haemaggultinating, hepatoprotective, radical scavenging, thyroid inhibitory, antiperoxidative and hypoglycemic effects and wound healing activities. The present review discusses the morphology, ethanobotany, phytochemical constituents, and traditional uses of each part of plants as well products of plant and pharmacological activities of each part of plant in details.

Keywords: Butea monosperma, morphology, ethnobotany, phytochemical, traditional uses, pharmacological properties

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INTRODUCTION

It is evident that without nature, human being life is impossible. There are three basic necessity of humans is food, clothes and shelter and now the fourth one is good health, which provided by plant kingdom. Nature stands a golden mark and provides the storehouse of remedies to cure all ailments of mankind. Plant kingdom represents a rich house of organic compounds, many of which have been used for medicinal purposes and could serve as lead for the development of novel agents having good efficacy in various pathological disorders in the coming years. Herbs have always been the principal form of medicine in India and presently they are becoming popular throughout the world, as people strive to stay healthy in the face of chronic stress and pollution, and to treat illness with medicines that work in count with the body's own defense. There is a widespread belief that green medicines are healthier and more harmless or safer than synthetic ones.

In traditional medicine, there are many natural crude drugs that have the potential to treat many disease and disorders. One of them is *Butea monosperma* (Lam.) Taub (Syn. *Butea frondosa*; Family Fabaceae) popularly known as 'palas', and commonly known as 'Flame of forest', palash, mutthuga, bijasneha, khakara, chichara, Bastard teak, Bengal kino[1].

Butea monosperma (Palas) is a medium-sized deciduous tree. It grows throughout the Indian subcontinent, especially in Indo-Gangetic plains. It is said that the tree is a form of Agnidev, God of Fire. It was a punishment given to him by Goddess Parvati for disturbing her and Lord Shiva's privacy. This tree gets up to 50 ft high, with stunning flower clusters. It loses its leaves as the flowers developed, in January - March. The trunk becomes twisted and gnarled by the wind, making it a conversation piece which is used as a specimen, or as a background component of the canopy.

Other Name/Synonyms of Butea Monosperma[2]

English **:** Flame of the forest, Bastard teakS, Parrot Tree

Hindi **:** Dhak, Palas, Chichra tesu, desukajhad, chalcha, kankrei

Marathi **:** Palas, Kakracha

Panjabi : Tesh

Kannada **:** Muttagamara, Muttulu

Malayalam **:** Plasu Camata, Muriku, Shamata

Sanskrit **:** Palasah, Kimsuka, Bramha Vrksa

Assamese **:** Palash

Oriya : Porasu, Kijuko

Tamil **:** Porasum, Parasu , Camata

Telugu **:** Modugu Puvvu

Gujrat **:** Khakhrao, Kesuda

Bangal **:** Palas, Polashi

Urdu **:** Palashpapra, Dhak (Tesu)

Scientific Classification of Butea Monosperma[3]

Kingdom	Plantae – Plants
Sub-kingdom	Tracheobionta – Vascular plants
Super-division	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Subclass	- Rosidae
Order	Fabales
Family	Fabaceae – Pea family
Genus	Butea Roxb.ex Wild. – Butea
Species	Monosperma (Lam.) Taubert – Bengal kino

Ecology

Butea monosperma is a tree of tropical and subtropical climate found throughout the drier parts of India, often gregarious in forests, open grasslands and wastelands. It is a characteristic tree of the plains, often forming pure patches in grazing grounds and other open places, escaping extermination owing to its resistance to browsing and its ability to reproduce from seed and root suckers. In its native habitat, most of the rain is received during the monsoon season, while the autumn and summer months are generally dry. The tree is very drought resistant and frost hardy, although the leaves turn white and fall off [4-8].

Biophysical Limits

Altitude:

Up to 1500 m, Mean annual temperature: -4 to 49^{0}C, Mean annual rainfall: 450-4500 mm[5].

Soil type:

It grows on a wide variety of soils including shallow, gravelly sites, black cotton soil, clay loams, and even saline or waterlogged soils. Seedlings thrive best on a rich loamy soil with pH 6-7 under high temperature and relative humidity [5,6].

Butea Species

There are various species of *Butea monosperma* available over the world they are as; *Butea acuminate, Butea affinis, Butea Africana, Butea apoensis, Butea balansae, Butea braamiana, Butea bracteolate, Butea cuneiforms, Butea crassfolia, Butea dubia, Butea ferruginous, Butea gyrocarpa, Butea harmandii, Butea laotica, Butea listeri, Butea littoralis, Butea loureirii, Butea macroptera, Butea maingayi, Butea merguensis, Butea minor, Butea oblong folia, Butea parviflora, Butea pellita, Butea peltata, Butea philippinensis, Butea potting, Butea pulchara, Butea purpurea, Butea ridleyi, Butea riparia, Butea rosea, Butea sanguinea, Butea sericophylla, Butea spirei, Butea squirmier, Butea suberecta, Butea superba, Butea varians, Butea volubilis* [9].

DOCUMENTED SPECIES DISTRIBUTION

Native: Cambodia, India, Indonesia, Japan, Laos, Myanmar, Nepal, Sri Lanka, Thailand, Vietnam

Exotic: China, Papua New Guinea

The above map shows countries where the species has been planted. It does neither suggest that the species can be planted in every ecological zone within that country, nor that the species cannot be planted in other countries than those depicted. Since some tree species are invasive and need to follow biosafety procedures that apply to planting site [5,8].

MORPHOLOGY OF BUTEA MONOSPERMA

It is an erect, medium sized tree of 12-15 m high, with a crooked trunk and irregular branches. The shoots are clothed with gray or brown silky pubescence. The bark is ash colored. The leaves 3 foliate, large and stipulate. Petiole is 10-15 cm long. Leaflets are obtuse, glabrous above, finely silky and conspicuously reticulately veined beneath with cunnate or deltoid base. From January to March the plant is bald. Flowers in rigid racemes of 15 cm long, densely brown velvety on bare branches. Calyx is dark, olive green to brown in colour and densely velvety outside. The

corolla is long with silky silvery hairs outside and bright orange red. Stamens are diadelphes, anthers uniform. Ovary has 2 ovule, style filiform, curved and stigma capitate. Pods argenteocanesent, narrowed, thickened at the sutures, splitting round the single apical seed, lowest part indehiscent. The seeds are flat, reniform, curved. The bark of palas is fibrous and bluish gray to light brown in color. It exudes a kind of red juice when injured.

The leaves are compound having three leaflets per leaf. The texture of the leaflets is fairly tough, coriascious with the surface glabrescent above and hairy silken beneath. The size varies from 15 cm to 20 cm by 10 cm x 15 cm. The shape is obliquely ovate and broadly elliptic (Figure.1). The leaves fall off by December and reappear during spring.

Figure 1: **Leaves of *Butea monosperma***

When the tree is leafless, it bears flaming orange to red-colored flower (Figure. 2). These flowers start appearing in February and stay on nearly up to the end of April. The size is nearly 2 to 4 cm in diameter. The calyx i.e. the lower whorl of the flower tends to be darkish gray like the supporting branch itself. The upper parts are brick red. These give the plant so handsome look despite it is leafless during spring season when entire terrain having palas trees wears a kind of exquisite orange and red hue. The flowers form a gorgeous canopy on the upper portion of the tree, giving the appearance of a flame from a distance.

The fruit of palas is a flat legume; a pod, nearly 15 cm long and 3 to 5 cm wide. Young pods have a lot of hair a velvety cover. The mature pods hang down like peculiar legumes. The seeds are flat, from 25 to 40 mm long, 15 to 25 mm wide, and 1.5 to 2 mm thick. The seed-coat is reddish-brown in color, glossy, and wrinkled, and encloses two large, leafy, yellowish cotyledons. The hilum is conspicuous, and situated near the middle of the concave edge of the seed.

Figure 2: Flowers of *Butea monosperma*

The wood is greenish white in color. It is porous and soft in texture and has annual rings though not very distinct. It generally perishes fast when used at sites open to vagaries of weather, but lasts much longer when used under water. It is therefore used for making well curbs and piles [10-15].

PHYTOCHEMISTRY

A number of constituents have been reported from various species of Butea and they belong to imides, lactones, flavonoids, sterols, and alkaloids [16].

Flowers

The main phytoconstituents of *B. monosperma* are butrin (1.5%), butein (0.37%) and butin (0.04%) [17]. Triterpene, isobutrin, coreopsin, isocoreopsin (butin 7-glucoside), sulphurein, monospermoside (butein 3-e-D-glucoside), isomonospermoside, chalcones, aurones, flavonoids (palasitrin, prunetin) and steroids are other phytoconstituents present in the flower. Phytochemical screening of the dried flowers of the allied species *B. frondosa* showed the presence of seven flavones and flavonoid constituents including butrin and isobutrin and also four free amino acids [18, 19].

Gupta et al. (1970) investigated three glucosides, identified as coreopsin, isocoreopsin and sulphurein. The remaining two are new and have been assigned the structures monospermoside and isomonospermoside [18]. Shah et al. (1992) isolated and identified free sugars and free amino acids from the petroleum ether extract of flowers [20].

Seeds

The seed of B. monosperma contains oil, proteolytic and lypolytic enzymes, plant proteinase and polypeptidase, a nitrogenous acidic compound, along with palasonin. It also contains monospermoside (butein 3-e-D-glucoside) and somonospermoside. From seed coat allophonic

acid has been isolated and identified [21, 22].

Singh et al. (1974) reported components of soft resin. Four essentially pure acid esters, which together constitute the bulk of soft resin were isolated. These acid esters were termed as jalaric ester-I, jalaric ester-II, laccijalaric ester-I and laccijalaric ester-II [19].

Leaves

Glucoside, Kino-oil contain oleic and linoleic acid, palmitic and lignoceric acid [23]. Mishra et al. (2000) reported 3,9-dimethoxypterocapan from ethyl acetate fraction of methanol extractives from leaves, and hexane fraction of methanol extractives yielded 3-alphahydroxyeuph- 25-enylheptacosanoate [24].

Barks

Contain kino-tannic acid, gallic acid and pyrocatechin [Nadkarni, 2002]. The plant also contains palasitrin, and major glycosides as butrin, alanind, allophanic acid, butolic acid, cyanidin, histidine, lupenone, lupeol, (-) - medicarpin, miroestrol, palasimide and shellolic acid [24, 25].

Stems

Guha et al. (1990) isolated 3-Z-hydroxyeuph-25-ene and 2, 14-dihydroxy-11, 12-dimethyl-8-oxo-octadec-11- enylcyclohexane from *B. monosperma* [26]. Shukla et al. (2000) isolated Stigmasterol-e-Dglucopyranoside and nonacosanoic acid [27].

Traditional Uses

Flowers:

Flowers are astringent to bowel, used to cure “Kapha”, leprosy, strangury, gout, skin diseases, thirst, sensation; flower juice is useful in eye diseases. Flower is bitter, aphrodisiac, expectorant, tonic, emmenagogue, diuretic, good in biliousness, inflammation and gonorrhoea. The dye is useful in enlargement of spleen. Flowers are depurative, as a poultice they are used to disperse swelling and to promote menstrual flow. It is also useful to prevent pus from urinogenital tracts of males. Flowers are crushed in milk and sugar is added, 3-4 spoons if drunk per day for a month helps to reduce body heat and chronic fever. Flowers are soaked in water overnight and a cup of this infusion is drunk every morning against leucorrhoea till cure [28-30].

Seeds:

Powdered seeds are consumed by children as remedy against intestinal worms. Seeds are crushed in milk and this mixture about 2 spoons is taken orally to treat urinal complaints and also against urinary stones. Fruit and seed are digestible, aperient, cure ‘Vata’ and ‘Kapha’, skin diseases, tumours, abdominal troubles and as per Ayurveda are given for Scorpion-sting. Fruit and seed are useful in piles, eye diseases and inflammation. When pounded with lemon juice and applied

act as powerful rubefacient and they have been successfully used in curing a form of herpes, knows as Dhobie's itch [31-34].

Leaves:

Leaves are good for the disease of the eye. Leaf is an appetizer, astringent, carminative, anthelmintic, aphrodisiac, tonic, lessens inflammation and lumbago, cures boils and piles. Petiole is chewed and the juice is sucked to cure cough, cold and stomach disorders. Leaf powder about 2 spoons per day for a month is drunk mixed with a cup of water to cure diabetes. Leaf extract is used as gargle in case of sore throat. Leaf extract about 3-4 spoons is drunk at night for 2-3 months. It checks irregular bleeding during menstruation [28-30, 32].

Gum:

Gum is applied for cracks on foot sole. Two spoons of diluted gum are advised for dysentery until cure. Gum is astringent to bowel, good in stomatitis, cough, pterygium, corneal opacities and cures excessive perspiration [30, 35, 36].

Roots:

The root cures night blindness and reduces defects of sights, useful in elephantiasis. Root pieces are heated and then 2-3 spoons of extract are advised at night as a remedy against impotency and it is administered for one month. Spoonful of root powder mixed with water is drunk as an antidote for snake bite [30, 35-37].

Stem bark:

Stem bark powder is used to apply on injury caused due to axe. Stem juice is applied on goitre of human being. Paste of stem bark is applied in case of body swellings. Bark is acrid, bitter, appetizer, aphrodisiac, laxative, anthelmintic, useful in fractures of the bones, diseases of theanus, dysentery, piles, hydrocele, cures ulcers and tumours. Bark is useful in biliousness, dysmenorrheal, liver disorder, gonorrhea and it also purifies the blood. The ash of young branch is prescribed in combination with other drugs in case of scorpion sting [28-30,35, 36].

In Ayurvedic literature the extensive use of this drug has been mentioned in the treatment of Krimi Roga (worm infestations) either alone or as a constituent of many prepared medicines. It is used as the component of some very important and widely used recipes of Ayurvedic medicines for the treatment of Krimi Roga. In Sushruta samhita this drug has been described under four different groups of herbal medicines e. g. Rudaradigana, Musakadigana, Amabasatadigana and Nyagrodhabigana dealing with different disorders eg. Medoroga, Striroga, Prameha and also credited with Kapha and Pittanasak properties. Ayurvedic authors have also described its efficacy in Netraroga and its astringent action in different conditions. A clinical trial of the plant

in worm infestation proved its effectiveness in cases of round worm and thread worm infestations and drug was found to be ineffective in the only case of tape worm infestation [28,29,35,36].

Miscellaneous Traditional Uses

Fiber:

Bark fibers are obtained from stem for making cordage [31,33, 37].

Fish-Poison:

Stem bark powder is used to stupefy fishes [37].

Fodder:

Green leaves are good fodder for domestic animals [32].

Domestic utensil:

Fresh leaves are used for making dinning plates and bowls [31, 33, 37].

Protection:

leaves are also used for making Ghongda to protect from rain.

Vegetables:

Flowers and young fruit are used as vegetables by tribals [37].

Dye:

Flowers are boiled in water and cooked to obtain a dye [38].

Festival:

Fresh twigs are tied on horns of bullocks on occasion of 'Pola' festival.

PRODUCTS OF BUTEA MONOSPERMA [7, 39, 40]

Fodder:

In India, young leaves are good fodder, eaten mainly by buffaloes. Though the leaves are fairly rich in nutrients, digestibility values are low, comparable only to those of straws.

Fuel:

Wood makes a fuel of moderate quality. Leaves are sometimes used as a fuel. The wood is burnt for gunpowder charcoal.

Fibre:

A coarse fibrous material obtained from the inner bark is used for cordage, caulking the seams of boats and making paper.

Timber:

The soft and not durable wood is light, about 570 kg/m³ air dry, white or yellowish-brown when fresh, but often turning greyish because of susceptibility to sap stain. It does not have great value

but is sometimes used for utensils.

Gum or resin:

A red exudate is obtained from the bark, hardening into a gum known as 'butea gum' or 'Bengal kino'. It can be used as a dye and as tannin.

Tannin or dyestuff:

A bright yellow to deep orange-red dye, known as butein, prepared from the flowers is used especially for dyeing silk and sometimes for cotton. This dye is used by Hindus to mark the forehead. The bark is used for tanning.

Lipids:

The seeds yield clear oil.

Poison:

Seeds show bactericidal and fungicidal activities.

Medicine:

The flowers are useful in the treatment of liver disorders and seeds act as an anthelmintic. An astringent gum oozing from the cut stem has medicinal properties as a powerful astringent and is applied in cases of diarrhoea.

Other products:

In India, the tree is an important host for the lac insect (Laccifer lacca), which produces shellac.

PHARMACOLOGICAL ACTIVITIES ON BUTEA MONOSPERMA

Different extracts and active constituents obtained from various parts of *B. monosperma* plant have been described section wise along with their respective biological activities.

Pharmacological activities of extracts obtained from *B. monosperma* leaves

Anti-filarial:

Sahare et al. (2008) reported the anti-filarial activity of aqueous extracts from *B. monosperma* leaves and roots. The extracts significantly inhibited the motility of microfilariae (*Brugia malayi*) in a concentration dependant manner *in vitro* with IC50 value at 83ng/ml suggesting anti-filarial effects [41].

Antidiabetic:

Sharma and Garg, (2009a, b) reported the antidiabetic activity of ethanolic extract of *B. monosperma* leaves on alloxan induced diabetes model in male rats. The results demonstrate to reduced the fasting blood glucose levels, increased the activities of antioxidant enzymes upon treatment of 300mg/kg dose for 45 days, suggesting that *B. monosperma* leaves have significant antioxidant and hypoglycemic effects [42,43].

Anti-inflammatory and anti-oxidant:

Borkar et al. (2010) have evaluated anti-inflammatory and antioxidant activity of ethanol, petroleum ether, ethyl acetate, chloroform and hexane extracts of *B. monosperma* leaves using HRBC (human red blood cells) membrane stabilizing method. The petroleum ether and chloroform extract showed significant anti-inflammatory effects whereas hexane, ethyl acetate and ethanol extracts had moderate anti-inflammatory activity[44]. Moreover, these extracts showed antioxidant effects[43]

Pharmacological activities of flower extracts and their active principles

Anti-cancer:

Choedon et al. (2010) recently reported anticancer property of aqueous extract obtained from the dried flowers of *B. monosperma* for antioxidative, anti-inflammatory, hepatoprotective, anti-proliferative, pro-apoptotic and anticancer activities in cancer model where it was found to inhibit cell proliferation and accumulation of cells in G1 phase with significant induction of apoptotic cell death suggesting promising anti-cancer properties [45].

Anticonvulsant:

Kasture et al., reported that petroleum ether extract of flowers of B. *monosperma* exhibits anticonvulsant activity (Kasture *et al.*, 2000). Kasture *et al.* (2002) also demonstrate that the active principle lies in acetone soluble part of petroleum ether extract of *B. monosperma* flowers (Kasture *et al.*, 2002) for anticonvulsant activity. This fraction protected animals from maximum electro shock, electrical kindling and Pentylenetetrazole induced convulsions in mice [46,47].

Antidiabetic:

Somani et al., reported the antidiabetic activity of ethanolic extract of B. *monosperma* flowers against alloxan-induced diabetic Wistar rats (Somani *et al.*, 2006). The study indicates the daily treatment of alloxan induced diabetic animals with 50% ethanolic extract of *B. monosperma* flowers for 45 days significantly lowered blood glucose level thereby preventing steep onset of hyperglycemia which was observed after alloxan administration and maintained body weight and blood glucose level close to the values observed in normal control and glibenclamide-treated diabetic mice. Moreover, the level of serum total cholesterol, triglyceride, low-density lipoprotein and very low-density lipoprotein cholesterol were also reduced suggesting antidiabetic potential [48]. The phytochemical analysis of the ethanolic extract revealed the presence of flavonoids, saponins and sterols, which are potent antihyperglycemic and anti-oxidative agents. Moreover, studies conducted by Sharma and Garg, (2009a) confirmed this antidiabetic effect[42].

Anti-inflammatory and antioxidant effects:

Shahavi and Desai, (2008) have shown the anti-inflammatory effect of methanolic extract of *B. monosperma* flowers in wistar rats. The results demonstrate dose dependent inhibition of the paw edema and granuloma at oral doses of 600 mg/kg and 800 mg/kg in carrageenin induced paw edema and cotton pellet granuloma inflammatory animal models [49]. Moreover, Rasheed *et al.* (2010) have investigated the molecular mechanism of anti-inflammatory activity in mast cells. Rasheed *et al.* (2010) isolated various polyphenols; butrin, isobutrin, isocoreopsin, and butein from *B. monosperma* flowers. They found that butrin, isobutrin, and butein significantly reduces the PMA and calcium ionophore A23187-induced inflammatory gene expression and production of TNF-α, IL- 6, and IL-8 in HMC-1 cells by inhibiting the activation of NF-kappa B[50]. Moreover, Lau *et al.* (2010) observed that butein significantly inhibits PMA-induced COX-2 expression in MCF-10A and MCF-7 breast cancer cells by inhibiting ERK and MAPK kinase followed by inhibition in total activity of PKC suggesting the anti-inflammatory and anti-cancer activity of butein [51]. Moreover, ethyl acetate, butanol and aqueous fractions from total methanolic extract of *B. monosperma* flowers possess free radical scavenging activities [17,43]. Edwin *et al.* (2009) quantified rutin and prepared aqueous extracts of *B. monosperma* flowers by soxhlet, decoction, ultrasonic and maceration methods and observed significant antioxidant activity [52].

Antimycobacterial and antimicrobial activity:

Chokchaisiri et al. (2009) suggested the various bioactive flavonoids like dihydrochalcone and dihydromonospermoside from *B. monosperma* flowers along with butein, monospermoside and isoliquiritigenin for antimycobacterial activity [53].

Yadava and Tiwari, (2007) have shown the anti fungal effect of *B. monosperma* against various fungal species [54]. Further study conducted by Burli and Khade, (2008) also highlights the presence of active antimicrobial constituents of *B. monosperma* flowers [55]. Vasu and Singara Charya (2010) have observed that antimicrobial activity of *B. monosperma* flowers is effective against *Pseudomonas aeruginosa*, *Bacillus cereus* and *Staphylococcus aureus* [56].

The antidopaminergic activity:

Velis et al. (2008) have reported the antidopaminergic activity of the methanolic extract of *B. monosperma* flowers. The antidopaminergic activity is present in the isoflavone isolated from ethyl acetate soluble fraction of methanolic extract which inhibited the foot shock-induced aggression in rats and potentiated haloperidol-induced catalepsy dose dependently [57].

The hepatoprotective effect:

Wagner et al., demonstrated the hepatoprotective activity of isobutrin and butrin isolated form *B. monosperma* flowers [58]. The study also confirmed by Sharma and Shukla, (2010) against CCl_4 induced acute liver injury model in rats. The aqueous extract restored the CCl_4 induced alteration in serum transaminases, protein, albumin, hepatic lipid peroxidation, reduced glutathione and total protein levels to that of control group [59].

Pharmacological activities of Butea monosperma seed extracts

Anti-conceptive:

Bhargava (1986) demonstrated anti-implantation activity of seed extract of *B. monosperma* when administrated orally to adult female rats at the doses of 5, 10 and 20 mg/rat from day 1 to day 5 of pregnancy. Bhargava, also observed that there was a dose dependent termination of pregnancy and reduction in the number of implantation sites at lower doses [60].

Antihelminthic effect:

Prashant et al., reported potent antihelminthic activity of methanolic extract of *B. monosperma* seeds [61]. Another study of Iqbal et al., also demonstrate the same activity and found potent antihelminthic effect against Trichostrongylid nematodes in sheep[62]. The crude powder obtained from the seeds of *B. monosperma* showed time and dose dependent antihelminthic effect when administered orally at doses 1, 2 and 3 g/kg to sheep naturally infected with mixed species of gastrointestinal nematodes [62].

Anti-hyperglycemic and Anti-hyperlipaemic:

Bavarva and Narasimhacharya, (2008) demonstrate the significant antidiabetic, anti-hyperlipaemic and antiperoxidative effects of ethanolic extract of *B. monosperma* seeds [63].

Antiviral:

Yadava and Tiwari, (2005) have isolated a potential antiviral flavone glycoside from the seeds of *B. monosperma* [64].

Antimicrobial activity:

The oil obtained from *B. monosperma* seeds showed a significant bactericidal and fungicidal effect *in vitro* [65].

Anti-inflammatory:

Gunakunru et al. (2004) has demonstrates the anti-inflammatory activity of fixed oil, mixed fatty acids, and unsaponifiable matter obtained from *B. monosperma* seeds. These *B. monosperma* derivatives possess significant anti-inflammatory effects against carrageenin-induced paw oedema and cotton pellet induced granuloma in rats [66].

Pharmacological activities of constituents of *Butea monosperma* stem bark

Anti-diarrhoeal:

Gunnakkunru et al. (2005), have reported the antidiarrhoeal activity of ethonolic extract of stem bark of *B. monosperma* against castor oil induced diarrhea and PGE2 induced enteropoolong in rats. The results revealed reduction of gastrointestinal motility after charcoal meal administration[67].

Wound healing:

Ethanolic extract of *B. monosperma* bark possess wound-healing properties [68, 69]. The extract accelerated the wound healing effect when applied topically on full excision wounds made on the back of rats. The topical application results in increased cellular proliferation and collagen synthesis at the wound site, which was corroborated, by increase in DNA, total protein and total collagen content in granulation tissues. The results also found to enhance the wound contraction and decreased epithelialization time in excision wound model, increased the tensile strength of the incision wound significantly and increased the granulation tissue weight and hydroxyproline content in the dead space wounds in comparison to the control group suggesting promising wound healing properties[69].

Osteogenic and Osteoprotective:

Bhargavan et al. (2009), have isolated two structurally related methoxyisoflavones; cajanin and isoformononetin from the stem bark extract of *B. monosperma*. They found that cajanin possess strong mitogenic as well as differentiation-promoting effects on osteoblasts. However, isoformononetin was found to potent anti-apoptotic effect and osteoblast differentiation promoting effects [70]. Similarly, Maurya *et al.*, (2009), performed the phytochemical investigation of the stem bark of *B. monosperma* and isolated three new compounds buteaspermin A, buteaspermin B and buteasperminol along with other known compounds. He reported that medicarpin, cajanin, formonentin, isoformonentin and cladrin isolated from stem bark responsible for osteogenic activity [71]. Moreover, the studies of Pandey *et al.* (2010) demonstrate the osteogenic and osteoprotective potential of the total extracts and standardized fraction from the stem bark of *B. monosperma* [72].

Anti-inflammatory:

The methanolic extract of the stem bark of *B. monosperma* exhibited anti-inflammatory and analgesic activity in carrageenan induced paw edema and acetic acid induced writhing and Pentozocine for hot plate test model [73].

Anti-stress:

Bhatwadekar *et al.* (1999) have shown the anti-stress effect of water-soluble part of ethanolic extract. The extract attenuated water immersion stress induced elevation of brain serotonin and plasma corticosterone levels and this anti-stress effect was comparable to that of diazepam [74].

Thyroid inhibitory and Hypoglycemic:

Panda *et al.* (2009) isolated stigmasterol form bark of *B. monosperma and studied it for* Thyroid inhibitory and Hypoglycemic activity where administration of stigmasterol to experimental animals for 20 days showed reduced serum triiodothyronine, thyroxin, and glucose concentrations with a concomitant increase in insulin. Moreover, there was significant decrease in hepatic lipid peroxidation and an increase in the activities of catalase, superoxide dismutase and glutathione upon the treatment suggesting promising thyroid inhibitory and hypoglycemic effects of Stigmasterol [75].

Anti-fungal:

Ratnayake Bandara *et al.*, isolated the active constituent medicarpin from petroleum and ethyl acetate extracts of the stem bark of *B. monosperma* and demonstrated the potent antifungal activity than the standard fungicide Benlate against *Cladosporium cladosporioides* [76].

Anti-ulcer:

Patil *et al.* (2009) demonstrate the antiulcer activity of methanolic extract of *B. monosperma* bark against aspirin and ethanol induced gastric ulcerations respectively suggesting free radical scavenging properties [77].

Pharmacological activities of *Butea monosperma* fruits extract and derivatives

Hypoglycemic effect:

Naeem and Khan, (2010) evaluated the hypoglycemic activity of powder prepared from *B. monosperma* fruits in normal and diabetic human volunteers suffering from diabetes type II. They found significant decrease in blood glucose, urine sugar, and plasma glycoprotein levels upon 30 days treatment. Moreover, there was reduction in lipid profile and the restoration of activities of liver enzymes suggesting potential anti-diabetic effects of *B. monosperma* fruit extract [78].

Anti-diabetic:

Akhtar et al. have assessed the hypoglycemic and hypolipidemic activity of *B. monosperma* in normal and diabetic human volunteers and promising antidiabetic effect [79, 80]. Thorat *et al.* (2010) prepared an herbal formulations consisting of three plant parts; *Piper betel*, *Butea monosperma* and *Trigonella foenum graecum* and investigated their anti-diabetic potential in normal and alloxan induced diabetic rats and found promising anti-diabetic potential [81, 82].

Antimicrobial and anti-fungal:

Different fractions obtained from *B. monosperma* possess significant antimicrobial effects across various bacterial and fungal species [83, 84].

Antihelminthic effect:

Agarwal *et al.* have studied the antihelminthic activity of herbal formulation. Pippali rasayana contains the active constituent *B. monosperma* which is prescribed for the treatment of chronic dysentery and worm infestations. They evaluated Pippali rasayana for anti-giardial and immuno-stimulatory activity in mice, infected with *Giardia lamblia* trophozoites and observed up to 98% recovery after 15 days of treatment from the infection (Agarwal *at al.*, 1994). After 15 days of drug treatment they found that there was a complete absence of *G. lamblia* (trophozoites/cysts) from the stools of 23 out of 25 patients [85, 86].

CONCLUSION

The present review reveals the use of all parts of Butea monosperma tree species are employed for various purposes by the various rural folks in the region India. This demonstrates that the *Butea monosperma* a blessing for indigenous people. The plant showed the great potentially in treating several ailments. These indigenous practices should be scientifically screened by team of ethnobotanist, botanist, phytochemist, pharmacologist and medicinal experts for appropriate tests. The details research work on characterization and standardization is essential for developing its formulations which can be beneficial for human being.

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