



Butea Monosperma: Phytochemistry and Pharmacology

Prashant Tiwari*, Susmita Jena and Pratap Kumar Sahu

School of Pharmaceutical Sciences, Siksha O Anusandhan (Deemed to be University), Bhubaneswar, India

*Corresponding Author: Prashant Tiwari, School of Pharmaceutical Sciences, Siksha O Anusandhan (Deemed to be University), Bhubaneswar, India.

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Abstract

Butea monosperma (BM) is a well-known medicinal plant which is a moderate sized deciduous tree and widely distributed in India, Ceylon and Burma. It has been used in traditional medicine practice from ancient time. It is also known as flame of forest commonly known as Palash or Dhak. Palash is described in Charaka Samhita, Susruta Samhita, Upanisads, Vedas, Astanga Sangraha and Astanga Hridaya. BM belonging to the family Leguminosae has a wide range of active principles like coreopsin, isocoreopsin, sulphurein, butein, butin, isobutrin, monospermoside and isomonospermoside, aurones, chalcones, flavonoids (palasitrin, prunetin) and steroids. BM contains phytoconstituents such as alkaloids, flavonoids, phenolic compounds, amino acids, glycosides, steroids etc. The pharmacological activity is mainly shown by flowers, seeds, barks, fruits, leaves etc. The current review focused on following pharmacological actions like hepatoprotective, antifertility, antifilarial, anti-diabetic, antiviral, anthelmintic, anticonvulsant, antifungal, antimicrobial, antiestrogenic, anticancer, antiinflammatory, antioxidant, antiulcer, wound healing, anti-diarrhoeal, anti-implantation, antidopaminergic, antimycobacterial, osteogenic and osteoprotective activity. These medicinal properties may provide potential active principles with higher efficacy and minimum side effects as compared to available synthetic drugs.

Keywords: *Butea monosperma*; Phytochemistry; Pharmacology; Ayurveda; Palash

Introduction

Butea monosperma (BM) commonly known as flame tree, belongs to the subfamily *Caesalpinioideae*, family *Fabaceae* (formerly Leguminosae). The plant is commonly called as Palash tree in India. It grows throughout India as well as South Asian peninsula [1]. It is a medium sized deciduous tree. It grows about 10-15 meters in height. It looks like small bush when the height is 1-2 meters due to more branching. Its flower is odourless and looks reddish in the flowering season during springs and leaves are trifoliolate. The plant is having numerous medicinal properties like appetizer, laxative, anthelmintic and aphrodisiac etc. The following parts of plants may be used such as flower, gum, seed, leaf, and bark [2-9]. As per Ayurveda, BM also has the property of reducing Kapha and Vata [10]. The various parts of BM contains many active constituents e.g. butein, butrin, flavonoid and steroids (flower), glucose, glycosides (roots) tannin (gum), oil, proteinase and polypeptidase (seed) etc. The present article describes the phytochemical and pharmacological activities of different parts of BM.

Ayurvedic context of *Butea monosperma*

BM has a great impact as a medicinal herb used in Ayurvedic medicine. The specific name monosperma means one seeded and refers to the fruit with a single seed near its apex belonging to the family Fabaceae [11]. On exhaustive review of Ayurveda, BM was originated as Palash. Its characteristic is well defined in Charaka Samhita, Susruta Samhita, Astanga Sangraha, Astanga Hridaya Vedas, and Upanisads. In Charaka Samhita, the plant is defined in Mahakasaya [12]. In Susruta Samhita, Palash is considered as Ambasthadi, Nyagrodhadi, Muskakadi and Rodhradi. Similarly, in Astanga Hridaya and Susruta Samhita Palash is also described in Ambasthadi, Muskakadi, Nyagrodhadi Gana and Rodhradi. In Astanga Sangraha, Vagbhata mentioned Palash in Asanadi, Rodhradi, Muskakadi, Ambasthadi and Nyagrodhadi Gana [11]. Palash also has detailed description in Samhita's such as Harita Samhita, Bhela Samhita, Sharangadhar Samhita and Kasyapa Samhita. It is also stated in Cikitsagranthas as Gadanigraha, Bhaishajya Ratnavali, Bhavaprakash Samhita and Cakradutta. Nighantus have defined the goodness

of Palash in various disease for example the rasa of Palash is useful in kasaya and tikta. According to Bhavaprakash Nighantu the fruit part of the BM is applicable in Krimi, Arsa and Vatakaphaja rogas [13].

Phytochemistry

BM contains various phytoconstituents like alkaloids, flavonoids, phenolic compounds, amino acids, glycosides, resin, saponin and steroids (Table 1). Here we have described various constituents present in different parts such as flower, gum, seed, leaves, bark and stem. The constituents are as follows:

- **Flower:** It contains triterpene butrin, isobutrin, coreopsin, sulphurein, isocoreopsin, monospermoside and chalcones, isomonospermoside, aurones, steroids and flavonoids. Glycoside of the BM contains 5,7-dihydroxy -3,6,4-trimethoxy flavone-7-O- α -L xylopyranosyl (1 \rightarrow 3)-O- α -L-arabinopyranosyl-(1 \rightarrow 4)-O- β -D galacto pyranoside [14,15].
- **Gum:** Gum contains mucilaginous material, pyrocatechin and tannins [16].
- **Seed:** Oil contains polypeptidase, lypolytic enzymes, proteinase and proteolytic [16]. Palasonin and nitrogenous acidic compounds is present in seeds. Seed also contains isomonospermoside, monospermoside and allophanic

acid. Flavone glycoside present in the seeds of BM which possess potential antiviral activity [17]. BM seeds contain fixed oil, mixed fatty acids, and unsaponifiable matter [18].

- **Resin:** Resin contains jalaric esters I, II and laccijalaric esters III, IV α amyryn, β -sitosterone its glucoside and sucrose; lactone-nheneicosanoic acid- δ -lactone [19].
- **Saponin:** Saponin contains butein, butin, butrin, colourless isomeric flavanone and chalcones [20].
- **Leaves:** Leaves contain kino-oil containing oleic, linoleic acid, lignoceric acid and palmitic [21].
- **Stem:** Stems contain 12 dimethyl-8-oxo-octadec-11-enylcyclohexane, Stigmasterol- β -D-glucopyranoside and nonacosanoic acid [22].
- **Bark:** Barks contain gallic acid, kino-tannic acid, pyrocatechin. Barks also contain allophanic acid, butolic acid, shellolic acid, butrin, alanind, palasitrin, cyanidin, histidine, palasimide and miroestrol [21,22]. Isolation from stem bark methanolic extract of BM gives two structurally related methoxyisoflavones; cajanin and isoformononetin [23]. The phytochemical investigation and isolation of the stem bark of BM contain following compounds such as buteaspermin A, buteaspermin B and buteasperminol, medicarpin, cajanin, formonentin, isoformonentin and cladrin [24]. The active constituent obtained from ethyl acetate and petroleum extracts of the stem bark of BM was medicarpin [25].

Plant Parts	Type of active principles	Example
Flowers	Triterpene	butrin, isobutrin, coreopsin, sulphurein, isocoreopsin, monospermoside, chalcones, isomonospermoside, steroids.
	Glycoside	5,7-dihydroxy -3,6,4-trimethoxy flavone-7-O- α -L xylopyranosyl (1 \rightarrow 3)-O- α -L-arabinopyranosyl-(1 \rightarrow 4)-O- β -D galacto pyranoside.
Gum	Tannins	Mucilaginous material, pyrocatechin
Seed	enzymes	Polypeptidase, lipolytic enzymes, proteinase and proteolytic enzymes
Resin	esters	Jalaric esters I, II and laccijalaric esters III, IV α amyryn.
Saponin	polyphenols	Chalcones, butein, butin
Leaves	Fatty acid	Kino-oil containing oleic, linoleic acid, lignoceric acid.
Bark	Amino acids	Allophanic acid, butolic acid, shellolic acid, butrin, alanind, palasitrin, cyanidin, histidine
Stem	steroids	Stigmasterol- β -D-glucopyranoside and nonacosanoic acid

Table 1: Various active constituents of *Butea monosperma*.

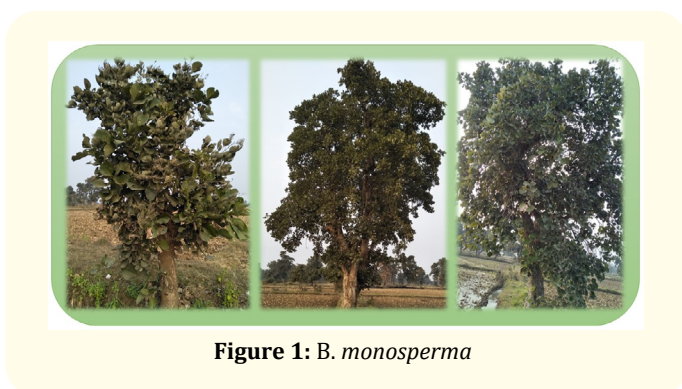


Figure 1: *B. monosperma*

Pharmacological properties of *B. monosperma*

Various parts of BM possess several pharmacological actions (Table 2). We have segregated multiple medicinal properties of different parts of BM such as leaves, flower, seed, bark and fruits. The actions of various parts of BM are as follows:

Leaves

- **Anti-filarial:** Aqueous extract of BM significantly inhibited the motility of microfilariae (*Brugia malayi*). This effect was seen in a dose dependent manner with IC50 value at 83ng/ml [26].

- **Antidiabetic:** Alloxan was used to induce diabetes in male rat. Oral administration of ethanolic extract of BM leaves showed antidiabetic activity. BM extract significantly lowers the blood glucose level and increased the activities of antioxidant enzymes upon treatment at 300mg/kg dose for continuous 45 days, which suggested that BM leaves have significant antioxidant and hypoglycemic effects [27,28].
- **Anti-inflammatory and anti-oxidant:** Different extracts of BM leaves showed anti-inflammatory activity in human red blood cells (HRBC) membrane stabilizing method. The petroleum ether and chloroform extract exhibited significant anti-inflammatory effects whereas hexane, ethyl acetate and ethanol extracts showed moderate antioxidant effects and anti-inflammatory activity [29,30].

Plants part	Extract	Pharmacological action	References
Leaves	Aqueous	Anti-filarial	26
	Ethanolic	Antidiabetic, antioxidant	34
	Petroleum ether, chloroform	Anti-inflammatory, anti-oxidant	29
Flowers	Aqueous	Anticancer, Hepatoprotective effect	31
	Petroleum	Anticonvulsant	32
	Ethanolic	Antihyperglycemic, antioxidant potential	34
	Methanolic	Anti-inflammatory, antioxidant effects, Anti-dopaminergic activity, Free radical scavenging effect	36, 40
Seed	Alcoholic	Hormone balancing effect	43
	Methanolic	Antifertility effect, Anthelmintic effect	43, 46
	Ethanolic	Anti-hyperglycemic and Anti-hyperlipidemic	47
Barks	Ethanolic	Anti-diarrhoeal, Wound healing activity, Anti-stress	52, 41
	Methanolic	Osteogenic and Osteoprotective activity, Anti-inflammatory, Effects on hormone level, Anti-ulcer	53, 55, 57
Fruits	Methanolic	Hypoglycemic effect	60
	Pippali rasayana	Antihelminthic effect	65

Table 2: Pharmacological action of different parts of *B. monosperma*.

Flowers

- **Anti-cancer:** Aqueous extract of BM showed anticancer activities by accumulation of cells in G₁ phase and inhibiting cell proliferation with significant induction of apoptotic cell death suggesting anticancer properties of BM [31].
- **Anticonvulsant:** Petroleum ether extract of BM has been fractionated with varying polarity such as ethyl acetate, n-hexane and methanol by column chromatography. Fractionated part of petroleum extract of BM exhibited anticonvulsant activity against seizures induced by maximum electroshock (MES), Pentylentetrazole (PTZ) and lithiumsulfate- pilocarpine nitrate. Additionally, triterpene present in BM exhibited anti-depressant effect [32].

Antihyperglycemic and antioxidant potential

50% ethanolic extract of BM flowers possess significant antidiabetic activity against alloxan-induced diabetes in wistar rats The

ethanolic extract of BM showed antidiabetic activity by reducing the level of total cholesterol, triglyceride and very low-density lipoprotein cholesterol [33]. The oxidative harm in the various organ like pancreas, liver and kidneys of diabetic mice shown by a remarkable elevation in thiobarbituric acid level and a distinct diminution in glutathione content was abolished by ethanolic extract of BM. Anti-diabetic and anti-oxidant activity of BM may be attributed due to the presence of flavonoids, saponins and sterols [34].

Anti-inflammatory and antioxidant effects

Methanolic extract of BM (600 mg/kg and 800 mg/kg) showed anti-inflammatory effect which was dose dependent. It inhibited the paw edema and granuloma in carrageenan induced paw edema and cotton pellet granuloma model in rats [35]. This may be due to the presence of various polyphenols like butrin, isobutrin, isocoreopsin, and butein in BM [36].

Antimycobacterial activity

BM flowers contain bioactive flavonoids such as dihydromonospermoside, dihydrochalcone, monospermoside, isoliquiritigenin and butein showed antimycobacterial activity [37]. The study revealed its antifungal activity against various fungal species [38].

Antimicrobial activity

5,7-dihydroxy-3,6,4-trimethoxy flavone-7-O- α -L xylopyranosyl (1 \rightarrow 3)-O- α -L-arabinopyranosyl-(1 \rightarrow 4)-O- β -D galactopyranoside showed antimicrobial activity. Seed oil of BM possess antimicrobial potential against pathogenic bacteria and fungi. So the oil has fungicidal and bactericidal properties [39].

Antidopaminergic activity

Isoflavone isolated methanolic extract of BM which showed antidopaminergic activity and inhibit the foot shock-induced aggression in rats and potentiated haloperidol-induced catalepsy in a dose dependent manner [40].

Hepatoprotective effect

Hepatoprotective effect of flowers of BM aqueous extract (200, 400, 800 mg/kg, p.o.) was examined against CCl₄ (1.5 ml/kg i.p.) induced hepatotoxicity. CCl₄ has the ability to cause liver cirrhosis and necrosis. Therefore CCl₄ administration significantly changed number of biochemical parameters such as albumin, protein, hepatic lipid peroxidation, reduced glutathione and total protein levels. It was witnessed that BM has restored all the altered biochemical parameters including histopathological alterations in dose dependent manner [41].

Free radical scavenging effect

The methanolic extract of flower part of BM showed free radical scavenging effect which was evaluated followed by 2,2 diphenyl-1-picrylhydrazyl (DPPH) radical, superoxide dismutase (SOD) assay. In addition, inhibition of erythrocytes hemolysis was also evaluated by 2, 2' azo-bis (amid inopropane) dihydrochloride (AAPH) antioxidant assay. These effect may be due to presence of higher phenolic contents in the extract [42].

Seeds

- **Hormone balancing effect:** Alcoholic extract of BM possess antiestrogenic effect and anti-implantation activities. However, the estrogenic activity is due to the presence of active constituents like Butin which also exhibits male contraceptive properties. Methanolic extracts of BM seed also possess antifertility effect and uterine peroxidase activities [43].
- **Anti-implantation activity:** Butin is an active compound of BM. Oral administration of Butin at the doses of 5, 10

and 20 mg/rat showed anti-implantation activity. A dose dependent response was seen during termination of pregnancy. Further, at lower doses, a decrease in the quantity of implantation sites was also noticed. Butin has estrogenic activity at comparable contraceptive doses observed in ovariectomized young female rats but was devoid of antiestrogenic activity [44].

- **Anthelmintic effect:** The methanolic extract of BM seeds possess significant anthelmintic activity against *Caenorhabditis elegans* [45]. The anthelmintic activity against *Trichostrongylid nematodes* in sheep strongly corroborate this finding. The methanolic extract of crude powder obtained from the seeds of BM (1, 2 and 3mg/kg) showed anthelmintic effect. Time and dose dependency was noticed [46]. In addition extract of same solvent also possess significant anthelmintic activity.
- **Anti-hyperglycemic and Anti-hyperlipidemic:** The ethanolic extract obtained from BM seeds possess antidiabetic, anti-hyperlipidemic and antiperoxidative effects. The ethanolic extract treated for four weeks exhibit significant antihyperglycemic effect with improved glucose tolerance in non-insulin dependent diabetic (NIDDM) rats [47].
- **Antiviral:** Flavone glycoside isolated from the seeds possess potential antiviral properties [17].
- **Antimicrobial activity:** BM seed oil showed a significant fungicidal and bactericidal effect *in vitro* which may be due to the presence of active constituents like medicarpin [48].
- **Anti-inflammatory:** Cotton pellet induced granuloma and carrageenin-induced paw oedema method were used for the evaluation of antiinflammatory activity. The study revealed that on oral administration of BM seed extract possess significant anti-inflammatory effects which may be due to presence of fixed oil, mixed fatty acids, and unsaponifiable matter present in the BM extract [49].

Barks

- **Anti-diarrhoeal:** Ethanolic extract of bark and stem parts of BM have potential anti-diarrhoeal activity against castor oil induced diarrhea and PGE2 induced enteropooling in rats. Oral administration of charcoal meal along with BM extract showed remarkable decrease in gastrointestinal motility [50].
- **Wound healing activity:** Ethanolic extract of BM bark possesses wound healing effect in rats [51]. It accelerated the wound healing effect when administered topically on full excision wounds made on the back of rats. The ethanolic extract of BM increased collagen synthesis as well as cellular proliferation at the wound infected area. The extract increased the wound contraction and decreased epithelialization time in excision wound model, increased the hydroxyproline content, granulation tissue weight and tensile strength of the incision wound area [52].
- **Osteogenic and Osteoprotective activity:** Cajanin isolated from stem bark methanolic extract of BM possesses

differentiation-promoting as well as powerful mitogenic effects on osteoblasts. However, isoformononetin was found to have potent anti-apoptotic effect and osteoblast differentiation promoting effects [53]. Stem bark extract of BM possesses osteogenic and osteoprotective properties [23,54].

- **Anti-inflammatory:** The methanolic extract of the stem bark of BM showed analgesic and anti-inflammatory action against acetic acid induced writhing, hot plate test model and carrageenan induced paw edema in a dose dependent manner comparable to diclofenac sodium [55].
- **Anti-stress:** Water soluble part of ethanolic extract of BM showed antistress effect. Ethanolic extract of BM decreases the elevated level of plasma corticosterone and brain serotonin and this anti-stress effect was comparable to that of diazepam [56].
- **Effects on hormone level:** Administration of Stigmasterol (2.6 mg/kg), isolated from the bark of methanolic extract of BM for 20 days in the experimental animals reduced serum triiodothyronine, thyroxin, and glucose concentrations with a concomitant increase in insulin. Moreover, there was significant increase in the level of superoxide dismutase, glutathione and catalase as well as decrease in hepatic lipid peroxidation upon the treatment suggesting promising thyroid inhibitory and hypoglycemic effects of Stigmasterol [57].
- **Anti-fungal:** Medicarpin had greater antifungal activity than the standard fungicide Benlate against *Cladosporium clado-sporioides* [58].
- **Anti-ulcer:** Methanolic extract of BM bark at 500mg/kg showed 79.30 and 82.20% healing against ethanol and aspirin induced gastric ulcerations respectively signifying free radical scavenging properties of the extract for anti-ulcer effect [59].

Fruits

Hypoglycemic effect: BM methanolic extract showed significant decrease in blood urine sugar, plasma glycoprotein and glucose levels upon treatment (3g/30ml of water for 30 days). Moreover, there was reduction in lipid profile and the restoration of activities of liver enzymes suggesting potential anti-diabetic effects of BM fruit extract [60]. The study revealed that herbal formulations consisting of three plant parts; Piper betel, *Butea monosperma* and *Trigonella foenum graecum* have anti-diabetic potential in control and alloxan induced diabetic rats [61,62].

Antimicrobial and anti-fungal: Different fractions obtained from BM possesses significant antimicrobial effects across various bacterial and fungal species [39,63,64].

Antihelminthic effect: Pippali rasayana containing the extract of BM for the evaluation of immuno-stimulatory and anti-giardial activity against *Giardia lamblia* and they has observed about 98% recovery from the infection. However, *in vitro* study suggested that

rasayana had no homicide effect over the parasite which showed significant activation of macrophages which is an indication of elevated level of macrophages migration index (MMI). BM extract (900mg/kg) also exhibited phagocytic activity. In addition, they administered Pippali Rasayana orally 1g, for 15 days duration and they noticed that here was an absolute absence of *Giardia lamblia* from the patients (25 treated, 25 placebo controls) [65]. The active principles obtained from this plant parts possess various biological activity have been tabulated in brief (See Table. 2).

Conclusion

Various bioactivity studies of *B. monosperma* plant derivatives are at the preliminary level requiring further studies to delineate the mechanism of actions. Only few studies shed light in the mechanism of actions in detail. This review provides an outlook on various phytochemistry and pharmacological aspects that need to be done to carry forward the available information in developing suitable clinical therapeutics out of *B. monosperma* plant.

Conflict of Interest

We declared that we have no conflict of interest.

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