Recent advances on the pharmacological profile of *Butea monosperma*

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**Abstract**

*Butea monosperma* belongs to the subfamily “Caesalpinioideae”, family “Fabaceae”. It grows throughout the south Asian peninsula. It is traditionally being used as various forms of medicine. Here we describe about the recent development in the studies of its various parts like leaves, stem bark, fruits, seeds, flowers and their extracts and active principles against various disorders like diabetes, cancer and helminthic infections. Moreover, the bioactivity of various parts for anti-inflammatory, antioxidant, anticonvulsant, anti-conceptive, antimicrobial, antiviral, osteogenic, osteoprotective and hepatoprotective properties have been discussed in details across various studies carried out in various experimental animal models, *in vitro*, *ex vivo* and clinical studies as well. This review provides adequate information to develop suitable therapeutics out of this plant parts.

**Keywords:** *Butea monosperma*, antidiabetic, anti-inflammatory, hepatoprotective, anti-cancer, anti-conceptive, osteogenic, osteoprotective

**Introduction**

*Butea monosperma* commonly called as flame of the forest or flame tree, belongs to the subfamily “Caesalpinioideae”, family “Fabaceae (formerly Leguminosae)”. It is also commonly called as Palash tree in central India. It grows throughout India and South Asian peninsula (Khan, 2009; Shah et al., 2009). It is a medium sized deciduous tree. It grows about 10-15 meters in height. When the tree is about 1-2 meters in height it looks like small bush due to more branching. The tree can adapt to extreme summer seasons experienced in India. Its seedling forms special features to adapt to extreme dry condition. Its flower is odorless and looks reddish in the flowering season during springs. The leaves are trifoliate. The plant parts used are bark, leaf, flower, seed and gum (Burli and Khade, 2007).

It is mainly useful as antihelmenthic, appetizer, aphrodisiac, laxative etc. (Prasad et al., 2006). Moreover, it is used for ethno-veterinary medicine and as a traditional medicine for many ailments in various parts of India and South Asia (Upadhyay et al., 2011; Mridula et al., 2008; Katewa et al., 2004; Aher et al., 2004; Rai and Nath, 2005; Sikarwar and Kumar, 2005; Tambekar and Saratkar, 2005; Jain et al., 2004). Moreover, they also have the property of reducing ‘Kapha’ and ‘Vata’ (Ayurveda) (Srivastava et al., 2002).

**Various plant parts and their biological activities**

Different extracts and active constituents obtained from various parts of *B. monosperma* plant have been described section wise along with their respective biological activities. Moreover, the active principles obtained from this plants part and which possess various biological activity have been tabulated in brief (See Table. 1).

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

**Anti-filarial:** Sahare et al. (2008) prepared extracts from *B. monosperma* leaves and roots with double distilled water, followed by filtration and concentrated the residue by keeping in hot air oven. This extract significantly inhibited the motility of microfilariae (*Brugia malayi*) in a concentration dependant manner *in vitro* with IC$_{50}$ value at 83ng/ml suggesting anti-filarial effects (Sahare et al., 2008).

**Antidiabetic:** Sharma and Garg, (2009a) evaluated the ethanolic extract of *B. monosperma* leaves (BMEE) on alloxan induced diabetes model in male rats. Sharma and Garg, (2009a) found that BMEE reduced the fasting blood glucose levels, increased the activities of antioxidant enzymes upon treatment at 300mg/kg dose for 45 days, suggesting that *B. monosperma* leaves have significant antioxidant and hypoglycemic effects (Sharma and Garg, 2009a; Sharma and Garg, 2009b).

**Anti-inflammatory and anti-oxidant:** Borkar et al. (2010) have evaluated the ethanol, petroleum ether, ethyl acetate, chloroform and hexane extracts of *B. monosperma* leaves for...
Table.1: Active principles of various plant parts from *B. monosperma* and their pharmacological effects

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<td>Active constituents from the seeds</td>
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anti-inflammatory activity by 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 (Borkar et al., 2010). Moreover, these extracts showed antioxidant effects (Borkar et al., 2008; Sharma and Garg, 2009b).

**Pharmacological activity of flower extracts and their active principles**

**Anti-cancer:** Choedon et al. (2010) have evaluated the aqueous extract obtained from the dried flowers of *B. monosperma* for antioxidative, anti-inflammatory, hepatoprotective, anti-proliferative, pro-apoptotic and anti-cancer 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. Moreover, oral administration of the extract in transgenic mice conferred hepatoprotection (Choedon et al., 2010).

**Anticonvulsant:** It has been reported that petroleum ether extract of flowers of *B. monosperma* exhibits anticonvulsant activity (Kasture et al., 2000). Kasture et al. (2002) found that the active principle lies in acetone soluble part of petroleum ether extract of *B. monosperma* flowers (Kasture et al., 2002). This fraction protected animals from maximum electro shock, electrical kindling and pentylenetetrazole-induced convulsions in mice.

**Antidiabetic:** The ethanolic extract of *B. monosperma* flowers have been reported to possess significant antidiabetic activity against alloxan-induced diabetic Wistar rats (Somani et al., 2006). The daily treatment of alloxan-induced diabetic animals with 50% ethanolic extract of *B. monosperma* flowers (BMEE) 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 (Somani et al., 2006). Moreover, the level of serum total cholesterol, triglyceride, low-density lipoprotein and very low-density lipoprotein cholesterol were also reduced suggesting antidiabetic potential of BMEE (Somani et al., 2006). The phytochemical analysis of the ethanolic extract revealed the presence of flavonoids, saponins and sterols, which are potent anti-hyperglycemic and anti-oxidative agents. Moreover, studies conducted by Sharma and Garg, (2009a) confirmed this antidiabetic effect.

**Anti-inflammatory and antioxidant effects:** Shahavi and Desai, (2008) have shown the anti-inflammatory effect of *B. monosperma* flowers in wistar rats where methanolic extract of *B. monosperma* flowers (MEBM) dose dependently inhibited 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 (Shahavi and Desai, 2008). 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 reduced 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 (Rasheed et al., 2010). Moreover, Lau et al. (2010) observed that butein significantly inhibits PMA-inducd 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.

Moreover, ethyl acetate, butanol and aqueous fractions from total methanolic extract of *B. monosperma* flowers possess free radical scavenging activities (Lavhale and Mishra, 2007; Sharma and Garg, 2009b). 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 (Edwin et al., 2009).

**Antimycobacterial and antimicrobial activity:** Chokchaisiri et al. (2009) have evaluated the various bioactive flavonoids like dihydrochalcone and dihydromonospermoside from *B. monosperma* flowers along with butein, monospermoside and isoliquiritigenin that showed antimycobacterial activity (Chokchaisiri et al., 2009). Yadava and Tiwari, (2007) have shown the anti fungal effect of *B. monosperma* against various fungal species (Yadava and Tiwari, 2007). Further study conducted by Burli and Khade, (2008) also highlights the presence of active antimicrobial constituents of *B. monosperma* flowers (Burli and Khade, 2008). Vasu and Singara Charya (2010) have observed that antimicrobial activity of *B. monosperma* flowers is effective against *Pseudomonas aeruginosa*, *Bacillus cereus* and *Staphylococcus aureus* (Vasu et al., 2010).

**The antipodaminergic activity:** Velis et al. (2008) have studied the antipodaminergic activity of the methanolic extract of *B. monosperma* flowers. The antipodaminergic 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 in a dose dependent manner (Velis et al., 2008).

**The hepatoprotective effect:** The isobutrin and butrin...
obtained from *B. monosperma* flowers seems to possess antihepatotoxic properties (Wagner et al., 1986) which have been confirmed by the studies of Sharma and Shukla, (2010) against CCl4 induced acute liver injury model in rats. The aqueous extract restored the CCl4 induced alteration in serum transaminases, protein, albumin, hepatic lipid peroxidation, reduced glutathione and total protein levels to that of control group (Sharma and Shukla, 2010).

**B. monosperma** seed extracts and their pharmacological activities

**Anti-conceptive:** Butin showed anti-implantation activity 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, 1986). Bhargava, (1986) observed that there was a dose dependent termination of pregnancy and reduction in the number of implantation sites at lower doses.

**Antihelminthic effect:** The methanolic extract of *B. monosperma* seeds possesses potent antihelminthic activity against *Caenorhabditis elegans* (Prashanth et al., 2001). Moreover, the antihelminthic activity studies of Iqbal et al. (2006) against Trichostongylid nematodes in sheep strongly corroborate this finding. 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 (Iqbal et al., 2006).

**Anti-hyperglycemic and Anti-hyperlipaemic:** The ethanolic extract obtained from *B. monosperma* seeds seems to possess significant antidiabetic, anti-hyperlipaemic and anti-peroxidative effects. Bavarva and Narasimhacharya, (2008) found that the four-week treatment with ethanolic Soxhlet extract exhibits significant antihyperglycemic effect with improved glucose tolerance in non-insulin dependent diabetes mellitus (NIDDM) rats (Bavarva and Narasimhacharya, 2008).

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

**Antimicrobial activity:** The oil obtained from *B. monosperma* seeds showed a significant bactericidal and fungicidal effect *in vitro* (Mehta et al., 1983).

**Anti-inflammatory:** Gunakunru et al. (2004) have evaluated the 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 edema and cotton pellet-induced granuloma in rats (Gunakunru et al., 2004).

**Constituents of B. monosperma** stem bark and their effects

**Anti-diarrhoeal:** Gunnakkunuru et al. (2005), have shown that the ethanolic extract obtained from the stem bark of *B. monosperma* have significant anti-diarrhoeal activity against castor oil induced diarrhea and PGE2 induced enteropooling in rats with further reduction in gastrointestinal motility after charcoal meal administration (Gunnakkunru et al., 2005).

**Wound healing:** Ethanal extract obtained from *B. monosperma* bark possess wound-healing properties in experimental animals (Sumittra et al., 2005; Gavimath et al., 2009). It accelerated the wound healing effect when administrated topically on full excision wounds made on the back of rats. Sumittra et al. (2005) found that the ethanolic extract 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. Gavimath et al. (2009) found that the extract enhanced 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 (Gavimath et al., 2009).

**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 have potent anti-apoptotic effect and osteoblast differentiation promoting effects (Bhargavan et al., 2009). Similarly, Maurya et al., (2009), did phytochemical investigation of the stem bark of *B. monosperma* and isolated three new compounds buteasperm A, buteasperm B and buteaspermol along with other known compounds. They found that medicarpin, cajanin, formonentin, isoformonentin and cladrin isolated from stem bark shows promising osteogenic activity (Maurya et al., 2009). Moreover, the studies of Pandey et al. (2010) suggest the osteogenic and osteoprotective potential of the total extracts and standardized fraction from the stem bark of *B. monosperma* (Pandey et al., 2010).

**Anti-inflammatory:** The methanolic extract of the stem bark of *B. monosperma* exhibited anti-inflammatory and analgesic activity in a dose dependant manner which are comparable to the standard drug diclofenac sodium for carrageenin-induced paw edema and acetic acid induced writhing and Pentozocine for hot plate test model (William and Mohan, 2007).

**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 (Bhatwadekar et al., 1999).

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**Thyroid inhibitory and Hypoglycemic:** Panda et al. (2009) administered Stigmasterol (2.6 mg/kg), isolated from the bark of *B. monosperma* for 20 days in the experimental animals and they observed 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 (Panda et al., 2009).

**Anti-fungal:** The active constituent obtained from petroleum and ethyl acetate extracts of the stem bark of *B. monosperma* was medicarpin and it had greater antifungal activity than the standard fungicide Benlate against *Cladosporium cladosporioides* (Ratnayake Bandara et al., 1989).

**Anti-ulcer:** Patil et al. (2009) observed that the methanolic extract of *B. monosperma* bark at 500mg/kg showed 79.30 and 82.20% recovery against aspirin and ethanol induced gastric ulcerations respectively suggesting free radical scavenging properties of the extract for anti-ulcer effect (Patil et al., 2009).

**Pharmacological effects of *B. monosperma* fruits derivatives**

**Hypoglycemic effect:** Naeem and Khan, (2010) evaluated the hypoglycemic activity powder prepared from *B. monosperma* fruits in normal and diabetic human volunteers suffering from diabetes type II ((non-insulin-dependent diabetes mellitus (NIDDM)). They found significant decrease in blood glucose, urine sugar, and plasma glycoprotein 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 *B. monosperma* fruit extract (Naeem and Khan, 2010).

**Anti-diabetic:** Akhtar et al. (2010a, b) have assessed the hypoglycemic and hypolipidemic activity of *B. monosperma* in normal and diabetic human volunteers and promising anti-diabetic effect (Akhtar et al., 2010a; Akhtar et al., 2010b). Thorat et al. (2010) prepared an herbal formulations consisting of three plant parts; *Piper betel, Butea monosperma* and *Trigonella foenum graecum* and they investigated their anti-diabetic potential in normal and alloxaan induced diabetic rats and found promising anti-diabetic potential (Thorat et al., 2010; Permender et al., 2010).

**Antimicrobial and anti-fungal:** Different fractions obtained from *B. monosperma* possess significant antimicrobial effects across various bacteria and fungal species (Shukla et al., 2001; Gurav et al., 2008).

**Antihelminthic effect:** Agarwal et al. (1994) have studied the Pippali rasayana, an Ayurvedic herbal formulation prepared from *Piper longum* and *B. monosperma* and 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 from the infection (Agarwal et al., 1994). They administered Pippali Rasayana orally 1g, three times a day for a period of 15 days to patients (25 treated, 25 placebo controls) suffering from giardiasis with clinical signs and symptoms, and stools positive for trophozoites/cysts of *Giardia lamblia*. 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 (Agrawal et al., 1997).

**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 details. This review provides an outlook on various aspects that need to be done to carry forward the available information in developing suitable clinical therapeutics out of *B. monosperma* plant.

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