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An Overview: On Phytochemical and Pharmacological Studies of Butea Monosperma

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Abstract: *Butea monosperma* popularly known as Flame of the Forest, Dhak, Palash or 'Bastard teak' which has immense potential and appears to have a broad spectrum of activity on several ailments. Previous phytochemical examination of this plant indicated the presence of various constituents some of these are Cajanin and isoformononetin; Stigmasterol; Butin; two known flavonoids, isobutrin (3, 4, 2', 4'-tetrahydroxychalcone-3, 4'-diglucoside), and the less active butrin (7, 3', 4'-trihydroxyflavanone-7, 3'-diglucoside); free sugars and free amino acids and (-)-3-hydroxy-9-methoxypterocarpan[(-)-medicarpin which were isolated from stem-bark extract; bark; seeds; flower; the petroleum ether extract of flowers and petroleum and ethyl acetate extract of stem bark. Its reported pharmacological properties include anthelmintic, anticonceptive, anticonvulsive, antidiabetic, antidiarrhoeal, antiestrogenic and antifertility, anti-inflammatory, antimicrobial, antifungal, antibacterial, antistress, chemopreventive, haemaggultinating, hepatoprotective, radical scavenging, Thyroid inhibitory, antiperoxidative and hypoglycemic effects and wound healing activities. Other then these an Ayurvedic herbal medicine which was prepared from *Piper longum* (Pippali) and *Butea monosperma* (Palash) has significant activity against Giardiasis.
Keywords: *Butea monosperma*, Palash, Phytochemical, Pharmacological properties.

Introduction

Butea monosperma (Lam.) is commonly known as Flame of forest, belongs to the family Fabaceae (1). It is locally called as palas, palash, mutthuga, bijasneha, dhak, khakara, chichra, Bastard Teak, Bengal Kino, Nourouc and is common throughout India, Burma and Ceylon except in very acrid parts. Generally it grows gregariously on open grasslands and scattered in mixed forest. Plantations can be raised both on irrigated and dry lands. The pods should be collected and sown before the commencement of rains, root suckers are freely produced and help in vegetative propagation. In India, palas ranks next to kusum (schleichera trijuga) as a host tree for lac insect (2, 3). It has proven to be a source of constitutive osteogenic agents belonging to isoflavonoid and pterocarpan groups. The genus Butea includes *Butea monosperma*, *Butea parviflora*, *Butea minor* and *Butea superba* widely distributed throughout India (4). It holds an important place because of its medicinal and other miscellaneous uses of economic value. It is one of the most beautiful tree has been put to some useful purpose. *Butea monosperma* is extensibly used in Ayurveda, Unani and Homeopathic medicine and has become a cynosure of modern medicine. The plants of this genus are well known for their colouring matters. Commonly *Butea monosperma* is used as tonic, astringent, aphrodisiac and diuretics (5).

It is an erect tree 12-15 m high with crooked trunk and irregular branches, bark rough, ash coloured, young parts downy. Leaves are 3-foliate, petioles 10-15 cm long, stipules linear lanceolate. Leaflets coriaceous (the terminal 10-20 cm long, broadly ovate from a cuneate base, the lateral smaller, 10-15 by 7.5 – 10 cm, obliquely rounded at the base, equilateral, the lower side the larger), all obtuse, glabrous above when old,

finely silky and conspicuously reticulately veined beneath; petioles 6 mm long, stout-stipels subulate, deciduous. Flowers are large, in a rigid racemes 15 cm long, 3 flowers together form the tumid nodes of the dark olive-green velvety rhachis: pedicels about twice as long as the calyx, densely brown-velvety: bracts and bracteoles small, deciduous. Calyx 13 mm long, dark olive-green, densely velvety outside, clothed with silky hairs within: teeth short, the 2 upper connate, the 3 lower equal, deltoid. Corolla 3.8-5 cm long, clothed outside with silky, silvery hairs, orange or salmon coloured: standard 2.5 cm broad: keel semicircular, beaked, veined. Pods stalked 12.5-20 by 2.5-5 cm, thickened at the sutures, reticulately veined argenteo–canescent : stalked 2 cm long (6).

Chemical Constituents:

Flower: Triterpene, butein, butin, isobutrin, coreopsin, isocoreopsin (butin 7-glucoside), sulphurein, monospermoside (butein 3-e-D-glucoside) and isomonospermoside, chalcones, aurones, flavonoids (palasitrin, prunetin) and steroids.
Gum: Tannins, mucilaginous material, pyrocatechin
Seed: Oil (yellow, tasteless), proteolytic and lypolytic enzymes, plant proteinase and polypeptidase. (Similar to yeast tripsin). A nitrogenous acidic compound, along with palasonin is present in seeds. It also contains monospermoside (butein 3-e-D-glucoside) and somonospermoside. From seed coat allophanic acid has been isolated and identified.
Resin: Jalaric esters I, II and laccijalaric esters III, IV.; Z- amyrin, e-sitosterone its glucoside and sucrose; lactone-nheneicosanoic acid-delta-lactone.
Sap: Chalcones, butein, butin, colourless isomeric flavanone and its glucosides, butrin.
Leaves: Glucoside, Kino-oil containing oleic and linoleic acid, palmitic and lignoceric acid.
Bark: Kino-tannic acid, Gallic acid, pyrocatechin. 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.
Stem: 3-Z-hydroxyeuph-25-ene and 2,14-dihydroxy-11,12- dimethyl-8-oxo-octadec-11-enylcyclohexane. Stigmasterol-e-D-glucopyranoside and nonacosanoic acid (6).

Traditional Uses:-

Flowers: Flowers are astringent to bowel, in 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. They are given to pregnant women in case of diarrhoea. 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.
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 seeds act as powerful rubefacient and they have been successfully used in curing a form of herpes, knows as Dhobie's itch.
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 perday 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
Gum: Gum is applied for cracks on foot sole. 2 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.
Roots: The root cures night blindness and zother defects of sights, useful in elephantiasis. Root pieces are heated and then 2-3 spoons of extract is 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 anantidote for snake bite.
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, appetiser, aphrodisiac, laxative, anthelmintic, useful in fractures of the bones, diseases of theanus, dysentery, piles, hydrocele, cures ulcers and tumours. Bark is useful in biliousness, dysmenorrhea, liver disorder, gonorrhoea and it also purifies the blood. The ash of young branch is prescribed in combination with other drugs in case of scorpion sting.
Ayurvedic literature extensive mention of this drug is available in the treatment of Krimi Roga (worm

infestations). It enters into the composition of some very important and widely used recipes of Ayurvedic medicines used in the treatment of Krimi Roga. In Sushruta samhita this drug has been described under four different groups of herbal medicines eg. Rudaradigana, Musakadigana, Amabasatadigana and Nyagrodhabigana dealing with different disorders eg.Medoroga, Striroga, Prameha and also credited with Kaphaand Pittanasak properties. The first mention of its Krimighna property is available in Sushruta samhita and the later Ayurvedic authors have also described its efficacy in Netraroga and its astringent action in different conditions. Iancient and later Ayurvedic literature this drug has been mentioned either alone or as a constituent of many prepared medicines used in the treatment of Krimi Roga. 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 (6).

Phytochemical Studies:

Cajanin and isoformononetin obtained from stem-bark extract of *Butea monosperma*. Cajanin had strong mitogenic as well as differentiation-promoting effects on osteoblasts & isoformononetin exhibited potent anti-apoptotic effect in addition to promoting osteoblast differentiation by acting via estrogen receptors in osteoblast. Both of these compounds was given at at 10.0 mg /kg/day orally dose to recently weaned female Sprague-Dawley rats for 30 days. Cajanin increased bone mineral density (BMD) at all skeletal sites studied, bone biomechanical strength, mineral apposition rate (MAR) and bone formation rate (BFR), compared with control. BMD levels at various anatomic positions were also increased with isoformononetin compared with control however, its effect was less potent than cajanin. Isoformononetin had very mild uterotrophic effect, whereas cajanin was devoid of any such effect (7).

One new dihydrochalcone, dihydromonospermoside was isolated from the flowers of *Butea monosperma* together with three known chalcones, butein monospermoside and isoliquiritigenin, one flavone, 7,3',4'-trihydroxyflavone, four flavanones, (-)-butin, (-)-butrin, (+)-isomonospermoside and (-)-liquiritigenin , and three isoflavones, formononetin, afrormosin and formononetin-7-O-beta-D-glucopyranoside. The isolated flavonoids exhibited varying antimycobacterial activity with the chalcone 2 being the most active compound (MIC 12.5 microg/ml) (8).

Phytochemical investigation from the stem bark of *Butea monosperma*, led to the isolation and identification of three new compounds named buteaspermin A, buteaspermin B and buteaspermanol, along with 19 known compounds, Some of isolated compounds showing promising osteogenicactivity, attributed to increased osteoblast proliferation, differentiation and mineralization as evidenced by marked increase in expression of alkaline phosphatase (9).

Stigmasterol, isolated from the bark of *Butea monosperma* was evaluated for its thyroid hormone and glucose regulatory efficacy in mice (10).

A new bioactive flavone glycoside was isolated from the methanol soluble fraction of the flowers of *Butea monosperma* O. Kuntze, which was identified as 5,7-dihydroxy-3,6,4'-trimethoxyflavone-7-O-alpha-L-xylopyranosyl-(1-->3)-O-alpha-L-arabinopyranosyl-(1-->4)-O-beta-D-galactopyranoside (1) by several colour reactions, chemical degradations and spectral analysis. The compound 1 shows antimicrobial activity against various fungal species (11).

A potential antiviral flavone glycoside has been isolated from the seeds of Butea monosperma O. Kuntze and its structure determined as 5,2'-dihydroxy-3,6,7-trimethoxyflavone-5-O-beta-D-xylopyranosyl-(1-->4)-O-beta-D-glucopyranoside (1) by various spectral analysis and chemical degradations (12).

Besides stigmasterol, stigmasterol-betaD-glucopyranoside and nonacosanoic acid, two new compounds isolated from the stems of *Butea monosperma* have been characterised as 3alpha-hydroxyeuph-25-ene and 2,14-dihydroxy-11,12-dimethyl-8-oxo-octadec-11- enylcyclohexane+ ++ by spectral data and chemicalstudies. 3,9-dimethoxypterocapan from ethyl acetate fraction of methanol extractives from leaves. And hexane fraction of methanol extractives yielded 3-alphahydroxyeuph-25-enylheptacosanoate (13).

Free sugars and free amino acids were isolated and identified from the petroleum ether extract of flowers (14).

Isolated antifungal compound from petroleum and ethyl acetate extract of stem bark from *Butea momosperma* which were identified as (-)-3-hydroxy-9-methoxypterocarpan[(-)-medicarpin. Both (-)-medicarpin and its acetate were active against *cladosporium cladosporioides*. The petroleum extract also yielded lupenone, lupeol and sitosterol. The two isoflavones isolated from ethyl acetate extract were found to be 5-methoxygenistein and prunetin (15).

Butin isolated from the seeds of *Butea monosperma* (16).

The extract from the flowers of *Butea monosperma* was fractionated by solvent partitioning and HPLC. The antihepatotoxic principles isolated consisted of two known flavonoids, isobutrin (3, 4, 2', 4'-tetrahydroxychalcone-3, 4'-diglucoside), and the less active butrin (7, 3', 4'-trihydroxyflavanone-7, 3'-diglucoside) (17).

Components of soft resin were reported and isolated four essentially pure acid esters, which together constitute the bulk of soft resin. They termed these acid esters, jalaric ester-I, jalaric ester-II, laccijalaric ester-I and laccijalaric ester-II (18).
By Reinvestigation of the flowers of *Butea monosperma*, revealed the presence of seven flavonoid glucosides. Two of them are butrin and isobutrin, which have been isolated earlier from the plant. Three glucosides have been identified as coreopsin, isocoreopsin and sulphurein. The remaining two are new and have been assigned the structures (monospermoside) and (isomonospermoside) (19).

Pharmacological Studies:-

Anthelmintic activity
seeds of *butea monosperma* administered as crude powder (cp) at doses of 1, 2 and 3 g/kg to sheep naturally infected with mixed species of gastrointestinal nematodes exhibited a dose and a time-dependent anthelmintic effect. the maximum reduction of 78.4% in eggs per gram of feces (epg) was recorded on day 10 after treatment with 3 g/kg. levamisole (7.5 mg/kg), a standard anthelmintic agent, exhibited 99.1% reduction in epg. the anthelmintic activity of different species of butea has been reported against *ascaridia galli*, *ascaris lumbricoides*, *earthworms*, *toxocara canis*, *oxyurids*, *dipylidium caninum* and taenia (20), methanol extract of butea monosperma seeds showed significant anthelmintic activity *in- vitro* (21).

Anticonceptive activity
Butin which is isolated from the seeds of *Butea monosperma* administered orally to adult female rats at the doses of 5, 10 and 20 mg/rat from day 1 to day 5 of pregnancy showed anti-implantation activity in 40%, 70% and 90% of the treated animals, respectively. At lower doses, there was a dose-dependent termination of pregnancy and reduction in the number of implantation sites. In ovariectomized young female rats, the butin exhibited estrogenic activity at comparable anticonceptive doses, but was devoid of anti-estrogenic activity. Butin is a weak estrogen in that a significant uterotrophic effect was discerned even at 1/20th the anticonceptive dose (16). It was reported that seed oil use as traditional sexual toner and contraceptive (22).

Anticonvulsive activity
it shows anticonvulsive activity, due to the presence of a triterpene (tbm) which present in the n-hexane:ethyl acetate (1:1) fraction of the petroleum ether extract of dried flowers of *butea monosperma* (bm). tbm exhibited anticonvulsant activity against seizures induced by maximum electroshock (mes) and its ld(50) was found to be 34.2+/-18.1 mg/kg. tbm also inhibited seizures induced by pentylenetetrazol (ptz), electrical kindling, and the combination of lithium sulfate and pilocarpine nitrate (li-pilo). tbm exhibited depressant effect on the central nervous system (23). the ethanolic extracts of leaves of *albizzia lebbeck* and flowers of *hibiscus rosa sinesis* and the petroleum ether extract of flowers of *butea monosperma* exhibited anticonvulsant activity. the acetone soluble part of petroleum ether extract of *butea monosperma* flowers showed anticonvulsant activity. the fractions protected animals from maximum electro shock, electrical kindling pentylenetetrazole and lithium–pilocarpine induced convulsion but failed to protect animals from strychnine-induced convulsions. the fractions raised brain contents of gamma-aminobutyric acid (gaba) and serotonin (24).

Antidiabetic activity
Single dose treatment ethanolic extract of *Butea monosperma* of (200 mg/kg, p.o.) significantly improved glucose tolerance and caused reduction in blood glucose level in alloxan-induced diabetic rats. Repeated oral treatment for 2 weeks significantly reduced blood glucose, serum cholesterol and improved HDL-cholesterol and albumin as compared to diabetic control group (25). Ethanolic extract of leaves also have antidiabetic and antioxidant potential in alloxan-induced diabetic mice (26). Ethanolic extract of seeds (300mg/kg b.w.) exhibited significant antidiabetic, hypolipaemic and antiperoxidative effects in non-insulin dependent diabetes mellitus rats (27). Aqueous extract significantly decreases blood glucose level both in normal ($p<0.01$) and alloxan induced diabetic ($p<0.001$) mice at 2 and 5 hr respectively. However, the hypoglycemic effect is peaked at 90min and is not sustained as observed for the standard drug metformin (28). The effect of *Butea monosperma* (Lamk.) Taub on blood glucose and lipid profiles in normal and diabetic human volunteers was evaluated which indicated a significant decrease ($P < 0.05$) in 2 h post- prandial blood glucose (mg/dl) on 21st day in the diabetic subgroups treated with 2 g and 3 g of powdered *B. monosperma* (Lamk.) Taub. A significant decrease in total cholesterol (mg/dl) was observed in normal and diabetic subgroups on day 21st post treatment. Both normal and diabetic groups exhibited a significant decrease in total lipids on day 21st. This study indicates that *B. monosperma* (Lamk.)Taub might possess important hypoglycemic and hypolipidemic properties (29).

Anti-diarrhoeal activity
Ethanolic extract of stem bark of *Butea monosperma* (Lam) Kuntz at 400 mg/kg and 800mg/kg inhibited

castor oil induced diarrhoea due to inhibiting gastrointestinal motility and PGE_2 induced enteropooling and it also reduced gastrointestinal motility after charcoal meal administration in Wistar albino rats (30). *Butea monosperma* gum has also been found useful in cases of chronic diarrhoea. It is a powerful astringent and also decreases bilirubin level (31).

Antiesterogenic and antifertility activity

Methanolic extracts of *Butea monosperma* exhibited effect on uterotropic and uterine peroxidase activities in ovariectomized rats & determine estrogenic/antiestrogenic potential of antifertility substances using rat uterine peroxidase assay (32). Alcoholic extract of flowers of the title plant has also been reported to exhibit antiestrogenic (33, 34) and antifertility (35) activities. Butin isolated from its flowers show both male and female contraceptive properties (36).

Anti-inflammatory activity

The leaves of *Butea monosperma* exhibit ocular anti-inflammatory activity in rabbits (37). The anti-inflammatory activity of methanolic extract of *Butea monosperma* evaluated by carrageenin induced paw edema and cotten pellet granuloma. In carrageenin induced paw edema at 600 and 800 mg/kg inhibition of paw edema, by 26 and 35% and in cotten pellet granuloma inhibition of granuloma tissue formation, by 22 and 28% (38).

Antimicrobial, Antifungal activity, antibacterial activity

Antifungal compound isolated from petroleum and ethyl acetate extract of stem bark from *Butea monosperma* which were identified as (-)-3-hydroxy-9-methoxypterocarpan [(-)-medicarpin. Both (-)-medicarpin and its acetate were active against *cladosporium cladosporioides* (15). The active constituent of low polarity was isolated by bioassay-monitored chromatographic fractionation, and identified as (-)-medicarpin by comparison of physical data. The antifungal activity of (-)-medicarpin was found to be greater than that of Benlate, a standard fungicide, while (-)-medicarpin acetate also exhibited significant activity against *C. cladosporiodes* (39). The seed oil of *Butea monosperma* shows significant bactericidal and fungicidal effect in in-vitro testing studied by the filter paper disk method against several human pathogenic bacteria and fungi (40). Gum of *Butea monosperma* is used to treat microbial and fungal infections in folk medicine. To validate this use, the in- vitro antimicrobial activity of petroleum ether and alcoholic extract of gum was evaluated against various microbial strains such as *Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Salmonella typhimurium*, *Pseudomonas aeuriogenosa*, *Escherichia coli*, *Candida albicans* and *Saccharomyces cerevisiae* by using disc diffusion method. Minimum inhibitory concentration (MIC) was determined by agar dilution technique. Both extracts showed significant inhibition against reference gram positive bacteria and fungal strains. MIC value of petroleum ether extract against gram positive and fungal strains was 300 µg / ml and that of alcoholic extract was 200 µg / ml. Neither extract showed inhibitions against gram negative bacteria (41).

Antistress activity

Water soluble part of ethanolic extract of flower attenuated water immersion stress, induced elevation of brain serotonin and plasma corticosterone levels. The ulcer index also decreased in dose dependent manner. Observed effects may be attributed to its nonspecific antistress activity (42).

Chemopreventive

Butea monosperma extract exhibited chemopreventive effects on hepatic carcinogenesis and on tumor promoter induced markers and oxidative stress in male Wistar rats. Treatment of male Wistar rats for five consecutive days with 2-AAF(2-acetylaminofluorine) i.p. induced significant hepatic toxicity, oxidative stress and hyperproliferation. Pretreatment of *B.monosperma* extract (100 and 200 mg/kg body weight) prevented oxidative stress by restoring the levels of antioxidant enzymes and also prevented toxicity at both doses. The promotion parameters induced (ornithine decarboxylase activity and DNA synthesis) by 2-AAF administration in diet with partial hepatectomy (PH) were also significantly suppressed dose dependently by B. monosperma. Thereafter, we proceeded with studies on rat liver carcinogenesis. After fourteen days of DEN(diethyl nitrosamines) treatment, dietary administration of 2-AAF with PH resulted in a 100% incidence of tumors in the animals. However, *B.monosperma* caused reduction in the number of tumors/ rat and percentage of tumor bearing rats at the end of the study, as confirmed histologically. Thus, their data suggests that *B.monosperma* extract is a potent chemopreventive agent which suppresses 2-AAF-induced hepatic carcinogenesis and oxidative damage in Wistar rats. The protective activity of the plant might be due to the two major constituents (butrin and isobutrin) (43).

Giardiasis

Giardiasis is a common gastrointestinal infection caused by a protozoal parasite, Giurdia *lamblia*. Pippali rasayana (PR), an Ayurvedic herbal medicine, prepared from *Piper longum* (Pippali) and *Butea*

monosperma (Palash) in which ash of stem, root, flower and leaves of *Butea monosperma* is used, has significant activity against Giardiasis It produced up to 98% recovery from the infection. The rasayana had no killing effect on the parasite in vitro. It induced significant activation of macrophages as evidenced by increased macrophage migration index (MMI) and phagocytic activity. With higher doses of PR recovery increased up to 98% at 900 mg/kg (44).

Hemagglutinating activity

Seeds of *Butea monosperma* showing specificity towards human erythrocytes (45). The lectins such as *Butea monosperma* agglutinin (BMA) isolated from the seeds of Butea monosperma are responsible for agglutinating property (46), this property was only shown by seeds not by flowers, leaves, roots and stems. Human blood group-A-specific agglutinins have been demonstrated in some of the N-acetyl galactosamine/galactose–binding lectins, such as the lectins. Hemagglutination test showed that N-acetyl galactosamine is the strongest inhibitor of agglutination (47).

Hepatoprotective

Isobutrin and Butrin, the antihepatotoxic principles of flowers was reported and this activity was monitored by means of CCl_4 and GaIN-induced liver lesion *in-vitro* (17). The methanolic extract of *B. monosperma* possesses hepatoprotective effects and also it might suppress the promotion stage via inhibition of oxidative stress and polyamine biosynthetic pathway by significant reduction in Thioacetamide-induced serum Aspartate transaminase (AST/SGOT), Alanine transaminase (ALT/SGPT), Lactate dehydrogenase (LDH) and gamma-Glutamyltranspeptidase (GGT) activities (48).

Radical scavenging activities

Ethyl acetate, butanol and aqueous fractions derived from total methanol extract of *Butea monosperma* flowers were evaluated for radical scavenging activities using different in vitro models like reducing power assay, scavenging of 2,2 diphenyl-1-picrylhydrazyl (DPPH) radical, nitric oxide radical, superoxide anion radical, hydroxyl radical and inhibition of erythrocyte hemolysis using 2, 2' azo-bis (amidinopropane) dihydrochloride (AAPH). Methanol extract along with its ethyl acetate and butanol fractions showed potent free radical scavenging activity, whereas aqueous fraction was found to be devoid of any radical scavenging properties. The observed activity could be due to the higher phenolic content in the extracts (16.1, 25.29, and 17.74% w/w in methanol extract, ethyl acetate and butanol fractionsrespectively) (49).

Thyroid inhibitory, antiperoxidative and hypoglycemic effects

Stigmasterol, isolated from the bark of *Butea monosperma* was evaluated for its thyroid hormone and glucose regulatory efficacy in mice by administrating 2.6 mg/kg/d for 20 days which reduced serum triiodothyronine (T3), thyroxin (T4) and glucose concentrations as well as the activity of hepatic glucose-6-phophatase (G-6-Pase) with a concomitant increase in insulin indicating its thyroid inhibiting and hypoglycemic properties. A decrease in the hepatic lipid peroxidation (LPO) and an increase in the activities of catalase (CAT), superoxide dismutase (SOD) and glutathione (GSH) suggested its antioxidative potential. The highest concentration tested (5.2 mg/kg) evoked pro-oxidative activity (10).

Wound healing

Topical administration of an alcoholic bark extract of *Butea monosperma* on cutaneous wound healing in rats increased cellular proliferation and collagen synthesis at the wound site, by increase in DNA, total protein and total collagen content of granulation tissues, the tensile strength also increased significantly & histopathological examinations also provide favourable result So, it possesses antioxidant properties, by its ability to reduce lipid peroxidation (50).

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