REVIEW
OF
LITERATURE
3.1. **BUTEA MONOSPERMA**

Plant was selected on random basis and data available on it was reviewed.

- **Botanical name:**
  
  *Butea monosperma* (Lam.) Kuntze.

- **Family:**
  
  Fabaceae

- **Vernacular names**
  
  - English - Flame of the forest
  - Hindi - Dhak
  - Kannada - Muthuga
  - Malayalam - Palas in Samatha
  - Marathi - Palas
  - Oriya - Kinjuko
  - Bengali - Palas
  - Sanskrit - Palasha

- **Habitat:**
  
  It is found in greater part of India, Burma, and Sri Lanka. It is capable of growing in water logged situation, black cotton soils, saline, swampy badly drained soils and on barren lands except in arid regions.

- **Parts used:**
  
  Bark, roots, leaves, gum, seed, stem and flowers.

- **Plant description:**
  
  It is an erect, medium sized tree, 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 coloured. The leaves are three foliate, large and stipulate. Petiole is 10-15 cm long. Leaflets are obtuse, glabrous above, fine 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 inside. Stamens are diadelphes, anthers uniform. Ovary 2 ovule, style filiform, curved and stigma capitate. Pods argenteo-canesent,
narrowed, thickened at the sutures, splitting round the single apical seed, lowest part indehiscent. The seeds are flat, reniform, curved (Puri and Seshadri, 1955).

- **Principal constituents:**
  
  Bark: Kino-tannic acid, gallic acid, pyrocatechin. The plant also contains palasitrin, and major glycosides as butrin, alanine, 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 non acosanoic acid.

  The main constituent of the flower is butrin (1.5 %), butein (0.37 %) and butin (0.04 %). It also contains flavonoids and steroids. Other than these in flowers, coreopsin, isocoreopsin, sulphurein (glycoside) and other two with monospermoside and isomonospermoside structures are also identified. Roots contain glucose, glycine, glucosides and aromatic compounds. Tetramers of leucocynidin are isolated from gum and stem bark. Seed contains oil. The bright colour of the flower is attributed to the presence of chakones and aurones (Puri and Seshadri, 1955; Sharma and Deshwal, 2011).

- **Medicinal uses:**
  
  - Flowers: Flowers are astringent to bowel, in cure cough (Kapha), leprosy, strangury, gout, skin diseases, thirst, sensation; flower juice is useful in eye diseases. Flower is bitter, aphrodisiac, expectorant, tonic, emmenagogue, diuretic, and good in biliousness, inflammation and gonorrhea.
  - 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 urinogenous 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 two spoons of this mixture is taken orally to treat urinal complaints and also against urinary stones.
  - Fruit and seed are digestible, aperients, cure ‘Vata’ and ‘Kapha’, skin diseases, tumors, 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, known 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 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

• 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.

• Roots: The root cures night blindness and other defects of sights, useful in elephantiasis. Root pieces are heated and 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 an antidote for snake bite.

• Stem bark: Stem bark powder is used to apply on injury caused due to axe. Stem juice is applied on goiter in human beings. 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 the anus, dysentery, piles, hydrocele, cures ulcers and tumors. Bark is useful in biliousness, dysmenorrhea, 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 (Sharma and Deshwal, 2011).

- **Phytochemical and pharmacological review of *Butea monosperma***:

  Gupta et al., studied the hepatoprotective activity of *Butea monosperma* in rats against CCl₄ as hepatotoxin. The ethanolic extract of *Butea monosperma* shows significant (P < 0.01) hepatoprotective effects in the CCl₄ intoxication in rats (Gupta et al., 2012).
Sharma and Garg studied antihyperglycemic, antihyperlipidemic and antioxidative properties of hydroethanolic extract of *Butea monosperma* bark in alloxan-induced diabetic mice (Sharma and Garg, 2012).

Mathan et al., reported the hepatoprotective and antitumorigenic properties of the aqueous extract and butanol fractions of *Butea monosperma* flowers in animal models (Mathan et al., 2011).

Lau et al., reported potential suppressive effect of the flavonoid on phorbol-12-myristate 13-acetate (PMA)-induced COX-2 expression in the non-tumorigenic MCF-10A and cancerous MCF-7 breast cells. Immunoblot and mRNA analyses revealed that butein at or below 10 μM significantly inhibited PMA-induced COX-2 expression in these breast cells (Lau et al., 2010).

Sharma and Shukla reported aqueous extract of flowers of *Butea monosperma* (Fabaceae) was evaluated at different dose levels (200, 400, 800 mg/kg, p.o.) for its protective efficacy against CCl₄ (1.5 ml/kg i.p.) induced acute liver injury to validate its use in traditional medicines. Therapy of *B. monosperma* showed its protective effect on biochemical and histopathological alterations at all the three doses in dose dependent manner. *B. monosperma* extract possess modulatory effect on drug metabolizing enzymes as it significantly decreased the hexobarbitone induced sleep time and increased excretory capacity of liver which was measured by BSP retention (Sharma and Shukla, 2011).

Rasheed et al., reported the butrin, isobutrin, and butein significantly reduced the phorbol 12-myristate 13-acetate 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-kB. In addition, isobutrin was most potent in suppressing the NF-kB p65 activation by inhibiting IkBα degradation, whereas butrin and butein were relatively less effective. In vitro kinase activity assay revealed that isobutrin was a potent inhibitor of I-kB kinase complex activity (Rasheed et al., 2010).

Sharma and Garg reported the treatment of alloxan-induced diabetic animals with 50% ethanolic extract of *Butea 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 (Sharma and Garg, 2009).
Chokchaisiri et al., reported a new dihydrochalcone, dihydromonospermoside, isolated from the flowers of *Butea monosperma* exhibited varying antimycobacterial activity (Chokchaisiri et al., 2009).

Panda et al., isolated stigmasterol, from the bark of *Butea monosperma*, and evaluated its thyroid hormone and glucose regulatory efficacy in mice (Panda et al., 2009).

Maurya et al., isolated stigmasterol, from the bark of *Butea monosperma*, and evaluated its thyroid hormone and glucose regulatory efficacy in mice (Maurya et al., 2009).

Yadava and Tiwari isolated a new bioactive flavone glycoside from the methanol soluble fraction of the flowers of *Butea monosperma* (Yadava and Tiwari, 2007).

Lavhale and Mishra studied the potent free radical scavenging activity of methanol extract of *Butea monosperma* flowers along with its ethyl acetate and butanol fractions, 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 fractions respectively) (Lavhale and Mishra, 2007).

Sehrawat et al., studied to offer dose-dependent protection and maintain the structural integrity of hepatic cells. This was evident from the significant reduction in TAA-induced serum GOT, GPT, Lactate dehydrogenase (LDH) and gamma-Glutamyl transpeptidase (GGT) activity (p < 0.001). These investigations validate the use of *Butea monosperma* in liver disorders by Ayurvedic physicians (Sehrawat et al., 2006).

Iqbal et al., studied the 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 they 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 (Iqbal et al., 2006).

Somani et al., reported anthyperglycemic activity of the ethanolic extract of *Butea monosperma* (BMEE), in glucose loaded and alloxan-induced diabetic rats (Somani et al., 2006).
Gunakkunru et al., reported the anti-diarrheal potential of the ethanolic extract of stem bark of *Butea monosperma* (Lam) Kuntz, using several experimental models in Wistar albino rats (Gunakkunru et al., 2005).

Kasture et al. 2002 reported the bioassay-guided fractionation of dried flowers of *Butea monosperma* (BM) to isolate the active principle responsible for its anticonvulsant activity (Kasture et al., 2002).

Mishra et al., reported two new compounds isolated from the stems of *Butea monosperma* have been characterized as 3α-hydroxyeuph-25-ene and 2,14-dihydroxy-11,12-dimethyl-8-oxo-octadec-11-enylecyclohexane by spectral data and chemical studies (Mishra et al., 2000).

Thiagarajan et al., reported antinociceptive effect of *Butea monosperma* on vincristine induced neuropathic pain model in rats (Thiagarajan et al., 2012).

Ahmed et al., reported insignificant antihyperglycemic activity of both leaf and bark extracts of *Butea monosperma* produced. The leaf and bark extracts reduced blood glucose to an extent of 28 % and 11 % respectively. It was also evidenced that both leaf and bark extracts did not increase insulin synthesis or secretion and did not improve pancreatic architecture as reflected by the histopathologic studies (Ahmed et al., 2012).

Donga et al., reported the possibility of toxic effect of *Butea monosperma* when administered in a powder form (Donga et al., 2011).

Sharma and Garg reported antihyperglycemic and antioxidative attribute of hydroethanolic extract of *Butea monosperma* (Lam.) seeds and its active constituents (Sharma and Garg, 2011).

Tarannum et al., reported inhibition of testicular and Vipera russelli snake venom hyaluronidase activity by *Butea monosperma* (Lam) Kuntze stem bark (Tarannum et al., 2011).

Abhilash et al., studied the crystallization and preliminary x-ray diffraction analysis of a galactose specific lectin from the seeds of *Butea monosperma* (Abhilash et al., 2011).

Kumari and Sharma reported stress-mediated alteration in V-ATPase and V-PPase of *Butea monosperm* (Kumari and Sharma, 2010).
Pandey et al., determined the skeletal effects of *Butea monosperma* total extract (BTE) and its acetone soluble fraction (ASF) from *Butea monosperma*, which is rich in methoxyisoflavones, in ovariectomized (OVx) rats, a model for postmenopausal bone loss (Pandey et al., 2010).

Choedon et al., studied the ability of aqueous extract of *Butea monosperma* flowers to impose growth arrest and trigger pro-apoptotic death in cell culture strongly correlated with its strong chemo preventive effect in vivo when given orally (Choedon et al., 2010).

Gupta et al., developed an isocratic, reversed phase, high performance liquid chromatographic (HPLC) method for the determination of the marker compounds K052 (iso-formononetin), K054 (methoxy derivative) and K080 (formononetin) in NP-1, an anti-osteoporotic plant product from *Butea monosperma* (Gupta et al., 2010).

Sharma and Garg studied antidiabetic and antioxidant potential of ethanolic extract of *Butea monosperma* leaves in alloxan-induced diabetic mice (Sharma and Garg, 2009).

Bavarva and Narasimhacharya reported preliminary study on antihyperglycemic and antihyperlipaemic effects of *Butea monosperma* in NIDDM (Bavarva and Narasimhacharya, 2008).

Shahavi and Desai studied the methanolic extract of *Butea monosperma* flowers (MEBM) for anti-inflammatory activity against carrageenin induced paw edema and cotton pellet granuloma in albino rats (Shahavi and Desai, 2008).

Yadava and Tiwari isolated a potential antiviral flavone glycoside 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 by spectral analysis and chemical degradations (Yadava and Tiwari, 2005).

Sumitra et al., studied efficacy of *Butea monosperma* on dermal wound healing in rats and reported that *Butea monosperma* possesses antioxidant properties, by its ability to reduce lipid peroxidation (Sumitra et al., 2005).

Kasture et al., studied the anticonvulsive activity of *Butea monosperma* in experimental animals (Kasture et al., 2000).
Agrawal et al., studied management of giardiasis by herbal drug Pippali Rasayana. There was a marked improvement in the clinical and haematological profile of the patients. Spontaneous recovery in 20 % cases was recorded in placebo controls (Agrawal et al., 1997).

Bandara et al., reported an antifungal constituent from the stem bark of *Butea monosperma* (Bandara et al., 1989).

Bhargava et al., isolated butin from the seeds of *Butea monosperma* and reported estrogenic and postcoital anticonceptive activity in rats (Bhargava, 1986).

Mehta et al., studied the in vitro antimicrobial efficiency of seed oil of *Butea monosperma* was by the filter paper disk method against several human pathogenic bacteria and fungi. The oil showed a significant bactericidal and fungicidal effect (Mehta et al., 1983).
3.2. BAUHINIA VARIEGATA

- **Botanical name:**
  
  *Bauhinia variegata* Linn

- **Family:**
  
  Leguminosae

- **Vernacular Names**
  
  - Sanskrit - Kanchanak
  - Bengali - Kanchana, Rakta Kanchana
  - English - Mountain Ebony
  - Guajarati - Champakati, Kanchnar
  - Hindi - Kachanar
  - Malayalam - Chuvanna Mandharam
  - Marathi - Kanchana, Raktakancana
  - Oriya - Kachana, Kaniara
  - Punjabi - Kanchnar

- **Habitat:**
  
  Sub-Himalayan tract and the forests of India and Burma

- **Parts used:**
  
  Bark, roots, leaves, seed, stem and flowers

- **Plant description:**
  
  A medium sized, deciduous tree found throughout India ascending to an altitude of 1300 meters in the Himalayas and the forests of India. Bark grey with longitudinal cracks, pale pink inside, leaves rather broader than deep, rigidly sub-cariaceous, deeply cordate, flowers variously colored, in few flowered lateral, sessile or short peduncled corymbs; pods long, hard, flat, glabrous, dehiscent, 10-15 seeded (Khare, 2007).

- **Principal constituents:**
  
  The stem contains β-sitosterol, lupeol, kaempferol-3-glucoside and 5, 7-dehydroxy and 5, 7-dimethoxyflavanone – 4 – O – α – L – rhamnopyranosyl- β-D-glucopyranosides. The pale violet flowers contain cyanidin-3-glucoside, maluidin-3-glucoside, maluidin-3-diglucoside, peonidin 3-diglucoside, while the white flowers contain kaempferol - 3- galactoside and kaempferol – 3 – rhamno glucoside. The bark yields fiber. Five flavonoids isolated from the different organs
of *Bauhinia variegata* was identified as quercetin, rutin quercetin, apigenin and apigenin 7-O-glucoside. Extraction of volatile oils from leaves by steam distillation consist of sesquiterpenes, β-caryophyllene, germacrene D (Patil et al., 2012).

**Medicinal uses:**
- Buds - a decoction is given in piles (also used against tumours), haematuria, menorrhagia.
- Dried buds are used in diarrhoea, dysentery, worm infestation, piles and tumours.
- Root - carminative, used in dyspepsia and flatulence (a decoction is reported to prevent obesity).
- Bark - astringent, anthelmintic; used externally in scrofula and skin diseases.
- Seeds - possess human blood agglutinating activity.
- Leaf - antifungal.

**Phytochemical and pharmacological review of *Bauhinia variegata*:**

Rajani and Ashok studied that alcoholic and aqueous extracts of *B. variegata* can effectively decrease plasma cholesterol, triglyceride, LDL, and VLDL and increase plasma HDL levels. In addition, the alcoholic and aqueous extracts have shown significant antioxidant activity. By the virtue of its antioxidant activity, *Bauhinia variegata* Linn may show antihyperlipidemic activity (Rajani and Ashok, 2009).

Mohamed et al., isolated a new triterpene saponin, from the leaves of *Bauhinia variegata* Linn. It was found to be nontoxic (LD50) and to have significant anti-inflammatory and antinociceptive activities. It also showed slight antischistosomal activity (Mohamed et al., 2009).

Agrawal and Pandey evaluated anticarcinogenic and antimutagenic potential of *Bauhinia variegata* extract in Swiss Albino Mice and reported significantly prevention of micronucleus formation and chromosomal aberrations in bone marrow cells of mice (Agrawal and Pandey, 2009).

Rajkapoor et al., isolated a flavanone from the stem of *Bauhinia variegata* and reported isolated flavanone for cytotoxic activity against 57 human tumour lines, representing leukaemia, non-small cell lung, colon, central nervous system, melanoma, ovarian, renal, prostate and breast cancers (Rajkapoor et al., 2009).
Lin and Ng prepared a melibiose binding lectin from *Bauhinia variegata* seeds and reported that the lectin inhibit proliferation in hepatoma HepG2 cells and breast cancer MCF7 cells with an IC(50) of 1.4 microM and 0.18 microM, respectively (Lin and Ng, 2008).

Rajkapoor et al., evaluated the antitumour activity of the ethanol extract of *Bauhinia variegata* (EBV) against Dalton's ascitic lymphoma (DAL) in Swiss albino mice (Rajkapoor et al., 2003).

Yadava and Reddy isolated a novel flavonol glycoside and reported anti-inflammatory activity of this novel compound (Yadava and Reddy 2003).

Reddy et al., isolated a flavanone and a dihydrodibenzoepxin from *Bauhinia variegata* from root bark (Reddy et al., 2003).

Kumar and Yadav synthesized different-sized silver nanoparticles by simply varying reaction conditions with leaf extracts of *Bauhinia variegata* and this suggested the safe use of SNP for various in vivo applications (Kumar and Yadav, 2012).

Kumar et al., reported antidiabetic activity of stem bark of *Bauhinia variegata* in alloxan-induced hyperglycemic rats (Kumar et al., 2012).

Mali and Dhake evaluated the effects of *Bauhinia variegata* stem bark extracts against milk-induced eosinophilia in mice (Mali and Dhake, 2011).

Neto et al., evaluated the healing potential of the lectin of *Bauhinia variegata* (nBVL) and its recombinant isoform (rBVL-1) indicates that the lectin of *Bauhinia variegata* possesses pro-healing properties and may be employed in the treatment of acute skin wounds. Bioactive compounds extracted from Indian wild legume seeds: antioxidant and type II diabetes-related enzyme inhibition properties (Neto et al., 2011).

Pani et al., reported nephroprotective effect of *Bauhinia variegata* (Linn.) whole stem extract against cisplatin-induced nephropathy in rats (Pani et al., 2011).

Rao et al., isolated the novel flavonoids and a triterpene caffeate from *Bauhinia variegata* and evaluated anti-inflammatory activity (Rao et al., 2008).

Azevedo et al., isolated the insulin-like proteins from leaves of *Bauhinia variegata* (Azevedo et al., 2006).
Yadava and Reddy isolated a new flavone glycoside, 5-hydroxy 7, 3', 4',5'tetra-methoxyflavone-5-O-β-D-xylopyranosyl-(1→2)-α-L-rhamnopyranoside from Bauhinia Variegata Linn (Yadava and Reddy, 2001).
3.3. *OCIMUM GRATISSIMUM*

- **Botanical name:**
  
  *Ocimum gratissimum* Linn

- **Family:**
  
  Lamiaceae

- **Vernacular Names:**
  
  - Punjabi - Banjere
  - Bengal - Ramtulsi
  - Hindi - Ram tulsi
  - Kannada - Nimmatulsi
  - Marathi - Ramatulsi
  - Sanskrit - Vriddhitulsi
  - Gujarati - Avachibavachi
  - Tamil - Elumicham tulsi

- **Habitat:**
  
  It is a perennial, woody shrub that is an herbal medicine has been practiced worldwide and distributed throughout India, often cultivated, Ceylon, is now recognized by World Health Organization (WHO) java, tropical Africa, South America, Nigeria and Asia. It as an essential building block for primary healthcare ISO found in some states of North India like Jammu, Punjab, Haryana and also cultivated in Kerala (Gupta et al., 2011).

- **Parts used:**
  
  Flowers, leaves, mucilage and seeds

- **Plant description:**
  
  Leaves are 6.3 cm to 12.5 cm long, elliptic - lanceolate, acute, coarse lycrenateser - rate, pubescent on sides, gland dotted, base cuneate petioles are 2.5 cm to 6.3 cm long, slender, more or less pubescent. Flowers are simple or branched rather short racemes, tolerably close whorls; rhachis quadrangular, softly pubescent; bractas sessile, longer than the calyx acuminate from broad ovate base, decussate and squarrose the young inflorescence, cilate, pedicels shorter than the calyx, softly pubescent.

  Calyx 3 mm long in flower, becoming twice as long in fruit, pubescent and glandular, upper lip rounded, veined, scarcely mucronate, curved upwards in fruit,
longer than lower, lower lip strongly nerved, the 2 central teeth short, subulate, the lateral teeth shorter and broader, lanceolate. Corolla 4 mm long, pale greenish yellow, pubescent outside; upper 3 mm broad with 4 rounded teeth; lower lip longer than upper, 1.25 mm broad. Stamens exerted upper filaments with a bearded tooth at the base. Nutlets are 1.5 mm in diameter subglobose, rugose and brown (Gupta et al., 2011).

- **Principal constituents:**
  Various phytoconstituents viz. monoterpenes, sesquiterpenes, aromatic compounds, oxygen containing aromatic compounds have been reported from the volatile oil of the plant leaves. The various monoterpenes e.g., a-thujene, a-pinene, [3-pinene, camphene, sabinene, myrcene, a-phellandrene, D-3-carene, a-terpinene, limonene, 1, 8-cineole, [3 - ocimene, terpinolene. The various oxygen-containing monoterpenes, (Z)-sabinene hydrate, linalol, bomeol, terpin-4-ol, (E) - ocimenone have also been isolated from the volatile oil of leaf of plant.

  The various documented sesquiterpenes are a-copaene, [3-elemene, a-caryophyllene, a-bergamotene, a-caryophyllene, germacrene-D], [3-selinene, bicyclogermacrene] from the leaf of the plant have been displayed. The other aromatic compounds p-cymene, estragole, thymol, carvacrol have also been reported from the volatile oil of leaf of plant (Gupta et al., 2011).

- **Medicinal uses:**
  The plant exhibited various biological activities including antidiabetic, muscle relaxant, anthelmintic, antinociceptive, antihypotensive, antileishmanial, antioxidant activity and anticonvulsant (Gupta et al., 2011).

- **Phytochemical and pharmacological review of Ocimum gratissimum:**
  Costa et al., evaluated the immunomodulatory effects of *Ocimum gratissimum* and rosmarinic acid (RA, a polyphenolic compound) in a murine model of respiratory allergy induced by the Blomia tropicalis (Bt) mite. Methanolic extract of *Ocimum gratissimum* has therapeutic potential in this murine model of respiratory allergy to a clinically relevant human sensitizer allergen (Costa et al., 2012).

  Pereira et al., prepared Mouth rinse containing *Ocimum gratissimum* was effective as antiplaque and antigingivitis agent, in a similar manner that chlorhexidine digluconate (Pereira et al., 2011).
Kpadonou Kpoviessi et al., studied interaction between the daytime of collection and vegetative stage of the plants and the antimicrobial properties and toxicity of the essential oil of *Ocimum gratissimum* from Benin (Kpadonou Kpoviessi et al., 2012).

Mahapatra et al., evaluated the immune functions and immune responses in nicotine-induced (10 mM) macrophages and concurrently establish the immunomodulatory role of aqueous extract of *Ocimum gratissimum* (Ae-Og) and ascorbic acid (Mahapatra et al., 2011).

Shivashankara et al., reported preclinical observations that Dietary agents (*Ocimum gratissimum*) in the prevention of alcohol-induced hepatotoxicity (Shivashankara et al., 2012).

Abiodun et al., reported the antitrypanosomal activity of *Ocimum gratissimum* (Abiodun et al., 2012).

Kamaraj et al., reported antiplasmodial potential of *Ocimum gratissimum* (Kamaraj et al., 2011).

Kar Mahapatra et al., reported alteration of immune functions and Th1/Th2 cytokine balance in nicotine-induced murine macrophages: immunomodulatory role of eugenol (isolated from *Ocimum gratissimum*) and N-acetylcysteine (Kar Mahapatra et al., 2011).

Chang et al., reported the anti-proliferation effect of caffeic acid (3, 4-dihydroxycinnamic acid), isolated from *Ocimum gratissimum* Linn, on human cervical cancer cells (HeLa cells) (Chang et al., 2010).

Sam-Wobo et al., studied the root and leaf extracts of *Ocimum gratissimum*, for repellent activities against the adults of *Simulium damnosum* sensu lato (Sam-Wobo et al., 2011).

Ye et al., reported that high performance liquid chromatography is a suitable analytical method for determining caffeic acid levels in *Ocimum gratissimum*, and caffeic acid had anti-proliferative effects on cervical cancer cell lines. Caffeic acid can significantly reduce the proliferation of HeLa cells in a time-dependent manner (Ye et al., 2010).

Bora et al., reported cerebroprotective effect of *Ocimum gratissimum* against focal ischemia and reperfusion-induced cerebral injury (Bora et al., 2011).
Mu-Jang et al., reported *Ocimum gratissimum* extract effectively inhibited the mitochondrial pathway and up regulated Bcl-2 expression, which may be important in protecting H9c2 cells from H2O2-induced cell death (Mu-Jang et al., 2010).

Chen et al., reported OGE suppressed the cell viability of A549 cells, which may result from the activation of apoptotic signaling and the inhibition of anti-apoptotic signaling, suggesting that OGE might be beneficial to lung carcinoma treatment (Chen et al., 2010).

Abiodun et al., reported the ethyl acetate extract of leaves of *Ocimum gratissimum* Linn. (Labiatae) showed the highest antiplasmodial activity (IC$_{50}$ 1.8-1.93 µg/mL) against *P. falciparum* K1 strain but elicited low cytotoxicity (selective index >10) (Abiodun et al., 2011).

Mahapatra et al., reported the potential use and beneficial role of *Ocimum gratissimum* as a modulator of nicotine-induced free radical generation, lipid-protein damage and antioxidant status in important immune cell, peritoneal macrophages (Mahapatra et al., 2009).

Ekunwe et al., reported potential cancer-fighting *Ocimum gratissimum* leaf extracts: increased anti-proliferation activity of partially purified fractions and their spectral fingerprints (Ekunwe et al., 2010).

Oparaocha et al., reported that *Ocimum gratissimum* grown in eastern Nigeria has mosquito-repellent and mosquitocidal potentials and the formulations could be used to reduce human-mosquito contacts and hence mosquito-borne diseases and irritations caused by their bites (Oparaocha et al., 2010).

Akinmoladun et al., reported the methanolic extracts of the *Ocimum gratissimum* possess significant antioxidant and radical scavenging activities that may be due to the phytochemical content of the plants and as such make them potential candidates as natural chemoprophylactic agents (Akinmoladun et al., 2010).
Okoli et al., reported the anticonvulsant and anxiolytic activities of leaf extracts and fraction of *Ocimum gratissimum* L. (Lamiaceae) using seizures induced by pentylenetetrazol and open-field tests in mice. The results showed that the extracts and fraction increased the latency of tonic and tonic-clonic seizures and death and elicited 50 % protection against mortality (Okoli et al., 2010).

Egesie et al., reported Safety and hypoglycaemic properties of aqueous leaf extract of *Ocimum gratissimum* in streptozotocin induced diabetic rats (Egesie et al., 2010).

Emeka and Elizabeth evaluated *Ocimum gratissimum* L for its antibacterial properties against four clinical bacteria isolates namely: Escherichia coli, Proteus mirabilis, Staphylococcus aureus and Pseudomonas aeruginosa and the antifungal properties using a clinical isolate of Candida albicans. A typed bacterium of Escherichia coli ATCC 11775 and another typed fungal strain of Candida albicans (ATCC 90028) were also included (Emeka and Elizabeth, 2009).

Ahonkhai et al., reported the antimicrobial activities of the volatile oils of *Ocimum gratissimum* L. were evaluated on the twenty nine organisms using agar diffusion and agar dilution methods. In the susceptibility tests, the volatile oils of *Ocimum gratissimum* independently inhibited the growth of Klebsiella pneumonia at a concentration of 0.51 % in the agar; Streptococcus viridians and Staphylococcus albus at 1.10 % and Pseudomonas aeruginosa at 10.0 %. Proteus vulgaris was inhibited at 0.53 % by the volatile oil of *Ocimum gratissimum* (Ahonkhai et al., 2009).

Kar Mahapatra et al., reported the protective effect of eugenol against in vitro nicotine-induced toxicity in murine peritoneal macrophages, compared with N-acetylcysteine. Eugenol was isolated from *Ocimum gratissimum* and characterized by HPLC, FTIR, H-NMR (Kar Mahapatra et al., 2009).

Ighodaro and Ebuehi suggested that the oral administration of the aqueous extract of *Ocimum gratissimum* may impair naturally generated oxidant/toxicant activity and thereby enhance specific activities of hepatic antioxidant enzymes in rats (Ighodaro and Ebuehi, 2009).

Nguefack et al., reported Food preservative potential of *Ocimum gratissimum* against mycotoxigenic fungi (Nguefack et al., 2009).
Silva et al., reported the HPLC analysis of ursolic acid (UA) content in *Ocimum gratissimum* (Silva et al., 2008).

Fandohan et al., reported the toxicity and gastric tolerance of essential oils from *Ocimum gratissimum* in wistar rats (Fandohan et al., 2008).

Tanko et al., reported antinociceptive and anti-inflammatory activities of aqueous leaves extract of *Ocimum gratissimum* (Labiatae) in rodents (Tanko et al., 2008).

Interaminense et al., examined the vascular effects of essential oil of *Ocimum gratissimum* L. (Labiatae) (EOOG) and its main constituent, eugenol (EUG) and the putative mechanisms underlying these effects. Additionally, the role of the vascular beta-adrenergic mechanism in the mediation of EOOG-induced hypotension has also been investigated (Interaminense et al., 2007).

Chaturvedi et al., reported preventive and protective effects of wild basil in ethanol-induced liver toxicity in rats. It also showed that *Ocimum gratissimum* prevents free radical damage to the liver and thus protects the organ from oxidative stress (Chaturvedi et al., 2007).

Nangia Makker et al., reported aqueous *Ocimum gratissimum* leaf extract inhibits proliferation, migration, anchorage independent growth, 3D growth and morphogenesis and induction of COX-2 protein in breast cancer cells. A comparative analysis with eugenol, apigenin and ursolic acid showed that the inhibitory effects on chemotaxis and 3D morphogenesis of breast cancer cells were specific to *Ocimum gratissimum* extract (Nangia Makker et al., 2007).

Braga et al., reported the antileishmanial and antifungal activity of *Ocimum gratissimum*. *Ocimum gratissimum* exhibited the best activity against *L. chagasi* (IC(50) of 71 µg/ml and antifungical activity of *Ocimum gratissimum*, extract were the most active against *C. albicans* (MIC of 1.25 mg/ml) (Braga et al., 2007).

Anroop et al., reported that the properties of the granules prepared with calcium carbonate using different concentrations of *Ocimum gratissimum* and compared with acacia 5 % (w/w), as standard *Ocimum gratissimum* at 2.3 % (w/w) level was found to be comparable with 5 % (w/w) of acacia. Effect on drug release with paracetamol indicated that *Ocimum* mucilage could be an alternative to acacia (Anroop et al., 2006)

Usip et al., evaluated repellent activity of *Ocimum gratissimum* (Labiatae) volatile oil against *Simulium damnosum* (Usip et al., 2006)
Ueda-Nakamura et al., suggested that *Ocimum gratissimum* essential oil and its compounds could be used as sources for new antileishmanial drugs (Ueda-Nakamura et al., 2006).

Lemos et al., observed that chloroformic fraction inhibited 23 isolates (92 %) of C. neoformans at a concentration of 62.5 µg/ml and eugenol inhibited 4 isolates (16 %) at a concentration of 0.9 µg/ml. This screening may be the basis for the study of *Ocimum gratissimum* as a possible antifungal agent (Lemos et al., 2005).

Interaminense et al., reported that i.v. treatment with EOOG or Eug dose-dependently decreased blood pressure in conscious DOCA-salt hypertensive rats, and this action is enhanced when compared with uninephrectomized controls. This enhancement appears related mainly to an increase in EOOG-induced vascular smooth relaxation rather than to enhanced sympathetic nervous system activity in this hypertensive model (Interaminense et al., 2005).

Silva et al., reported that extracts of *Ocimum gratissimum* are active in vitro against human pathogenic dermatophytes (Silva et al., 2005).

Tchoumbougnang et al., reported the essential oils obtained by hydro distillation from fresh leaves of *Ocimum gratissimum* growing in Cameroon were analyzed by GC and GC/MS. The main constituents of the oil of *Ocimum gratissimum* were gamma-terpinene (21.9 %), beta-phellandrene (21.1 %), limonene (11.4 %) and thymol (11.2 %). The effects of oil showed significant antimalarial activities in the four-day suppressive in vivo test in mice (Tchoumbougnang et al., 2005).

Oboh studied that investigated the ability of *Ocimum gratissimum* to prevent garlic-induced hemolytic anemia (Oboh, 2004).

Cavalcanti et al., reported larvicidal activity of essential oils from *Ocimum gratissimum* against aedes aegypti L (Cavalcanti et al., 2004).

Fandohan et al., reported the effect of essential oils on the growth of *Fusarium verticillioides* and fumonisin contamination in corn (Fandohan et al., 2004).

Osuagwu et al., reported that the methanolic extracts of *Ocimum gratissimum* could be a potential wound healing agent due to its ability to enhance wound contraction (Osuagwu et al., 2004).
Nakamura et al., reported the essential oil of *Ocimum gratissimum* is a potential candidate as a phytotherapeutic agent in some fungal diseases and for the control of fungi in the environment (Nakamura et al., 2004).

Pereira et al., reported the antibacterial activity of essential oils extracted from medicinal plants (*Ocimum gratissimum*) on bacterial strains derived from 100 urine samples. Plant extracts were applied using a Steers replicator and petri dishes were incubated at 37 degrees C for 24 hours. Salvia officinalis, L. showed enhanced inhibitory activity compared to the other two herbs, with 100 % efficiency against Klebsiella and Enterobacter species, 96 % against Escherichia coli, 83 % against Proteus mirabilis, and 75 % against *Morganella morganii* (Pereira et al., 2004).

Lahlou et al., reported cardiovascular effects of the essential oil of *Ocimum gratissimum* leaves in rats: role of the autonomic nervous system (Lahlou et al., 2004).

Orafidiya et al., studied on the acute and sub-chronic toxicity of the essential oil of *Ocimum gratissimum* L. leaf. The study revealed that Ocimum oil might be better tolerated when administered orally for systemic delivery, the oil has toxic potentialities that should not be overlooked (Orafidiya et al., 2004).

Orafidiya et al., reported wound-healing properties of essential oil of *Ocimum gratissimum* Linn. There was a marked enhancement in the inflammatory and proliferative phases of wound healing in the rabbits treated with *Ocimum* oil, suggesting that the oil facilitated the healing process to a greater extent than the control and reference products. Wounds treated with cetavlex showed no sign of healing for eight days but responded to *Ocimum gratissimum* oil after a three-day wash-out period (Orafidiya et al., 2003).

Ngassoum et al., reported antimicrobial activities of essential oils of fresh leaves of *Ocimum gratissimum* and the essential oil of the dried fruits of *Zanthoxylum xanthoxyloides* was carried out. The essential oils showed extensive inhibition zones and are, therefore, effective antimicrobial systems (Ngassoum et al., 2003).
Rabelo et al., reported the antinociceptive effects of the essential oil of *Ocimum gratissimum* L. (Labiatae) (EOOG) in two classical models of pain in male Swiss mice (25-35 g), the writhing test and the formalin test. EOOG possesses interesting antinociceptive properties in the writhing and formalin tests due to relatively low toxicity of essential oil of *Ocimum gratissimum* L. EOOG (Rabelo et al., 2003).

Pessoa et al., evaluated eugenol against haemonchus contortus, gastrointestinal parasite of small ruminants. The oil and eugenol were diluted in Tween 20 (0.5 %) at five different concentrations. In the egg hatch test, H. contortus eggs were obtained from feces of goats experimentally infected. At 0.50 % concentration, the essential oil and eugenol showed a maximum eclodibility inhibition. These results suggest a possible utilization of the essential oil of *Ocimum gratissimum* as an aid to the control of gastrointestinal helmintosis of small ruminants (Pessoa et al., 2002).

Madeira et al., reported that EOOG exerts relaxant effects on intestinal smooth muscle, consistent with the popular use of the plant to treat gastrointestinal disorders (Madeira et al., 2002).

Orafidiya et al., reported that antibacterial effects, higher than those of commercial antiseptic products at 2 % *Ocimum* oil concentration in some bases. The properties of base into which the oil was incorporated affected its activity. It was more effective in hydrophilic bases than in lipophilic bases. Solubilization and microemulsification grossly reduced its activity (Orafidiya et al., 2001).

Kishore Dubey et al., reported that essential oils showed five chemotypes. An Indian chemotype, with a high level of ethyl cinnamate, presents, in vitro, an interesting spectrum of antifungal properties (Kishore Dubey et al., 2000).

Aguiyi et al., reported the hypoglycemic effect of the methanolic extract of *Ocimum gratissimum* leaves was evaluated in normal and alloxan-induced diabetic rats. Intraperitoneal injection of the extract (400 mg/kg) significantly reduced plasma levels both in normal and diabetic rats by 56 % and 68 %, respectively (Aguiyi et al., 2000).
Offiah and Chikwendu reported antidiarrhoeal effects of aqueous extract of the leaves of *Ocimum gratissimum*. The extract inhibited castor oil-induced diarrhoea in rats as judged by a decrease in the number of wet faeces in the extract-treated rats. In addition, the extract inhibited the propulsive movement of intestinal contents (Offiah and Chikwendu, 1999).

Nakamura et al., reported the essential oil (EO) of *Ocimum gratissimum* inhibited Staphylococcus aureus at a concentration of 0.75 mg/ml. The minimum bactericidal concentration of EO was within a twofold dilution of the MIC for this organism. The compound that showed antibacterial activity in the EO of *O. gratissimum* was identified as eugenol (Nakamura et al., 1999).

Aziba et al., reported the aqueous extracts of *Ocimum gratissimum* in isolated rabbit jejunum (IRJ); rat stomach strip (RSS); and also its analgesic properties in mice. The extract caused a dose dependent inhibition of the rabbit jejunum spontaneous pendular movement (Aziba et al., 1999).

Martins et al., reported major compounds in the volatile oil of *Ocimum gratissimum* were thymol (48.1 %) and P-cymene (12.5 %) (Martins et al., 1999).

Ilori et al., reported the antidiarrhoeal activities of leaf extracts of *Ocimum gratissimum* were by disc diffusion and tube dilution methods. The extracts were active against Aeromonas sobria, Escherichia coli, Plesiomonas shigelloides, Salmonella typhi, and Shigella dysenteriae. The minimum inhibitory concentrations were from 4.00 to 50.00 mg/ml, while the minimum bactericidal concentration ranged from 8.00 to 62 mg/ml (Ilori et al., 1996).

Onajobi reported smooth muscle contracting lipid-soluble principles in chromatographic fractions of *Ocimum gratissimum* (Onajobi, 1986).