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OCIMUM SANCTUM (TULSI); PROTECTOR OF LIFE: A REVIEW

Pranali Wasate*[1], Navnath Kashid[2] and Rohini Kulkarni Pandhare[3]

[1]Research Student, Baburaoji Adaskar Mahavidyalaya Kaij, Beed (MS) 431123.
[2]Associate Professor, Baburaoji Adaskar Mahavidyalaya Kaij, Beed (MS) 431123.
[3]Principal, Government College of Arts and Science Aurangabad (MS) 431001.

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***Corresponding Author**
Pranali Wasate
Research Student, Baburaoji Adaskar Mahavidyalaya Kaij, Beed (MS) 431123.

ABSTRACT

Ocimum sanctum, popularly known as Tulsi, one of the most important plants in India. It is of both religious and medicinal value and is found to grow well in moist soil. The plant possesses antifertility, anticancer, antidiabetic, antifungal, antimicrobial, hepatoprotective, cardioprotective, antiemetic, antispasmodic, analgesic, adaptogenic, diaphoretic, antimalarial, anti-inflammatory, and antipyretic properties. The plant having important constituents, Eugenol (1-hydroxy-2-methoxy-4-allylbenzene), is responsible for its myriad therapeutic properties, including antiarthritic effects. Additionally, linolenic acid, a constituent of Tulsi oil, is also shown to possess anti-inflammatory activity. The present review article includes the description of plant, distribution, botanical characteristics, chemicals, Antibacterial, Antifungal and traditional uses.

KEYWORDS: *Ocimum sanctum*, Tulsi, Phytoconstituents, Antimicrobial, Medicinal Properties.

INTRODUCTION

Ocimum sanctum belongs to family Labiatae, commonly known as the '*holy basil'* in English and Tulsi in almost all Indian languages. It is herb primarily native to the tropical and subtropical Asia and is today cultivated and naturalized in other tropical areas. In the Indian language of Sanskrit, Tulsi means the '*incomparable one'* and true to its meaning is probably the most important plant in India both from religious and medicinal values. Tulsi is revered by the Indian Hindus and has immense ceremonial value. It enjoys the pride of place among all accessories required for all religious, family, and community functions like marriage, Puja (religious festivals), and Sraddha ceremony (religious function performed after cremation).

The antiquity of the use of Tulsi in these practices is authenticated in the ancient Indian scriptures and is still followed throughout India (Gupta *et al*., 2002).

The three main morphotypes cultivated in India and Nepal is Ram Tulsi, Krishna Tulsi and wild Vanatulsi, (Kothari *et al* 2005). This plant is grown all over India for its medicinal as well as for religious purposes in houses, temples and gardens. It is also grown on commercial basis in vast stretches of farmlands to cater to herbal, cosmetic, and pharmaceutical industries. The medicinal uses of Tulsi is well-documented and is extensively used in the Indian traditional systems of medicine, that is, Ayurveda, Unani, Siddha, and the Asian folk medicine in India, Nepal, SriLanka, Malaysia, Indonesia and Burma for treating various diseases either alone or in combination with other herbal plants. Tulsi has been used for thousands of years for its diverse healing properties and is regarded in Ayurveda as the "elixir of life" that promotes longevity. (Satyavati *et al* 2008).

Botanical Description

Tulsi plant is an erect, much branched, fragrant and erected plant attaining a height of about 30-60 cm when mature. Its aromatic leaves are simple, opposite, elliptic, oblong, obtuse or acute with entire or sub serrate or dentate margins, growing up to 5 cm long. The Tulsi flowers are small having purple to reddish colour, present in small compact clusters on cylindrical spikes. Stalk less heart-shaped bracts are there at the base of each flower cluster. Sepal cup is not hairy within. Flowers are rarely longer than 5 mm, calyx tube bearded outside near base. Flower tube is hairy. The fruits are small and the seeds yellow to reddish in colour (Buddhadev, S.G *et al* 2014).

Phytoconstituents

The leaves of *Ocimum sanctum* contain 0.7% volatile oil comprising about 71% eugenol and 20% methyl eugenol. The oil also contains carvacrol and sesquiterpine hydrocarbon caryophyllene. Fresh leaves and stem of OS extract yielded some phenolic compounds (antioxidants) such as cirsilineol, circimaritin, isothymusin, apigenin and rosameric acid, and appreciable quantities of eugenol. (Yanpallewar *et al* 2004). Two flavenoid, viz., orientin and vicenin from aqueous leaf extract of *Ocimum sanctum* have been isolated. Ursolic acid, apigenin, luteolin, apigenin-7-O-glucuronide, luteolin-7- O glucuronide, orientin and molludistin have also been isolated from the leaf extract. *Ocimum sanctum* also contains a number of sesquiterpenes and monoterpenes viz., bornyl acetate, pinenes, camphene,

campesterol, cholesterol, stigmasterol and sitosterol.(Indian Herbal Pharmacopoeia. Mumbai, India, 2002).

Traditional medicinal Uses

Tulsi is also known as *"the elixir of life"* since it promotes longevity. Different parts of the plant are used in Ayurveda and Siddha systems of medicine for prevention and cure of many illnesses and everyday ailments like common cold, headache, cough, influenza, earache, fever, colic pain, sore throat, bronchitis, asthma, hepatic diseases, malarial fever, as an antidote for snake bite and scorpion sting, flatulence, migraine headaches, fatigue, skin diseases, wound, insomnia, arthritis, digestive disorders, night blindness and diarrhoea. The leaves are good for nerves and to sharpen memory. Chewing of Tulsi leaves also cures ulcers and infections of mouth. A few leaves dropped in drinking water or food stuff can purify it and can kill germs in it. Holy Basil is so good for boosting up the immune system. It protects from nearly all sorts of infections from viruses, bacteria, fungi and protozoa. Recent studies show that it is also helpful in inhibiting the growth of HIV and carcinogenic cells (Kumar *et al* 2012).

Fever and common cold: Tulsi leaves are widely used against fever and cold. Leaves of Tulsi are boiled with cardamom in half a litre of water. Boiled decoction is mixed with sugar and milk helps to bring down the body temperature (Joseph 2013, Jain *et al* 2015). Leaves boiled with tea act as a preventing agent against dengue and malaria fever (Kumar *et al* 2012). Roots of tulsi plant taken in the form of decoction act as a diaphoretic agent in case of malaria fever (Amberker 2011).

Coughs: Tulsi is an important constituent of many Ayurvedic cough syrups and expectorants. It helps to mobilize mucus in bronchitis and asthma. Chewing tulsi leaves relieves cold and flu. (Amberker 2011, Joseph *et al* 2013, Jain *et al* 2015).

Eye care: The leaf juice of *Ocimum sanctum* along with triphala is used in Ayurvedic eye drop preparations recommended for glaucoma, cataract, chronic conjunctivitis & other painful eye diseases. In daily routine, one may use about three drops of tulsi oil along with honey and it is supposed to improve eye sight (Rajeswari 1952).

Healing Power: The Tulsi plant has many medicinal properties. The leaves are a nerve tonic and also sharpen memory. They promote the removal of the catarrhal matter and phlegm

from the bronchial tube. The leaves strengthen the stomach and induce copious perspiration. The seed of the plant are mucilaginous, (Singh *et al* 2012, Jain *et al* 2015).

Sore Throat: Water boiled with basil leaves can be taken as drink in case of sore throat. This water can also be used as a gargle. (Joseph *et al* 2013).

Respiratory Disorder: The herb is useful in the treatment of respiratory system disorder. A decoction of the leaves, with honey and ginger is an effective remedy for bronchitis, asthma, influenza, cough and cold. (Mali *et al* 2011). A decoction of the leaves, cloves and common salt also gives immediate relief in case of influenza. They should be boiled in half a litre of water till only half the water is left and add then taken (Bhateja 2012).

Kidney Stone: Basil has strengthening effect on the kidney. In case of renal stone the juice of basil leaves and honey, if taken regularly for 6 months it will expel them via the urinary tract (Amberker 2011, Bhateja 2012, Ahmed 2016).

Malaria fever: Decoction of the root of tulsi plant is given is given as a diaphoretic in malarial fevers. Ayurvedic preparations containing *Ocimum sanctum*, *Allium sativum*, *Piper nigrum* and *Curcuma longa* have been shown to possess anti-malarial activity against *Plasmodium vivax* and *Plasmodium falciparum* (Rajeswari *et al* 1952).

Used as a heart tonic: Affinity of *Ocimum sanctum* for rasa dathu refers to the primary waters of the body. The word rasa means sap, juice, or liquid. In the physical body, rasa refers directly to the plasma, or non cellular portion of the blood; the lymph, and interstitial fluids helps to increase circulation through the heart where there is congestion from high vatta and kapha doshas. In Ayurveda, vatta and kapha are doshas, condensed from the elements water and earth. It is the principle of stabilizing energy, governs growth in the body and mind, is concerned with structure, stability, lubrication, and fluid balance and is eliminated from the body through the urine. Eugenol from *Ocimum sanctum* has been reported to possess the vasorelaxing action on rabbit arterial tissue indicating its therapeutic importance as a vasodilator. Methyl ugenol was identified as the major constituent of *Ocimum sanctum* oil and probably accounted for the observed larvacidal action of the oil (Sebastran *et al* 2006, Glolade *et al* 2008).

Skin care: In case of ring worm or other related diseases such as leucoderma paste of tulsi leaves is applied on the affected area to cure these ailments. In case of chicken pox tulsi

leaves are taken externally with saffron to treat the disease (singh J *et al* 2003, Govil J N. *et al* 1998).

BIO-POTENTIAL OF TULSI

Anti-arthritic activity: The anti-arthritic activity of *Ocimum sanctum* fixed oil was evaluated against formaldehyde-induced arthritis in rats. The fixed oil significantly reduced the diameter of inflamed paw. On intra-peritoneal administration of the fixed oil daily for 10 days, there was marked improvement in the arthritic conditions in rats. The anti-arthritic effect at 3 ml/kg dose was comparable to aspirin by 100 mg/kg,ip11. The fixed oil inhibited carrageenan and inflammatory mediators (e.g., serotonin, histamine, bradykinin and PGE2) induced inflammation. It is natural that the oil could inhibit any inflammatory response involving these mediators. The result suggests potentially useful antiarthritic activity of the inflammation models, including adjuvant as well as turpentine oil-induced joint oedema in rats. (Singh *et al* 1996).

Antiasthmatic Activity: 50% aqueous ethanol extract of dried and fresh leaves and the volatile and fixed oils of *Ocimum sanctum* was evaluated against histamine and acetylcholine induced pre-convulsive dysponea (PCD) in guinea pigs. The 50% ethanol extract and volatile oil extracted from fresh leaves and fixed oil from the seeds significantly protected the guinea pigs against histamine and acetylcholine induced preconvulsive dyspnea. However, the 50% ethanol extract of dried leaves did not protect the guinea pigs against histamine induced preconvulsive dyspnea (Singh *et al* 1991).

Antibacterial Activity: Antibacterial activity of the aqueous, alcoholic, chloroform extract and oil obtained from leaves of *Ocimum sanctum* were studied against *E.coli, P.aeruginosa, S. typhimurium* and *S.aureus.* Extract obtained from *Ocimum sanctum* were observed equally effective against pathogenic gram positive and gram negative bacteria (Mishra *et al* 2011).

Anticancer: Fresh leaf paste (topically) aqueous and ethanolic extract (orally) for their chemo preventive activity against 7, 12-dimethylbenzaanthracene (DMBA) induced (0.5%) hamster buccal pouch carcinogenesis. Incidence of papillomas and squamous cell carcinomas were significantly reduced and increased the survival rate in the topically applied leaf paste and orally administered extracts to animals. Histopathological observation made on the mucosa confirmed the profound effect of the orally administered aqueous extract than other. (Karthikeyan *et al* 1999).

Anticataract activity: The Aqueous Extract of fresh leaves of *Ocimum sanctum* delayed the process of cataractogenesis in experimental models of cataract galacto semiccataractin rats by 30% galactose and naphthalene cataract in rabbits by1g/kg naphthalene). Ocimum sanctum 1 and 2g/kg delayed the onset as well as subsequent maturation of cataract significantly in both the models (Gupta *et al* 2002).

Anticataleptic Activity: In 2010 studied the anticataleptic activity of the aqueous extract (300 mg/kg, i.p) and the alcoholic extract (300 mg/kg, i.p) of the leaves of *Ocimum sanctum* and observed a significant ($P < 0.001$) reduction in cataleptic scores. (Aswar *et al* 2010).

Anticoagulant Activity: *Ocimum sanctum* fixed oil (3 ml/kg,ip) was studied for anticoagulant activity. It was observed that blood clotting time was prolonged and the response was comparable to that obtained with aspirin (100 mg/kg). The effect appears to be due to the anti-aggregatory action of oilon platelets (Singh S *et al* 2001).

Anticonvulsant Activity: Different extractives of stem, leaf and stem callus of *Ocimum sanctum* were tested for anticonvulsant activity against standard drug phenytoin using maximal electroshock (MES) model. Ethanol and chloroform extractives of stem, leaf and stem calli were effective in preventing tonic convulsions induced by transcorneal electroshock (Jaggi *et al* 2003).

Antidiabetic: Ethanolic extract of *Ocimum sanctum* significantly decreases the blood glucose, glycosylated haemoglobin and urea with a concomitant increase in glycogen, haemoglobin and protein in streptozotocin-induced diabetic rats. This extracts also resulted in an increase in insulin and peptide levels and glucose tolerance. (Narendhirakannan *et al* 2006). The constituents of *Ocimum sanctum* leaf extracts have stimulatory effects on physiological pathways of insulin secretion, which may underlie its reported antidiabetic action. (Hannan *et al* 2006).

Antihypertensive Activity: The *Ocimum sanctum* fixed oil administered intravenously produced hypotensive effect in anaesthetized dog which seems to be due to its peripheral vasodilatory action. Essential fatty acids like linoleic and linolenic acid contained in the *Ocimum sanctum* oil produce series 1 and 3 (PGE1 and PGE3) prostaglandins and inhibit the formation of series 2 prostaglandins (PGE2)(Pandey et al 2010).

Anti-inflammatory: Singh in his study reported that linoleic acid present in different amount in the fixed oil of different species of *Ocimum sanctum* has the capacity to block both the cyclooxygenase and lipoxygenase pathways of arachidonate metabolism and could be responsible for the anti-inflammatory activity. (Singh *et al* 1998).

Antiemetic Activity: Tulsi leaves also check vomiting and used for antiemetic action (Kumar *et al* 2011).

Anti-Fertility activity: Albino rats treated with benzene extract of *Ocimum sanctum* leaves (250 mg/kg body weight) decreased the total sperm count and sperm motility. The effects were the results of androgen deprivation due to the anti-androgenic property of *Ocimum sanctum* leaves. There was an increasing in sperm testosterone level whereas the level of FSH and LH, sperm count were reduced in rabbits (Kadian *et al* 2012).

Anti-fungal activity: Methanolic fraction and aqueous fraction of *Ocimum sanctum* showed anti fungal activity against dermatophytic fungus i.e. *T. rubrum* etc. Aqueous fraction showed better anti dermatophytic activity as compared to methanolic fraction (Balakumar *et al* 2011).

Anthelmintic activity: The anthelmintic activity of the essential oil from *Ocimum sanctum* was evaluated by Caenorhabditis elegance model. Eugenol exhibited an ED50 of 62.1 µg/ml and being the predominant component of the essential oil, it was suggested as the putative anthelmintic principle (Asha *et al* 2001).

Anti-tubercular activity: Tulsi also has anti-tubercular activity & inhibits in vitro growth of *Mycobacteriumtuberculosis* (Rajeswari *et al* 1952).

Anti-stress activity: the plant extracts exhibit anti-stress activity by improving sorbitol dehydrogenase assay (SDH) level in albino rats. (Rajeswari *et al* 1952, Reghunandan *et al* 1969, Liv J *et al* 1995).

As an antidote: Tulsi have been recommended for use as antidote for dog bite, scorpion bite and insect bite in traditional system of medicine (Rajeswari *et al* 1952, Khanna *et al* 2003)

Antimicrobial: Higher content of linoleic acid in *Ocimum sanctum* fixed oil could contribute towards its antibacterial activity. The oil show good antibacterial activity against *Staphylococcus aureus, Bacillus pumius* and *Pseudomonas aeruginosa*, where *S. aureus* was

the most sensitive organism (Singh *et al* 2005). The aqueous extract of *Ocimum sanctum* (60 mg/kg) show wide zones of inhibition compared to alcoholic extract against *Klebsiella, E. coli, Proteus, S. aureus* and *Candida albicans* when studied by agar diffusion method. Alcoholic extract showed wider zone for *Vibrio cholerae*. (Geeta *et al* 2001).

Antineoplastic mechanism: Eugenol-induced apoptosis was facilitated through the generation of reactive oxygen species, mitochondrial permeability, release of cytochrome c, and decrease in the levels of antiapoptotic protein bcl-2.(Yoo *et al* 2005, Kim *et al* 2005) Ethanolic extract being nonpolar invariably contains eugenol, luteolin, ursolic acid, and oleanolic acid in differing ratios (Singh *et al* 2007) of these, experimental studies have shown that eugenol and luteolin possess anticancer effects in vitro.(Lin et al 2008). Luteolin depending on the concentration can biochemically function as either an antioxidant or a pro-oxidant. Multiple studies have shown that luteolin's anticancer property is coupled with the stimulation of apoptosis, inhibition of cell proliferation, angiogenesis, and metastasis. (Karthikeyan *et al* 1999).

Antinociceptive (Analgesic): The analgesic activity of alcoholic leaf extract of *Ocimum sanctum* (50, 100 mg/kg, ip; 50, 100, 200 mg/kg, po) was tested in mice using glacial acetic acid induced writhing test. *Ocimum sanctum* reduced the number of writhes. *Ocimum sanctum* (50, 100 mg/kg ip) also increased the tail withdrawal latency in mice. (Khanna *et al* 2003).

Antioxidant: The antioxidant capacity of essential oils obtained by steam hydro distillation from *Ocimum sanctum* was evaluated using a high-performance liquid chromatography (HPLC) based hypoxanthine xanthine oxidase and OPPH assays. In hypoxanthine xanthine oxidase assay, strong antioxidant capacity was evident from *Ocimum sanctum* (IC50 = 0.46 µL/ml) (Trevisan *et al* 2006).

Anti-plasmodial Activity: Leaf extract, root extracts, the stem and flower extracts of *Ocimum sanctum* showed excellent anti-plasmodial activity in a study carried out by on three different species of *Ocimum*. The in vitro anti-plasmodial activity might be due to the presence of alkaloids, glycosides, flavonoids, phenols, saponins, triterpenoids, proteins, resins, steroids and tannins in the ethanolicextracts of tested plants (Inbaneson *et al* 2012).

Antipyretic Activity: The antipyretic activity of *Ocimum sanctum* fixed oil was evaluated by testing it against typhoidparatyphoid A/B vaccine-induced pyrexia in rats. The antipyretic activity was elicited by decreased fever in the rats when the oil was administered topically on their lips. A dose of 3 ml/kg of fixed oil is comparable to aspirin to elicit its antipyretic activity. (Pandey et al 2010).

Antiviral: The essential oils like Eugenol of Tulsi leaves produce anti-viral activity. Different types of extracts of *Ocimum sanctum* have anti-viral activity against different viruses e.g. Hematopoietic Necrosis Virus (IHNV), polio virus type 3, herpes virus (HSV), hepatitis B virus, New castle Disease Virus. Ethanolic extract of Tulsiplant leaves in a range of 22.5 mg/ml concentration inhibit replicationof polio type 3 virus in VERO cells. The extracted components of this plant like linalool, apigenin and ursolic acid show broad spectrum antiviral activity against DNA viruses like RNA virus and adenoviruses. One study also proves its efficacy against new castle disease of poultry (Jayati *et al* 2013).

Cardiac activity: Oral feeding of hydro alcoholic extract of *Ocimum sanctum* (100 mg/kg) to male Wister rats subjected to chronic-resistant stress (6 h/day for 21 days) significantly prevented the chronic-resistant stress/induced rise in plasma cAMP level, myocardial superoxide dismutase and catalase activitiesas well as the light microscopic changes in the myocardium.(Sood *et al* 2006).

Central Nervous System (CNS) depressant activity: The AlE of *Ocimum sanctum* prolonged the time of lost reflex in mice due to pentobarbital (40 mg/kg, ip), decreased the recovery time and severity of electroshock and pentylene tetrazole induced convulsions. It also decreased apomorphine induced fighting time and ambulation in "open field" trials. At high doses, *Ocimum sanctum* extract increased swimming time suggesting a CNS stimulant and/or anti stress activity. The effect was comparable to that of desipramine, an antidepressant drug.(Mukherjee *et al* 2005).

Chemopreventive activity: The chemopreventive effect of *Ocimum sanctum* leaf extract is probably through the induction of hepatic/extrahepatic glutathione S-transferase (GST) in mice. Elevated levels of reduced glutathione (GSH) in liver, lung and stomach tissues in *Ocimum sanctum* extract supplemented mice were also found (Prashar *et al* 1995).

Demulcent/Stimulant/Expectorant: Traditionally, juice of the leaves of *Ocimum sanctum* plant was used as demulcent, stimulant and expectorant. The seeds are mucilaginous and demulcent and are given in different ailments of genito-urinarysystem. An infusion of leaf had been used as anti-spasmodic in gastric disorders of children (Mondal *et al* 2009).

Effect on gene transcription: The genes that have direct role in artherogenesis include LDRL, LxRalpha, PPARs, CD-36 because these genes control lipid metabolism, cytotoxin production and cellular activity within the arterial wall. To know whether or not the polyphenols extracted from *Ocimum sanctum* have any effect on the transcription of these genes, Kaul et al. cultured human mononuclear cells in the presence of polyphenols extracted from *Ocimum sanctum*. Transcriptional expression of these genes was measured by using RT-PCR and SCION IMAGE analysis software. These polyphenolic extracts were found to have the inherent capacity to inhibit the transcriptional expression of these genes (Kaul D *et al* 2005).

Genome sequence: The genome of the tulsi plant has been sequenced and reported as a draft, estimated to be 612 mega bases, with results showing genes for biosynthesis of anthocyanins in Shyama Tulsi, ursolic acid and eugenol in Rama Tulsi.

Gastroprotective: The antiulcerogenic property of *Ocimum sanctum* was studied in pyloric-ligated and aspirin-treated rats. The extract of reduced ulcer index, free and total acidity on acute and chronic administration seven days pretreatment increased the mucus secretion also. So it may be concluded that *Ocimum sanctum* extract has anti-ulcerogenic property against experimental ulcers and it is due to its ability to reduce acid secretion and increase mucus secretion (Mandal *et al* 1993).

Genotoxicity: In vivo cytogenetic assay in Allium cepa root tip cells has been carried out to detect the modifying effect of *Ocimumsanctum* aqueous leaf extract against chromium (Cr) and mercury (Hg)-induced genotoxicity. It was observed that the roots post-treated with the leaf extract showed highly significant recovery in mitotic index (MI) and chromosomal aberrations. When compared to pre-treated (Cr/Hg) samples, the lower doses of the leaf extract were found to be more effective than the higher doses.(Babu K *et al* 2006).

Hepatoprotective Activity: The hepatoprotective activity of *Ocimum sanctum* alcoholic leaf extract against paracetamol-induced liver damage in Albino rats synergism with silymarin

and concluded that *Ocimum sanctum* alcoholic leaf extract showed significant hepatoprotective activity and synergism with silymarin (Lahon *et al* 2011).

Hypolipidemic: Administration of *Ocimum sanctum* seed oil (0.8 gm/kg body weight/day) for four weeks, in cholesterol-fed (100 mg/kg body weight/day) rabbits significantly decreases serum cholesterol, triacylglycerol and LDL + VLDL cholesterol as compared to untreated cholesterol-fed group suggesting the hypo-cholesterolemic activity of *Ocimum sanctum* (Trevisan *et al* 2006).

Immunomodulatory Activity: The aqueous extract of *Ocimum sanctum* at the oral doses of100, 200 mg/kg/day in rats enhances the production of RBC, WBC, haemoglobin and also enhanced the production of antibodies without affecting the biochemical parameters (Jeba *et al* 2011).

Insecticidal activity: Tulsi extract and essential oil have also been found to possess insecticidal and larvicidalactivity against mosquitoes (Rajeswari *et al* 1952).

Memory enhancer activity: The AlE of dried whole plant of *Ocimum sanctum* ameliorated the amnesic effect of scopolamine (0.4 mg/kg) and aging-induced memory deficits in mice. Passive avoidance paradigm served as the exteroceptive behavioural model. *Ocimum sanctum* extract increased step-down latency (SDL) and acetylcholinesterase inhibition significantly. Hence, *Ocimum sanctum* can be employed in the treatment of cognitive disorders such as dementia and Alzheimer's disease (Singh *et al* 2007).

Miscellaneous activity: *Ocimum sanctum* fixed oil increases blood clotting time and percentage increase was comparable to aspirin and could be due to inhibition of platelet aggregation. The oil also increased pentobarbitone-induced sleeping time in rats indicating probable inhibitory effect of oil towards cytochromic enzyme responsible for hepatic metabolism of pentobarbitone (Singh *et al* 2001).

Mosquitocidal activity: Mosquitocidal activity of Tulsi was investigated using its eugenol and triglyceride (isolated from Tulsi's hexane extract) on fourth instars *Aedes aegypti*larvae. When seeds of Tulsi was placed in water, it exude within one hour, a mucilaginous substance (polysaccharides) and larvae which came in contact with seeds became firmly attached to it and died due to drowning of larvae (Hasan, S.B. *et al* 1994).

Neuroprotective Activity: *Ocimum sanctum* shows ameliorative potential in attenuating vincristine induced peripheral neuropathic pain in rats which may be attributed to decrease in oxidative stress and calcium levels. Administration of *Ocimum sanctum* (100 and 200 mg/kg p.o.) and its saponin rich fraction (100 and 200 mg/kg p.o.) for 14 days significantly attenuated vincristine-induced neuropathic pain along with decrease in oxidative stress and calcium levels (Kaur G *et al* 2010).

Oral implications: Intracranial irrigant

Tulsi has shown to be effective when used as an intracranial irrigant of primary molars at a concentration of 4%, as shown by some authors. This antibacterial activity is thought to be due to the active ingredient eugenol, as mentioned in the text previously. Hence, Tulsi can be used safely even at a higher concentration as compared to sodium hypochlorite due to its non bio friendly reactions to the developing tooth buds, burning sensation to the tissues, as well as inadvertent allergic reactions.(Prabhakar *et al* 2015).

Toothache: The leaves of *Ocimum sanctum* which contains a considerable amount of eugenol and methyl eugenol provides an analgesic effect due to its cyclooxygenase (COX)-2 inhibition activity.(Singh *et al* 1996).

Candidiasis: The antifungal effect of the essential of *Ocimum sanctum* and its two main components, that is, eugenol and linalool, have been investigated against two Candida species which are known to cause oral candidiasis in a study and it was concluded that linalool is more promising and effective against Candida.(Khan *et al* 2010).

Anticariogenic Agent: In an in-vitro study, the various concentrations of Tulsi extracts were assessed against *Streptococcus* mutants and concluded that Tulsi extracts at 4% has a maximum anticariogenic potential.(Madhuri *et al* 2007).

Sexually transmitted disease: Extract of *Ocimum sanctum* caused inhibition of *Neisseria gonorrhoeae* clinical isolates and WHO organization strains. The activity is comparable to penicillin and ciprofloxacin (Shokeen *et al* 2005)

Thyroid activity: The extract of *Ocimum sanctum* leaf extract (OSE) on the changes in the concentrations of serum Triiodothyronine (T3), Thyronine (T4) and serum cholesterol were investigated. OSE at the dose of 0.5 g/kg body weight for 15 days significantly decreased serum T4 concentration; however, no marked changes were observed in serum T3 level,

T3/T4 ratio and in the concentration of serum cholesterol. It appears that OSE is antithyroidic in nature. (Panda *et al* 1998).

Toxicity: The median lethal dose (LD50) of *Ocimum sanctum* fixed oil was determined after ipadministration in mice. The fixed oil was well tolerated upto 30 ml/kg, while 100%mortality was recorded with a dose of 55 ml/kg. The LD50 of oil was 42.5ml/kg. There was found no untowardeffecton subacute toxicity study of *Ocimum sanctum* fixed oil at a dose of 3 ml/ kg/day, ip for 14 days inrats (Singh *et al* 2007).

Wound healing activity: The wound healing effect of aqueous extract of *Ocimum sanctum* in rats. Wound-breaking strength in incision wound model, epithelization period and percent wound concentration in excision wound model were studied owing to increased per cent wound contraction. *Ocimum sanctum* may be useful in the management of abnormal healing such as keloids and hypertropic scars.(Shetty *et al* 2006).

CONCLUSION

All over the world scientific research is getting momentum to evaluate the pharmacological activities, side effects and medicinal uses of *Ocimum sanctum* against different diseases. On the basis of various experimental and clinical researches. It is observed from various studies that the *Ocimum sanctum* have a number of pharmaceutical and medicinal property and according to this it is effective in the treatment of a number of diseases. Future research on sacred basil should be emphasized for control of various diseases.

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