



A COMPREHENSIVE REVIEW ARTICLE ON PHARMACOLOGICAL ACTIVITIES OF OCIMUM SANCTUM (TULSI)

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Abstract:

Since ancient times, herbal medicine, the backbone of traditional medicine in many nations, has played a significant role in curing human diseases. Medicinal plants are rich in bioactive chemicals and chemical structures that may have therapeutic potential. Tulsi is a Sanskrit word that translates to "unrivalled one." *Ocimum sanctum*, also known as Holy Basil, is a Lamiaceae family plant. The plant is known for its pungent, bitter, spicy, light, and dry flavour. Due to its beneficially various characteristics, Holy Basil is well-known and has been employed in Ayurvedic and Greek medicine for centuries. The information on pharmacological characteristics, extracts, and plant parts utilised for *Ocimum sanctum* is compiled in this review. *Ocimum sanctum* (OS) has many medicinal properties like antioxidant, antidiabetic, antiulcer, anticancer, antibacterial, antifungal and other. This is an effort to help researchers and clinicians to be aware of the magical properties and the effectiveness of Tulsi.

Keywords: Herbal medicine, *Ocimum sanctum*, Pharmacological properties

I. INTRODUCTION:

Tulsi is a significant emblem in Hindu religious heritage. Although the word 'tulsi' connotes incomparability, its other name, Vishnupriya, refers to the one who pleases Lord Vishnu. Its mythology has pervaded Indian culture down the ages, and it can be found in most Indian homes and is adored. Tulsi, also known as Holy Basil or *Ocimum sanctum* in botanical terms, is a member of the Lamiaceae plant family. Due to its wide range of medicinal characteristics, it has made a significant contribution to science both in ancient times and in modern studies. Tulsi is divided into two types: vanya (wild) and gramya (cultivated) (grown in homes). Despite the fact that they are used in the same way, the former has darker leaves. Tulsi is a well-known home treatment for a variety of ailments such as wound, bronchitis, liver diseases, catarrhal fever, otalgia, lumbago, hiccough, ophthalmia, gastric disorders, genitourinary disorders, skin diseases, various forms of poisoning and psychosomatic stress disorders[1-2].

Aromatic, stomachic, carminative, demulcent, diaphoretic, diuretic, expectorant, alexiteric, vermifuge, and febrifuge qualities are also present in tulsi leaves.[3] Three types of tulsi are commonly described. Rama or Sri Tulsi (green leaves) and Krishna or Shyama tulsi (purplish leaves) are two botanically and phytochemically distinct cultivars of *Ocimum tenuiflorum* (or *Ocimum sanctum* L.), [4,5] whereas *Ocimum gratissimum* is a third variety of tulsi known as Vana or wild/forest tulsi (dark green foliage) [6,7].

***Ocimum sanctum* L. (Tulsi): *Ocimum sanctum* L.**

Tulsi is a 30–60 cm tall, highly branching sub-shrub with simple opposite green or purple leaves and aromatic hairy stems. The leaves are oblong, up to 5 cm long, and serrated, with a petiole present. Purplish flowers grow in compact whorls in lengthy racemes.

Chemical Constituents :

Some of the phytoconstituents which are present in *ocimum sanctum*.The different parts of *Ocimum sanctum* contain different types of constituents in varying amounts. The leaves contain a high content of essential oils which include Toluene, Camphene, Octane, Benzene, Citronellol, Sabinene, Limocene, Ledol, Dimethylbenzene, Ethyl-2- methylbutyrate, Eugenol, Terpinolene, β -elemene, Isocaryophyllene, Iso-eugenol, α -amorphene, α -guaiane, α -humulene, α -terpeneol, Borneol, Calamine, Nerolidol, Carvacrol, Geraneol, Humulene oxide, Elemol,

Tetradecanal, (EZ)-famesol, Cissquisainenehydrate, α -bisbolol, Selin-11-en-4- α -ol, α -murolene, 14-hydroxy- α -humulene [8]. To separate constituents' extraction is performed in many ways. When alcoholic extraction of leaves and aerial parts of plants was done, it was found to contain Luteolin, Orientin, Urosolic acid, Apigenin-7-O-glucuronide, Luteolin-7-O-glucuronide, Isorientin, Aesculin, Triacantanolferulate, Vallinin acid, Gallic acid, Circineol, Aesculetin, Triacantanolferulate, Chlogenic acid, Stigmasterol, Caffiec acid, Urosolic acid, 4-hydroxybenzoic acid, Vicenin-2, Chlorogenic acid, Procatechuic acid, Phenylpropaneglucoisides, β -Stigmasterol. Fixed oils such as Oleic acid, Stearic acid, Hexourenic acid, Palmitic acid, Linodilinolin, and Linolenic acid are abundant in the seeds of this plant. phenolic substances such as Apigenin, Circimaritin, Isothymusin, Eugenol, and Rosameric acid were extracted from fresh leaves and stems [9]. Monoterpenes and sesquiterpenes such as Neral and Campene can also be found in *O. sanctum*. [10] Cholesterol and stigma sterol This herb also contains vitamins A and C, which help to boost antibody synthesis by up to 20% and give disease protection [11, 12].

II. EXTRACT AND PLANT PARTS UTILISED FOR PHARMACOLOGICAL ACTIVITIES:

The pharmacological activities of *Ocimum sanctum* extract and plant parts used in table no.1 are as follows:

Table No.1: Extract and part of the plant used for pharmacological Activities

Sr.No	Therapeutic Activity	Extract used	Part used
1.	Antifungal activity	Methanolic/aqueous/Acetone, hexane, chloroform, n-butanol	Leaves
2.	Hepatoprotective activity	Ethanol/aqueous/Alcoholic	Whole Plant(Aerial)
3.	Wound Healing	Alcoholic/ Aqueous Extract	Plant
4.	Anticoagulant activity	Aqueous	Leaf
5.	Anthelmintic Activity	Essential oil/Aqueous extract	Leaves
6.	Antiarthritic activity	Fixed oil,aqueous extract	Leaves
7.	Antidiabetic activity	Ethanol/aqueous	Leaves
8.	Radioprotective activity	Aqueous	Leaves
9.	Antiulcer activity	Ethanol/aqueous/fixed oil	Leaves
10.	Antioxidant activity	Volatile oil	Fresh Leaves And Stem
11.	Analgesic activity	Ethanol extract	Leaves,Roots
12.	Antimalarial activity	Aqueous extract	Roots
13.	Antipyretic activity	Fixed oil	Leaves,Roots
14.	Anti-Fertility activity	Benzene	Leaves
15.	Antiemetic Activity	Aqueous	Leaves
16.	Anti-plasmodial Activity	Ethanol	Leaf,Root,Stem And Flower
17.	Immunomodulatory Activity	Aqueous/Ethanol	Leaves
18.	Anticancer activity	Ethanol /Aqueous	Leaves
19.	Anticataract activity	Aqueous	Fresh Leaves
20.	Central Nervous System (CNS) depressant activity	Fixed oil,Ethanol extract	Whole Plant
21.	Thyroid Activity	Aqueous	Whole Plant
22.	Memory enhancer activity	Alcoholic extract,Ethanol	Whole Plant
23.	Anti-anaphylactic, antihistaminic and mast cell stabilization activity	Aqueous extract	Leaves

24.	Hypolipidemic activity	Essential oil/Aqueous extract	Leaves
25.	Anti-helmenthic activity	Essential oil/Aqueous extract	Leaves
26.	Anticonvulsant activity	Ethanol/Choloroform	Stem,Leaves
27.	Anti-stress activity	Ethanolic	Plant
28.	Anti-microbial activity	Ethanolic	Leaves

III. PHARMACOLOGICAL ACTIVITIES

Pre-Clinical studies:

O. sanctum L. has showed a variety of pre-clinical actions in animal models and *in vitro* research over the last two decades. Here are a few examples of important findings:

Antifungal properties:

Ocimum sanctum exhibited essential characteristics such as antifungal efficacy. *Ocimum sanctum* extracts in aqueous, hexane, choloroform, n-butanol, and other solvents demonstrated antifungal action. *Ocimum sanctum* protects food from bio-deterioration during storage. Many plant fungus, including *Alternaria tenuis*, *Helminthosporium* sp., and *Curvularia penniseli*, were found to be sensitive to aqueous and acetone extracts of *Ocimum sanctum* L. Tulsi essential oil was found to be effective against *Alternaria solani*, *Candida guilliermondii*, *Colletotricum capsici*, *Curvularia* sp., *Fusarium solani*, and *Helminthosporium oryzae*. Essential oil and eugenol were found efficacious in checking growth of *Aspergillus flavus*. Hence, *Ocimum sanctum* essential oil and eugenol can be used as plant based safe preservatives against fungal spoilage of food stuff during storage.[13]

Hepatoprotective activity:

By acting as a part of detoxifying system, it improves the elimination of toxic chemicals and act as a hepatoprotective agent [14]. The study showed that when alcoholic extract of Tulsi plant orally administered, it exhibited hepatoprotective effect against Paracetamol, Carbon tetrachloride and anti-tuberculosis drugs induced liver injury in albino rats. When extract of *Ocimum sanctum* were used in male albino rats weighing 100-150 g of Wistar strain (5-6 weeks) the level of enzymes was reduced. Biometry Research Unit, Indian Statistical Institute, 203 revealed that cold water extract of Tulsi plant produced hepatotonic effect against Paracetamol and Carbon tetrachloride when albino rats fed orally for 6 days with Tulsi extract [15]. When Tulsi extract is used as adjunct with silymarin it show significant hepatoprotective effect [16].

Wound healing :

The wound-healing ability of *Ocimum sanctum* has been demonstrated in rats using two different concentrations (200 and 400 mg/kg). Excision, incise, and dead space wound models were utilized in this research. The researchers found that Ascorbic acid, Hexose amine, L-Hydroxyproline, and Malondialdehyde extracted from Tulsi have wound healing activity employing Van Gieson and Masson Trichome strains in histological evaluation of granuloma tissue determination. Tulsi can be utilised as an adjuvant therapy in the treatment of burn wounds, according to various research [17,18,19].

Anticoagulant activity:

The OS fixed oil (3 ml/kg) causes a lengthening in blood clotting time that is comparable to that of aspirin (100 mg/kg). This is attributed to Tulsi oil's anti-aggregator properties on platelets [20].

Anthelmintic properties:

In vitro testing of *Ocimum sanctum* essential oil and eugenol revealed significant anthelmintic action in the *Caenorhabditis elegans* model. The ED₅₀ for eugenol was 62.1 g/ml. Eugenol, the most abundant component of the essential oil, has been proposed as a possible anthelmintic principle [21,22]. When compared to albendazole, ursolic acid contained in Tulsi has a high potential for paralysing and killing worms [23].

Antiarthritic activity:

Against formaldehyde-induced arthritis in rats, activity of fixed oils of OS was observed that reduced the diameter of inflamed paw. The arthritic difficulties in rats were greatly improved when fixed oils were supplied intraperitoneally daily for ten days. The fixed oil inhibits inflammation through reducing the effects of carrageenan and certain other inflammatory mediators (e.g. serotonin, bradykinin, histamine and PGE2) [24,25].

Antidiabetic activity :

Tulsi has anti-diabetic properties, according to one study, which found that an aqueous extract of Tulsi dramatically decreases blood glucose levels in diabetic mice[26,27]. Similarly, other studies also confirm a fall of fasting blood sugar level and HBA1c was also contributed by the hypoglycemic effect of Tulsi [28,29]. Tulsi can also help with metabolic disorders and can be administered in conjunction with other treatments [26]. It is effective in liver disease and improves the metabolic breakdown of toxins. It lowers fasting blood glucose and helps to balance plasma glucose levels and insulin-mediated metabolism [30].

Radioprotective properties:

In 1995, the radioprotective effect of OS was first discovered. [31] Two isolated flavonoids are orientin and vicenin. When compared to synthetic radioprotectors, the radioprotective effect of OS leaves was superior. They have shown significant protection to the human lymphocytes against the clastogenic effect of radiation at low, non toxic concentrations.[32] At higher doses, the combination of OS leaf extract and WR-2721 (a synthetic radio protector) boosted bone marrow cell protection while lowering WR-2721 toxicity, signalling that the combination could give promising radioprotection in people[33].

Antiulcer activity:

The fixed oil of OS administered intraperitoneally elicited significant antiulcer activity against aspirin, indomethacin, alcohol (ethanol 50%), histamine, reserpine, serotonin or stress-induced ulcers in rats.[34] The fixed oil significantly possessed antiulcer activity due to its lipoxygenase inhibitory, histamine antagonistic and antisecretory effects[35].

Antioxidant activity:

The antioxidant activity of OS has been reported by many workers.[36,37] The antioxidant properties of flavonoids and their relation to membrane protection have been observed. Antioxidant activity of the flavonoids (orientin and vicenin) in vivo was expressed in a significant reduction in the radiation induced lipid peroxidation in mouse liver.[38] OS extract has significant ability to scavenge highly reactive free radicals.[39] The phenolic compounds, viz., cirsilin, cirsimaritin, isothymusin, apigenin and rosmarinic acid, and appreciable quantities of eugenol (a major component of the volatile oil) from OS extract of fresh leaves and stems possessed good antioxidant activity.[40]

Analgesic activity:

In experimental pain models, the OS oil was found to have little analgesic efficacy (tail flick, tail clip and tail immersion methods).However, it was effective against acetic acid induced writhing method in mice in a dose dependent manner. The writhing inhibiting activity of the oil is suggested to be peripherally mediated due to combined inhibitory effects of prostaglandins, histamine and acetylcholine.[41]

Antimalarial activity:

Ayurvedic preparation containing *Ocimum sanctum*, *Piper nigrum* Linn. and *Curcuma longa* Linn. has been shown to possess antimalarial activity against *Plasmodium vivax* and highly effective against *Plasmodium falciparum*[42]. A decoction prepared from the roots of the Tulsi plant is used as a diaphoretic in malarial fever [43]. Tulsi is an important constituent of many Ayurvedic cough syrups and expectorants.

Antipyretic activity:

The antipyretic activity of *Ocimum sanctum* fixed oil was tested in rats after they developed pyrexia due to the typhoid-paratyphoid A/B vaccine. The antipyretic effect of the oil on IP administration was demonstrated by a significant reduction in the febrile response. The oil's antipyretic efficacy was comparable to aspirin at a dose of 3 ml/kg. Furthermore, the fixed oil has prostaglandin inhibitory effect, and this may be used in the future. [44]

Anti-Fertility activity:

The total sperm count and sperm motility were both reduced in albino rats given a benzene extract of *Ocimum sanctum* leaves (250mg/kg body weight). Because of the anti-androgenic properties of *O. sanctum* leaves, the effects were caused by androgen deprivation. In rabbits, sperm testosterone levels increased while FSH and LH levels decreased and sperm count decreased [45].

Antiemetic Activity:

Tulsi leaves also check vomiting and used for antiemetic action [46].

Anti-plasmodial Activity:

In a study conducted by Inbaneson et al. in 2012 on three different species of *Ocimum*, leaf extracts, root extracts, stem and flower extracts of *Ocimum sanctum* exhibited excellent anti-plasmodial efficacy. The presence of alkaloids, glycosides, flavonoids, phenols, saponins, triterpenoids, proteins, resins, steroids, and tannins in the ethanolic extracts of examined plants could explain the in vitro anti-plasmodial activity [47].

Immunomodulatory Activity:

Jeba *et al.* in 2011 studied that aqueous extract of *Ocimum sanctum* at the oral doses of 100, 200 mg/kg/day in rats enhances the production of RBC, WBC, hemoglobin and also enhanced the production of antibodies without affecting the biochemical parameters [48].

Anticancer activity:

Cancer has been a leading cause of death in the developing countries. With changing standard of living and food habits and also due to availability of curative treatment for many infectious diseases, cancer is surpassing other ailments as a principle cause of morbidity and mortality even in developing countries. The current treatment techniques for various cancers, surgery, radiotherapy, and chemotherapy, are costly, mutilating, have substantial side effects, and are associated with residual morbidity as well as frequent relapses. Various plants are employed in Ayurveda as a possible source of anticancer and antitumor effects. In mice with Sarcoma-180 solid tumours, an ethanolic extract of *Ocimum sanctum* mediated a significant reduction in tumour cell size and an improvement in survival. Similar results were also obtained by others where anticancer activity of *O. sanctum* in Lewis lung carcinoma animal model has been reported [49]. Urosolic acid and oleanic acid possess anticancer property. *Ocimum* has the ability to protect the DNA of the body from dangerous radiations.

Anticataract activity:

In experimental models of cataract (galactose cataract in rats by 30% galactose and naphthalene cataract in rabbits by 1g/kg naphthalene), an aqueous extract of fresh leaves of *Ocimum sanctum* delayed the process of cataractogenesis. In both mice, *Ocimum sanctum* 1 and 2g/kg significantly delayed the onset and subsequent maturation of cataract [50].

Central Nervous System (CNS) depressant activity:

The AIE of OS lowered the recovery time and severity of electroshock and pentylenetetrazole caused convulsions in mice owing to pentobarbital (40 mg/kg, ip) and prolonged the length of lost reflex in mice due to pentobarbital (40 mg/kg, ip). In "open field" trials, it also reduced apomorphine-induced fighting time and ambulation. OS extract enhanced swimming time at high doses, implying a CNS stimulant and/or antistress effect. The effect was comparable to that of the antidepressant medication desipramine. In rats, OS fixed oil (2-3 ml/kg, ip) has been shown to prolong pentobarbitone-induced sleep period. Fixed oil may be responsible for potentiation of pentobarbitone-induced sleeping time by inhibiting hepatic metabolism and renal clearance of pentobarbitone [51].

Thyroid Activity:

The effects of *O. sanctum* L. leaf extract (OSE) on blood Triiodothyronine (T3), Thyronine (T4), and serum cholesterol concentrations were examined. [52] OSE at a dose of 0.5 g/kg body weight for 15 days significantly reduced serum T4 concentration; however, no significant changes in blood T3, T3/T4 ratio, or serum cholesterol concentration were found. OSE appears to have an antithyroid effect.

Memory enhancer activity:

Alcoholic extract of *Ocimum sanctum* (OS) L. ameliorated the amnesic effect of scopolamine (0.4 mg/kg) and aging-induced memory deficits in mice. OS extract increased step-down latency (SDL) and acetylcholinesterase inhibition significantly. As a result, OS can be used to treat cognitive diseases including dementia and Alzheimer's disease. [53]

Anti-anaphylactic, antihistaminic and mast cell stabilization activity:

Sridevi *et al.* showed potent benefits of *Ocimum sanctum* L. in the treatment of asthma and related conditions. The findings from various studies reveal that the antihistaminic and antianaphylactic activity of *Ocimum sanctum* L. extract which is mainly due to its mast cell stabilizing potential, suppression of IgE and inhibition of release of inflammatory mediators. Thus use of *Ocimum sanctum* L. leaves proved the strong rationale behind the mentioned therapeutic activities.

Hypolipidemic activity:

Hypolipidemic activity is a term used to describe the action of lowering cholesterol levels. The leaves of *Ocimum sanctum* L. (OS) lower serum lipid profiles in both normal and diabetic mice. The essential oil derived from the leaves of *Ocimum sanctum* L. possesses anti-hypercholesterolemic properties. In plasma, rat liver, lung, kidney, and brain, the aqueous extract reduced LPO production and enhanced antioxidant enzymes. [54]

Anti-helmenthic activity:

In the caenorhabditis elegans model, the essential oil of *Ocimum sanctum* L. displayed significant antihelmenthic action. The proposed antihelmenthic principle is eugenol, which is the most abundant component of the essential oil. [55]

Anticonvulsant activity:

Different extracts of stem, leaf and leaves of OS were tested for anticonvulsant activity by maximal electroshock model using phenytoin as standard. It was observed that ethanol and chloroform extract of leaf and stem were effective in preventing toxic convulsions induced by trans corneal electroshock. In pentobarbitone-induced rats, OS fixed oil (2-3 ml/kg ip) was found to have anticonvulsant properties. OS fixed oil (2-3 ml/kg ip) has been reported to show anticonvulsing property in pentobarbitone-induced rats.[56]

Anti-stress activity:

Ocimum sanctum L, a medicinal herb that widely claimed to posses antistressor activity and used extensively in the Indian system of medicine for a variety of disorders, Administration of the 70% ethonolic extract of *Ocimum sanctum* L. normalizes the alteration in neurotransmitter levels due to noise stress, emphasizing the antistressor potential of this plant.

Anti-microbial activity:

Antimicrobial activity has been shown in *Ocimum sanctum*. Extracts of *Ocimum sanctum* L. in ethanol, methanol, and organic solvents inhibit *Escherichia coli*, *Staphylococci* sp., *Shigella* sp., *Staphylococcus aureus*, and *Enterobacteria* sp. [57] *Pseudomonas aeruginosa*, *Staphylococci* sp., *Salmonella typhi*, *Klebsiella pneumonia*, *Proteus*, *Candida albicans*, *Mycobacterium tuberculosis*, and *Micrococcus pyogenes* are all susceptible to *Ocimum sanctum*. [58,59]. These results shows that OS can act as an effective antibacterial agent against a wide range of microorganisms.

IV. CONCLUSION

Since the dawn of civilization, plants have been utilized to treat diseases all throughout the world. Tulsi is grown for its religious and medical properties. It is widely used as a medicinal plant and a herbal tea in South Asia. *Ocimum sanctum* possesses a wide range of pharmacological actions, according to a thorough review of the literature. Ayurvedic ancient medicine has used various parts of the plant to treat a variety of ailments, including the common cold, cough, headache, flu, asthma, fever, colic pain, sore throat, bronchitis, hepatic diseases, malaria fever, as an antidote for snake bite, fatigue, skin diseases, wound, insomnia, arthritis, influenza, digestive disorders, night blindness, and diarrhea. It is widely used in *Ayurveda* for the treatment of various disorders. *Ocimum sanctum* is extensively used as antioxidant, immune-modulatory, antipyretic, anticancer, chemopreventive, radio-protective, anti-hypertensive and cardio protective and antimicrobial activity etc. The present review article contains all of the relevant information about the classical literature as well as current research on phytoconstituents and pharmacological effect.

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