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## Diversified potentials of *Ocimum sanctum* Linn (Tulsi): An exhaustive survey

<sup>1</sup>Ekta Singh, <sup>1</sup>Sheel Sharma, <sup>2</sup>Jaya Dwivedi and <sup>2</sup>Swapnil Sharma

<sup>1</sup>Dept. of Food Science and Nutrition, Banasthali University, Banasthali (Raj), India

<sup>2</sup>Dept. of Chemistry, Banasthali University, Banasthali (Raj), India

<sup>3</sup>Dept. of Pharmacy, Banasthali University, Banasthali (Raj), India

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### ABSTRACT

*Ocimum sanctum* (also tulsi, tulasī, or Holy Basil is an aromatic plant in the family Lamiaceae which is native throughout the old world tropics and widespread as a cultivated plant and an escaped weed. Tulsi is cultivated for religious and medicinal purposes, and for its essential oil. It is widely known across South Asia as a medicinal plant and an herbal tea, commonly used in Ayurveda, and has an important role within the Vaishnavite tradition of Hinduism, in which devotees perform worship involving tulsi plants or leaves. Eugenol (1-hydroxy-2-methoxy-4-allylbenzene), the active constituent present in *Ocimum sanctum* L., has been found to be largely responsible for the therapeutic potentials of Tulsi. In the present review, efforts have been made to sum up different aspects of scientific studies on this medicinal plant. Scientific evidences are available on various medicinal aspects i.e. antimicrobial, adaptogenic, antidiabetic, hepatoprotective, anti-inflammatory, anti-carcinogenic, radioprotective, immunomodulatory, neuroprotective, cardio-protective, etc. Thus, *Ocimum sanctum* contain several bioactive compounds may contribute to the health effects and are easily available for consumption to increase the nutritional status as well as act as safe guarding against possible deficiencies.

**Key words:** Eugenol, Phytochemicals, Antioxidant, Antibacterial, Stress.

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### INTRODUCTION

Plants are one of the most important sources of medicines. Today the large numbers of drugs in use are derived from plants, like morphine from *papaver somniferum*, aswagandha from *withania somnifera*, ephedrine from *ephedra vulgaris*, atropine from *atropa belladonna*, reserpine from *routphia serpentina* etc. The medicinal plants are rich in secondary metabolites and essential oils of therapeutic importance. The important advantages claimed for therapeutic uses of medicinal plants in various ailments are their safety besides being economical, effective and their easy availability [1-2]. Because of these advantages the medicinal plants have been widely used by the traditional medical practitioners in their day to day practice. According to a survey of World

Health Organization, the practitioners of traditional system of medicine treat about 80% of patients in India, 85% in Burma and 90% in Bangladesh [3]. In traditional systems of medicine the Indian medicinal plants have been used in successful management of various disease conditions like bronchial asthma, chronic fever, cold, cough, malaria, dysentery, convulsions, diabetes, diarrhoea, arthritis, emetic syndrome, skin diseases, insect bite etc. and in treatment of gastric, hepatic, cardiovascular & immunological disorders [4]. In Ayurveda *OS L.* (Tulsi) has been well documented for its therapeutic potentials and described as antiasthmatic (Dashemani Shwasaharni) and cough suppressant drugs (Kaphaghna) [5]. In last few decades several studies have been carried out by scientists and researchers to suggest the role of essential oils & eugenol in therapeutic potentials of *OS L.* [6]. Eugenol is a phenolic compound and major constituent of essential oils extracted from different parts of this plant. The therapeutic potential of it has been established on the basis of several pharmacological studies carried out with eugenol and steam distilled, petroleum ether and benzene extracts of different parts of this plant [7-10]. *OS* has been revered in India over five thousand years, as a healing balm for body, mind and spirit and is known to bestow an amazing number of health benefits. Three varieties of Tulsi are –

- Rama or Light Tulsi (*Ocimum Sanctum*)
- Shyama or Dark Tulsi (*Ocimum Sanctum*)
- Vana Tulsi (*Ocimum Gratissimum*)

#### Plant Anatomy:

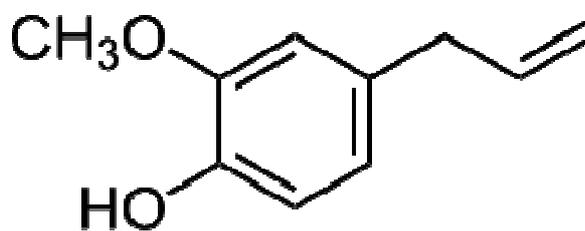
Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Lamiales
Family	:	Lamiaceae
Genus	:	<i>Ocimum</i>
Species	:	<i>O. tenuiflorum</i>
Botanical Name	:	<i>Ocimum Tenuiflorum</i>



#### Phytoconstituents:

The leaf of *OS* contains 0.7% volatile oil comprising about 71% eugenol and 20% methyl eugenol. The oil also contains carvacrol and sesquiterpene hydrocarbon caryophyllene [11]. 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 [12] Two flavonoids, viz., orientin and vicenin from aqueous leaf extract of *OS* 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 [13]. OS also contains a number of sesquiterpenes and monoterpenes viz., bornyl acetate,  $\alpha$ -elemene, neral,  $\alpha$ - and  $\beta$ -pinenes, camphene, campesterol, cholesterol, stigmasterol and  $\beta$ -sitosterol [14].



Eugenol

**Traditional uses:** OS is also known as "the elixir of life" since it promotes longevity. Different parts of plant are used in ayurveda and siddha systems of medicine for prevention and cure of many illnesses like common cold, headache, cough, flu, earache, fever, colic pain, sore throat, bronchitis, asthma, hepatic diseases, malaria fever, as an antidote for snake bite and scorpion sting, flatulence, migraine headaches, fatigue, skin diseases, wound, insomnia, arthritis, digestive disorders, night blindness, diarrhoea and influenza. The leaves are good for nerves and to sharpen memory. Chewing of OS leaves also cures ulcers and infections of mouth [15].

#### **Pharmacological potentials of OS:**

##### **Antioxidant activity:**

The antioxidant activity of *O. Santum* has been reported by many workers [16-18]. The antioxidant properties of flavonoids and their relation to membrane protection have been observed [19]. 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 [20]. *O.Santum* extract has significant ability to scavenge highly reactive free radicals [21]. The phenolic compounds, viz., cirsilineol, 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 [22].

##### **Adaptogenic activity/antistress activity:**

An adaptogen is an agent that helps the body adapt more efficiently to stress. Adaptogen reduce the intensity and negative impact of stress caused by tension, emotional difficulties, poor life style habits, disease and infection, pollution and other factors. Tulsi is one of the most effective adaptogen known. The immunostimulant capacity of OS may be responsible for the adaptogenic action of plant [23]. The alcoholic extract of OS whole plant increased the physical endurance (survival time) of swimming mice, prevented stress induced ulcers and milk induced leucocytosis, respectively in rats and mice, indicating induction of non-specifically increased resistance against a variety of stress induced biological changes by OS in animals [24].

##### **Immuno- modulator activity:**

An immuno modulator is an agent that balance and improve of the body in fighting antigens like disease causing agents such as bacteria, viruses, microbes, allergens etc. and maintaining health. Tulsi is one of the effective immuno modulator [25]. Steam distilled extract from the fresh leaves of OS showed modification in the humoral immune response in albino rats which could be attributed to such mechanisms as antibody production, release of mediators of hypersensitivity reactions and tissues responses to these mediators in the target organs [26]. *O.*

Santum seed oil appears to modulate both humoral and cell-mediated immune responsiveness and GABAergic pathways may mediate these immunomodulatory effects [27].

**Anticancer activity:** The alcoholic extract (AIE) of leaves of OS has a modulatory influence on carcinogen metabolizing enzymes such as cytochrome P-450, cytochrome-b5, aryl hydrocarbon hydroxylase and glutathione-S-transferase (GST), which are important in detoxification of carcinogens and mutagens [28-29]. The anticancer activity of OS has been reported against human fibrosarcoma cells culture [30]. OS significantly decreased the incidence of benzo (a) pyrene induced neoplasia of stomach of mice and 3'-methyl-4-dimethylaminoazobenzene induced hepatomas in rats [31]. The alcoholic extract of the leaves of OS was shown to have an inhibitory effect on chemically induced skin papillomas in mice [32]. Topical treatment of OS leaf extract in 7,12- dimethylbenz(a)anthracene (DMBA) induced papillomagenesis significantly reduced the tumour incidence, average number of papillomas mouse and cumulative number of papillomas in mice. Topical application of the extract OS significantly elevated reduced GSH content and GST activities [33]. A similar activity was observed for eugenol, a flavonoids present in many plants, including Tulsi [34]. Oral treatment of fresh leaves paste of Tulsi may have the ability to prevent the early events of DMBA induced buccal pouch carcinogenesis [35]. Leaf extract of OS blocks or suppresses the events associated with chemical carcinogenesis by inhibiting metabolic activation of the carcinogen [36].

**Chemopreventive activity:** The chemopreventive effect of OS leaf extract is probably through the induction of hepatic/extrahepatic GST in mice. Elevated levels of reduced GSH in liver, lung and stomach tissues in OS extract supplemented mice were also found [37]. Significant antiproliferative and chemopreventive activities were observed in mice with high concentration of OS seed oil. The potential chemopreventive activity of seed oil has been partly attributed to its antioxidant activity [38].

**Radioprotective activity:** The radioprotective effect of OS was firstly reported in the year 1995. Two isolated flavonoids, viz., orientin and vicenin from OS leaves showed better radioprotective effect as compared with synthetic radioprotectors. They have shown significant protection to the human lymphocytes against the clastogenic effect of radiation at low, non toxic concentrations [39]. The combination of OS leaf extract with WR-2721 (a synthetic radioprotector) resulting in higher bone marrow cell protection and reduction in the toxicity of WR-2721 at higher doses, suggested that the combination would have promising radioprotection in humans [40].

**Antihypertensive and cardioprotective activities:** The transient cerebral ischemia and long term cerebral hypoperfusion (causing cellular oedema, gliosis and perivascular inflammatory infiltrate) have been prevented by OS [41]. ( Kelm etal 2000). The OS fixed oil administered intravenously produced hypotensive effect in anaesthetized dog, which seems to be due to its peripheral vasodilator action. Essential fatty acids like linoleic and linolenic acids, contained in the OS oil produce series 1 and 3 (PGE1 and PGE3) prostaglandins and inhibit the formation of series 2 prostaglandins (PGE2) [42]. The long term feeding of OS offers significant protection against isoproterenol-induced myocardial necrosis in Wistar rats through enhancement of endogenous antioxidant [43].

**Antimicrobial activity:** Aqueous extract of OS showed growth inhibition for *Klesbiella*, *E. coli*, *Proteus* and *Staphylococcus aureus*; while alcoholic extract of OS showed growth inhibition for *Vibrio cholera* [44]. The alcoholic extract of OS was also found to be active against multidrug-resistant strains of *S. aureus* that are also resistant to common beta lactam antibiotics [45]. Similarly, OS was found to be active against resistant *Neisseria gonorrhoea* strains [46]. OS fixed

oil showed good antibacterial activity against *Bacillus pumilus*, *Pseudomonas aeruginosa* and *S. aureus*. Higher content of linolenic acid in OS fixed oil could contribute towards its antibacterial activity [47].

**Central Nervous System (CNS) depressant activity:** The alcoholic extract of OS prolonged the time of lost reflex in mice due to pentobarbital (40 mg/kg, ip), decreased the recovery time and severity of electroshock and pentylenetetrazole induced convulsions. It also decreased apomorphine induced fighting time and ambulation in "open field" trials. At high doses, OS extract increased swimming time suggesting a CNS stimulant and/or antistress activity. The effect was comparable to that of desipramine, an antidepressant drug. OS fixed oil (2-3 ml/kg, ip) has been reported to increase pentobarbitone-induced sleeping time in rats. The inhibition of hepatic metabolism of pentobarbitone / renal clearance by fixed oil could be responsible for potentiation of pentobarbitone-induced sleeping time [42].

**Analgesic activity:** The OS oil was found to be devoid of analgesic activity in experimental pain models (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 [48].

**Anti-inflammatory activity:** Methanolic extract (500 mg/kg) and aqueous suspension of OS showed analgesic, antipyretic and anti-inflammatory effects in acute (carrageenan-induced pedal oedema) and chronic (croton oil induced granuloma and exudate formation) inflammations in rats [49]. The fixed oil and linolenic acid possess significant anti-inflammatory activity against PGE<sub>2</sub>, leukotriene and arachidonic acid induced paw oedema in rats by virtue of their capacity to block both the cyclo-oxygenase and lipoxygenase pathways of arachidonic acid metabolism [50-51].

**Antipyretic activity:** The antipyretic activity of OS fixed oil was evaluated by testing it against typhoid-paratyphoid A/B vaccine-induced pyrexia in rats. The oil on ip administration considerably reduced the febrile response indicating its antipyretic activity. At a dose of 3 ml/kg, the antipyretic activity of the oil was comparable to aspirin. Further, the fixed oil possessed prostaglandin inhibitory activity and the same could explain its antipyretic activity [52].

**Hepatoprotective activity:** Oral administration of hydroethanolic extract of OS leaves @ 200 mg/kg in male Wistar albino rats gave protection against liver injury induced by paracetamol [53]. The cold water extract (3g/100 g, orally for 6 days) of OS was found to be effective against carbon tetrachloride (0.2 ml/100 g, subcutaneously) induced liver damage in albino rats [54].

**Memory enhancer activity:** The Alcoholic extract of dried whole plant of OS 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. OS extract increased step-down latency (SDL) and acetyl cholinesterase inhibition significantly. Hence, OS can be employed in the treatment of cognitive disorders such as dementia and Alzheimer's disease [55].

**Antifertility activity:** Benzene extract of fresh OS leaves in male rats showed decreased total sperm count, sperm motility and weight of testis [56]. The long term feeding (up to 3 months) of OS leaves (200 and 400 mg/kg) to adult male and female albino rats along with normal diet decreased sperm count, sperm motility and weight of male reproductive organs [57].

**Antidiabetic activity:** Oral administration of OS extract led to marked lowering of blood sugar in normal, glucosefed hyperglycemic and streptozotocin-induced diabetic rats [58]. A randomized, placebo-controlled, cross over single blind human trial indicated a significant decrease in fasting and postprandial blood glucose levels by 17.6% and 7.3%, respectively. Urine glucose levels showed a similar trend [59]. Further, OS has aldose reductase activity, which may help in reducing the complications of diabetes such as cataract, retinopathy, etc [60].

**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 [61]. The fixed oil significantly possessed antiulcer activity due to its lipoxigenase inhibitory, histamine antagonistic and antisecretory effects [62].

**Antiarthritic activity:** The antiarthritic activity of OS fixed oil was evaluated against formaldehyde-induced arthritis in rats. The fixed oil significantly reduced the diameter of inflamed paw. On intraperitoneal 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 @ 100 mg/kg, ip41. 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 [63].

**Anticataract activity:** The AqE of fresh leaves of OS delayed the process of cataractogenesis in experimental models of cataract (galactosemic cataract in rats by 30% galactose and naphthalene cataract in rabbits by 1 g/kg naphthalene). OS 1 and 2 g/kg delayed the onset as well as subsequent maturation of cataract significantly in both the models [64].

**Anticoagulant activity:** The OS fixed oil (3 ml/kg, ip) prolonged blood clotting time 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 oil on platelets [65].

**Anti-thyroid activity:** The effects of *Ocimum sanctum* leaf extract on the changes in the concentrations of serum T3, T4 were investigated in the male mouse. *Ocimum sanctum* leaf exhibited anti-thyroidic and anti-oxidative properties [66].

**Anthelmintic activity of *ocimum sanctum*:** The essential oil of *Ocimum sanctum* showed potent anthelmintic activity in the *Caenorhabditis elegans* model [67].

**Ethnoveterinary activity:** The whole plant is used in treatment of glossitis, ulcers, maggots in wounds, anthrax, pneumonia, tympanitis, pain in abdomen, constipation, stoppage of urination, liver fuke, loss of appetite, stomach pain, dog bite, cold and cough, cannabis poisoning, opacity of cornea, swelling of lungs, tachycardia, sprains and sore eyes. The leaves are used in treatment of bleeding, cough and cold, eye diseases, udder infection and wound healing in ruminants [68].

**Anti-toxic effect:** Oral administration of *Ocimum sanctum* extract provided protection against HgCl<sub>2</sub> induced toxicity in Swiss albino mice [69].

**Effect on reproductive system:** Feeding Tulsi leaves along with the normal diet in adult male Wistar rats decreased in sexual behavioural score [70].

**Anti-amnesic and nootropic activity of *ocimum sanctum*:** When compared to control, scopolamine and aged groups of mice, *Ocimum sanctum* whole plant extract decreased transfer latency and increased step down latency significantly [71].

**Effect on nervous system:** *Ocimum sanctum* could be a probable herbal remedy for noise induced biogenic amine alterations [72].

*Ocimum sanctum* treatment significantly prevented hypoperfusion-induced functional and structural disturbances [73].

*Ocimum sanctum* leaf extract protected mice against haloperidol-induced catalepsy and protective effects are comparable with standard drugs, scopolamine and ondansetron [74].

### **Hindusim**

Tulsi or Tulasi is a sacred plant for Hindus. Water mixed with tulsi petals is given to the dying to raise their departing souls to heaven. Tulsi, which is Sanskrit for "the incomparable one", is worshipped throughout India, most often regarded as a consort of Krishna in the form of Lakshmi. [75]. According to Brahma Vaivarta Purana tulsi is an expression of Sita. There are two types of tulsi worshipped in Hinduism: "Rama tulsi" has light green leaves and is larger in size; "Shyama tulsi" has dark green leaves and is important for the worship of Hanuman [76]. Many Hindus have tulsi plants growing in front of or near their home, often in special pots. Traditionally tulsi is planted in the center of the central courtyard of Hindu houses. It is also frequently grown next to Hanuman temples, especially in Varanasi.

In the ceremony of Tulsi Vivah, tulsi is ceremonially married to Krishna annually on the eleventh day of the waxing moon or twelfth of the month of Kartika in the lunar calendar. This day also marks the end of the four-month Cāturmāsya period, which is considered inauspicious for weddings and other rituals, and so the day inaugurates the annual marriage season in India. The ritual lighting of lamps each evening during Kartika includes the worship of the tulsi plant, which is held to be auspicious for the home. Vaishnavas especially follow the daily worship of tulsi during Kartika [77].

### **Cultural Importance:**

Tulsi is the sacred plant dearer to the Lord Vishnu. Tulsi symbolizes purity. It is considered as the holy plant in the Indian Subcontinent. Tulsi got its name from Tulasi Devi, who was one of Lord Krishna's eternal consorts. In India people grow Tulsi as the religious plant and worship it. Its leaves are used in temples for the worship purposes and also on the several occasions such as marriage. According to one story, Tulsi was a Gopi who fell in love with Krishna and so had a curse laid on her by his consort Radha. She is very dear to Vishnu. Tulsi is also mentioned in the stories of Mira and Radha immortalized in Jayadeva's Gita Govinda. A Hindu house is considered incomplete without the Tulsi plant in the courtyard. Tulsi is believed to promote longevity and lifelong happiness. Hindus perform special Tulsi puja in the Kartik month which starts after Sharad Poornima. It is the time of the Tulsi vivah (marriage). On this day Tulsi is decorated and coloured as a bride. Even today people in India maintain a potted Tulsi plant. The women's water the plant, light up the diya near it and worships it daily. The stems, leaves, seeds and even the soil are considered as holy. According to the ancient texts Tulsi is glorified as the one who helps in bringing people closer to the divine.

## CONCLUSION

The healthy look is in and fitness has become a religion for present generation, so is the mindless gulping of supplementary pill to sustain and boost their system. In fact, according to medical consultation they could even prove to be fatal for life. Instead if they choose the nature's products, they would not only benefit immensely, but also can cut cost to by those bitter pills to great extent. In the developing countries, increased cost of medication and their side effects are of great concern to general public; opening new channels of pharmacological investigations focusing on natural medication and diverting human trends toward natural cure. Such vitalizer is freely available in nature is ubiquitous 'Tulsi' or Holy Basil. It contains phytochemicals working together these compounds process antioxidant, antibacterial and immune enhancing properties that maintain good health status. So, it can be concluded that *Ocimum sanctum* or Tulsi is a traditionally and clinically proved medicinal herb for both its application and efficacy.

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