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A REVIEW ON PHYTOCHEMICAL AND PHARMACOLOGICAL USES OF *OCIMUM SANCTUM LINN*

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ABSTRACT

Ocimum sanctum Linn. (Tulsi), a sacred and traditional medicinal plant of India which belongs to the family Lamiaceae possesses innumerable health benefits and therefore regarded as the "Elixir of Life". The entire plant body including its leaves, stem, root, inflorescence and seed are proved to be significant medicinal value and hence it is one among the inevitable plant used in the preparation of various ayurvedic pharmacological products. The plant is a rich source of various components including eugenol, Vicenin- 2, linoleic acid, oleic acid, rosmarinic acid, Ocimarin, isorientin, orientin, isovitexin, aesculectin, aesculin, chlorgrnic acid, galuteolin, circineol, gallic acid, Citronellal, Camphene, Sabinene, Dimethyl benzene, Myrecene, Ethyl benzene, Limocene, Vitamin C, Calcium, Phosphorous and many more. *Ocimum sanctum* L. is a plant which is used in several traditional medicine systems to cure various diseases. This plant has been known to possess antibacterial activity, antianaphylactic activity, antihistaminic and mast cell stabilization activity, wound healing effect, radio-protective effect, antidiabetic effect, antioxidant activity, anti-carcinogenic properties, immunologic effects, contraceptive effect, larvicidal property, anti genotoxic effect, neuro-protective effect, cardio-protective effect and other miscellaneous activities. This review elucidates indepth literature survey particularly focussing the phytochemical constituents of Tulsi as well as extrapolating its Ethanopharmacological property.

KEY WORDS: Medicinal plant, *Ocimum sanctum* L., pharmacology, phytochemistry.

INTRODUCTION

Tulsi is an important symbol of the Hindu religious tradition. Although the word '*Tulsi*' gives the connotation of the incomparable one, its other name, Vishnupriya means the one that pleases Lord Vishnu. Found in most of the Indian homes and worshipped, its legend has Permeated Indian ethos down the ages. Known in English as Holy Basil and botanically called *Ocimum sanctum*, Tulsi belongs to plant family Lamiaceae. It has made important contribution to the field of science from ancient times as also to modern research due to its large number of medicinal properties.

Tulsi, the Queen of herbs, the legendary 'Incomparable one' of India, is one of the holiest and most cherished of the many healing and healthy giving herbs of the orient. The sacred basil, Tulsi, is renowned[1] for its religious and spiritual sanctity, as well as for its important role in the traditional Ayurvedic and Unani system of holistic health and herbal medicine of the East. It is mentioned by Charaka in the Charaka Samhita; an Ayurvedic text. Tulsi is considered to be an adaptogen, balancing different processes in the body, and helpful for adapting to stress. Marked by its strong aroma and astringent taste, it is regarded in Ayurveda as a kind of 'elixir of life' and believed to promote longevity. Tulsi extracts are used in Ayurvedic remedies for common colds, headaches, stomach disorders, inflammation, heart disease, various forms of poisoning and malaria. Traditionally, *O. sanctum* L. is taken in many forms, as herbal tea, dried power or fresh leaf. For centuries, the dried leaves of Tulsi have been mixed with stored grains to repel insects.[2]

Scientific Classification

Kingdom: Plantae
(unranked) Angiosperms
(unranked) Eudicots
(unranked) Asterids
Order: Lamiales
Family: Lamiaceae
Genus: *Ocimum*
Species: *O. tenuiflorum*
Binomial name: *Ocimum sanctum* L.

Vernacular names of *Ocimum sanctum*

Hindi: Tulsi

Marathi: Tulas

Assamese: Tulasi

Bengali : Tulasi

Kannada : Thulasi

Tamil : Thulasi

Telugu : Tulasi, Brynda, Gaappaara Chettu

Botanical description

Ocimum sanctum L. (Tulsi) is an erect, much branched sub-shrub 30-60 cm tall, with simple opposite green or purple leaves that are strongly scented and hairy stems. Leaves have petiole and are ovate, up to 5 cm long, usually somewhat toothed. Flowers are purplish in elongate racemes in close whorls. Tulsi is native throughout the world tropics and widespread as a cultivated plant and an escaped weed. It is cultivated for religious and medicinal purposes and for its essential oil. Tulsi is an important symbol in many Hindu religious traditions, which link the plant with Goddess figure. The name 'Tulsi in Sanskrit means 'the incomparable one'. The presence of a Tulsi plant symbolizes the religious bend of a Hindu family.

Origin and distribution

Tulsi grows wild in the tropics and warm regions. The plant is distributed and cultivated throughout India. In India, the plant is grown throughout the country from Andaman and Nicobar islands to the Himalayas up to 1800 meters above the sea level. It is also abundantly found in Malaysia, Australia, West Africa and some of the Arab countries. Basil was brought

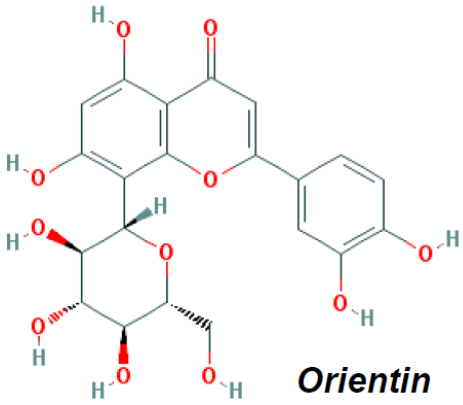
from India to Europe through the Middle East in the sixteenth century, and subsequently to America in the seventeenth century.[3, 4]

Phytochemistry of *Ocimum sanctum* L

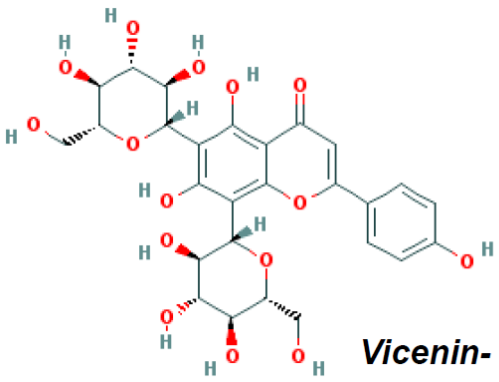
The leaves of OS contain 0.7% volatile oil comprising about 71% eugenol and 20% methyl eugenol. The oil also contains carvacrol and sesquiterpine hydrocarbon caryophyllene.[6] Fresh leaves and stem of OS extract yielded some phenolic compounds (antioxidants) such as cirsilineol, circimaritin, isothymusin, apigenin and rosameric acid, and appreciable quantities of eugenol.[7] Two flavonoids, viz., orientin and vicenin from aqueous leaf extract of OS have been isolated.[5] Ursolic acid, apigenin, luteolin, apigenin-7-O-glucuronide, luteolin-7-O glucuronide, orientin and molludistin have also been isolated from the leaf extract.[8] OS also contains a number of sesquiterpenes and monoterpenes viz., bornyl acetate, β-elemene, neral, α- and β-pinenes, camphene, campesterol, cholesterol, stigmasterol and β-sitosterol.[9]

Table III: Phytochemicals Present in Ocimum sanctum

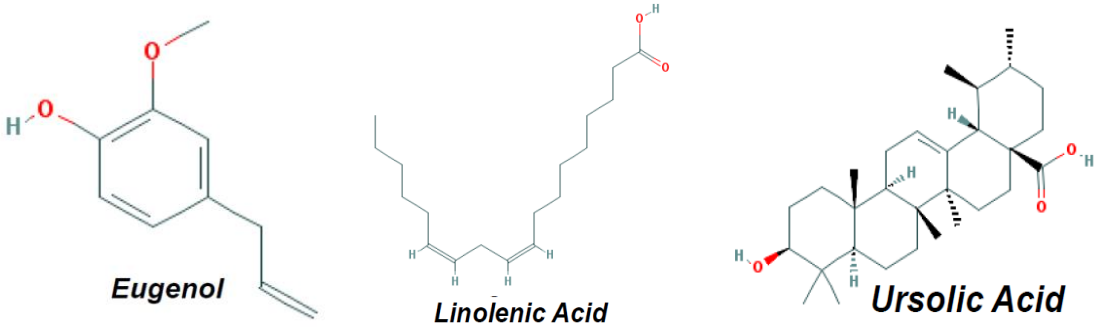
Extracts	Phyto Chemicals	Plant Parts
Fixed oil [10]	Linoleic acid, Linolenic acid, Oleic acid, Palmitric acid, Stearic acid.	Seeds
Essential oil[11, 12, 14]	Aromadendrene oxide, Benzaldehyde, Borneol, Bornyl acetate, Camphor, Caryophyllene oxide, cis-α-Terpineol, Cubenol, Cardinene, D-Limonene, Eicosane, Eucalyptol, Eugenol, Farnesene, Farnesol, Furaldehyde, Germacrene, Heptanol, Humulene, Limonene, n-butylbenzoate, Ocimene, Oleic acid, Sabinene, Selinene, Phytol, Veridifloro, α-Camphene, α- Myrcene, α-Pinene, β-Pinene, α-Thujene, β-Guaiene, β-Gurjunene, methyl chavicol and linalool.	Leaves
Mineral Contents[13]	Vitamin C, Vitamin A, Calcium, Phosphours, Chromium, Copper, Zink, Iron.	Whole Plant
Alcoholic Extract	Aesculectin, Aesculin, Apgenin, Caffiec acid, Chlorgenic Acid, Circineol, Gallic Acid, Galuteolin, Isorientin, Isovitexin, Luteolin, Molludistin, Orientin, Procatechuic acid, Stigmsterol, Urosolic acid, Vallinin, Viceni, Vitexin, Vllinin acid.	Leaves/ Areal Parts



Orientin



Vicenin- 2



Traditional uses

Tulsi 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 and everyday ailments 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, diarrhea and influenza. The leaves are good for nerves and to sharpen memory. Chewing of Tulsi leaves also cures ulcers and infections of mouth.[15]

Pharmacological activities of *Ocimum sanctum*

Anticancer activity: The anticancer activity of OS has been proved and cited by several investigators.[16-19] The alcoholic extract (AlE) 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.[20] The anticancer activity of OS has been reported against human fibrosarcoma cells culture, wherein AlE of this drug induced cytotoxicity 50 µg/ml and above. Morphologically, the cells showed shrunken cytoplasm and condensed nuclei. The DNA was found to be fragmented on observation in agarose gel electrophoresis.[21] OS significantly decreased the incidence of benzo(a)pyrine induced neoplasia of forestomach of mice and 3'-methyl-4-dimethylaminoazobenzene induced hepatomas in rats.[22] The AlE of the leaves of OS was shown to have an inhibitory effect on chemically induced skin papillomas in mice.[23] Topical treatment of Tulsi 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 significantly elevated reduced GSH content and GST activities.[24] A similar activity was observed for eugenol, a flavonoid

present in many plants, including Tulsi.[25] Oral treatment of fresh leaves paste of Tulsi may have the ability to prevent the early events of DMBA induced buccal pouch carcinogenesis.[26] Leaf extract of OS blocks or suppresses the events associated with chemical carcinogenesis by inhibiting metabolic activation of the carcinogen. The anticancer activity of OS was observed in Swiss albino mice bearing Ehrlich ascites carcinoma (EAC) and S 180 tumours.[27]

Antidiabetic Activity

Ten fractions (F1-F10) were isolated from hydroalcoholic extract of OS aerial part by column chromatography. All the fractions F1 to F10 were screened for antidiabetic activity in alloxan induced diabetic rats by estimating serum glucose level and lipid parameters. The bioactive fraction (F5) was found to be potent antidiabetic by ameliorating glucose and lipid parameters (total cholesterol, triglycerides, low and high density lipoprotein cholesterol). The extensive spectroscopic data analysis reveals that, the isolated bioactive compound elucidated as tetracyclic triterpenoid.[29,30] Hannan et al., in 2006 studied the effects of ethanol extract and five partition fractions of OS leaves on insulin secretion together with an evaluation of their mechanisms of action and concluded that Ocimum sanctum leaf extracts stimulate insulin secretion from perfused pancreas, isolated islets and clonal pancreatic–cells.[29] The antidiabetic effects of Ethyl acetate, Petroleum-ether, and Chloroform fractions from ethanolic extract of the leaves of OS were investigated in normal and alloxan induced diabetic rats (AIDRs). Administration of these fractions to the AIDRs resulted in the significant elevation of liver glycogen content. In diabetic rats, SGOT and SGPT levels were significantly elevated that were further reduced after i.p. administration of these fractions. These results indicate that different fractions of OS have favorable effects in bringing down the severity of diabetes together with hepatoprotectivity.[30] Methanolic extracts of leaves of various Ocimum species were explored and compared for antidiabetic activity. All extracts were able to show antidiabetic activity at 0.5 mg/Kg concentration. The activities are well comparable with the standard drug, glibenclamide. The methanolic extract of OS showed better antidiabetic activity in comparison with other species of Ocimum and standard drug. The data were verified as statistically significant by using one way ANOVA at 5 % level of significance ($p < 0.05$).[31]

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.[32] Significant antiproliferative and chemopreventive activities were observed in mice with high concentration of OS seed oil.[33] The potential chemopreventive activity of seed oil has been partly attributed to its antioxidant activity.[34]

Radioprotective activity: The radioprotective effect of OS was firstly reported in the year 1995.[35] 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.[36] 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.[37]

Antioxidant activity: The antioxidant activity of OS has been reported by many workers. The antioxidant properties of flavonoids and their relation to membrane protection have been observed.[38] 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. OS extract has significant ability to scavenge highly reactive free radicals.[39] 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.

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 OS28. The OS 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 acids, contained in the OS oil produce series 1 and 3 (PGE1 and PGE3) prostglandins and inhibit the formation of series 2 prostglandins (PGE2).[40] The long term feeding of OS offers significant protection against isoproterenol-induced myocardial necrosis in Wistar rats through enhancement of endogenous antioxidant.[41]

Antimicrobial activity: AqE of OS showed growth inhibition for *Klesbiella, E. coli, Proteus* and *Staphylococcus aureus*; while AlE of OS showed growth inhibition for *Vibrio cholera.*[42]

The AlE of OS was also found to be active against multidrug-resistant strains of *S.aureus* that are also resistant to common beta lactam antibiotics.[43] Similarly, OS was found to be active against resistant *Neisseria gonorrhea* strains.[44] 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.[45]

Immunomodulatory activity: 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. OS seed oil appears to modulate both humoral and cell-mediated immune responsiveness and GABAergic pathways may mediate these immunomodulatory effects.[46]

Central Nervous System (CNS) depressant activity: The AlE 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 pentylenetetrazoleinduced 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.[47] 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.

Antiinflammatory activity: Methanolic extract (500 mg/kg) and aqueous suspension of OS showed analgesic, antipyretic and antiinflammatory effects in acute (carrageenan-induced pedal oedema) and chronic (croton oil induced granuloma and exudate formation) inflammations in rats.[48] The fixed oil and linolenic acid possess significant antiinflammatory activity against PGE2, leukotriene and arachidonic acid induced paw oedema in rats by virtue of their capacity to block both the cyclooxygenase and lipoxygenase pathways of arachidonic acid metabolism.[49]

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.[50]

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.[51]

Memory enhancer activity: The AlE 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 acetylcholinesterase inhibition significantly. Hence, OS can be employed in the treatment of cognitive disorders such as dementia and Alzheimer's disease.[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]

Antifertility activity: Benzene extract of fresh OS leaves in male rats showed decreased total sperm count, sperm motility and weight of testis.[55] 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.[56]

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.[64] The fixed oil significantly possessed antiulcer activity due to its lipoxygenase inhibitory, histamine antagonistic and antisecretory effects.[57]

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 antiarthritic effect at 3 ml/kg dose was comparable to aspirin 100 mg/kg, ip.[63] 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.[58]

Adaptogenic activity/antistress activity: The immunostimulant capacity of OS may be responsible for the adaptogenic action of plant.[62] The AlE 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.[59]

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.

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 antiaggregator action of oil on platelets.[60]

Toxicity: The median lethal dose (LD50) of OS fixed oil was determined after ip administration in mice. The fixed oil was well tolerated up to 30 ml/kg, while 100% mortality was recorded with a dose of 55 ml/kg. The LD50 of oil was 42.5 ml/kg. There was found no untoward effect on subacute toxicity study of OS fixed oil at a dose of 3 ml/ kg/day, ip for 14 days in rats.[61]

CONCLUSION

The significance of *Ocimum sanctum* and its extracts as source of medicines dates back to centuries and hence it is mentioned in age old art of medicine the “Ayurveda”. It is remarkably evident that the Tulsi leaves and its juice effectively reduces many diseases

including the digestive disorders, respiratory disorders, kidney related problems, Cardiovascular disorders, Cancer, mosquito repellent and all. Proper conservation and sustainable use of such plant resources may enhance the longevity of human life as well as contribute considerably against the drug resistant microorganisms. In the developing countries, increased cost of medication and their side effects are of great concern to general public hence opening new channels of pharmacological investigations focusing on natural medication and diverting human trends toward natural cure. The scientific research on *Ocimum sanctum* L. suggests a huge biological potential of this plant. It is strongly believed that detailed information as presented in this review on the phytochemical and various biological functions of the extracts might provide detailed evidence for the use of this plant in different medicines.

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