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THE PHARMACOLOGICAL ACTIVITY OF TULSI (*OCIMUM SANCTUM*): A REVIEW ARTICLE

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ABSTRACT

In the present review, an attempt has been made to congregate the botanical, phytochemical, pharmacological and toxicological information on Tulsi (*Ocimum sanctum, Lamiaceae*). *Ocimum sanctum* has been adored in almost all ancient ayurvedic texts for its extraordinary medicinal properties. It is pungent and bitter in taste and hot, light and dry in effect. Its seeds are considered to be cold in effect. The roots, leaves and seeds of Tulsi possess several medicinal properties such as stimulant, aromatic and antipyretic. This plant has been known to possess antibacterial activity, antianaphylactic activity, antihistaminic and mast cell stabilization activity, wound healing effect, radioprotective effect, antidiabetic effect, antioxidant activity, anti-carcinogenic properties, immunologic effects, contraceptive effect, anti genotoxic effect, neuroprotective effect, cardio-protective effect and other miscellaneous activities. This review help for the researchers as well as clinicians dealing with *O. sanctum* to know its proper usage as this herb is seemed to be highly valuable, possessing many pharmacological / medicinal properties.

KEYWORDS: Ocimum sanctum (OS, Tulsi), ethno medicinal, Phytochemistry and Pharmacological activities.

INTRODUCTION

The name Tulsi is derived from ‘Sanskrit’, which means “matchless one”. This plant belongs to the family Labiatae, characterized by square stem and specific aroma. The Botanical name of Tulsi is Ocimum sanctum (Linn). 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.[1] Tulsi is a popular home remedy for many 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. Tulsi is considered to be an adaptogen, balancing different processes in the body, and helpful for adapting to stress. It has also aromatic, stomachic, carminative, demulcent, diaphoretic, diuretic, expectorant, alexiteric, vermifuge and febrifuge properties. It has also been used in the treatment of snake-bite and scorpion-sting as described in ancient texts by Charaka and Sushruta. This plant is revered as an elixir of life. For centuries, the dried leaves of Tulsi have been mixed with stored grains to repel insects.[2,3]

Scientific classification

Kingdom: Plantae

Order: Lamiales

Family: Lamiaceae

Genus: Ocimum

Species: Ocimum tenuiflorum

Botanical Description

Tulsi grows wild in the tropics and warm regions. The plant is distributed and cultivated throughout India. It is cultivated for religious and medicinal purposes and for its essential oil. It is an erect, much branched, fragrant and erected plant attaining a height of about 30-60 cm when mature (Fig.1). Its aromatic leaves are simple, opposite, elliptic, oblong, obtuse or acute with entire or dentate margins, growing up to 5 cm long. The Tulsi flowers are small, purplish in elongate racemes in close whorls. The fruits are small and the seeds are reddish-yellow in colour. The plant is bitter and acrid.[4]

Fig.1: Habitat of Ocimum sanctum (Tulsi)

Fig.2: Ocimum basilicum Linn.

Traditional uses

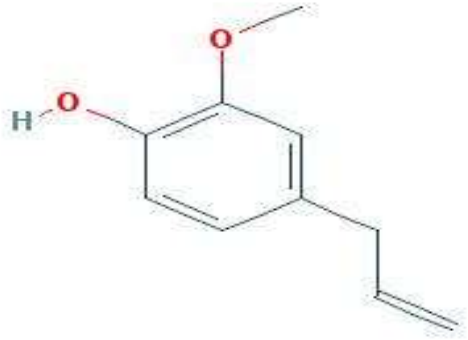
Tulsi is also known as "the elixir of life" since it promotes longevity. Ocimum sanctum has found to be various medicinal properties. Various parts of tulsi plant (leaves, flowers, stem, root, seeds etc) are known to possess therapeutic properties and also used, as expectorant, analgesic, anticancer, anti-asthmatic, antiemetic, diaphoretic, anti-diabetic, anti-fertility, hepatoprotective, hypotensive, hypolipidmic and anti-stress agents. Tulsi has also been used in treatment of fever, bronchitis, arthritis, convulsions etc. Chewing of Tulsi leaves also cures ulcers and infections of mouth[5,6]

Phytoconstituents

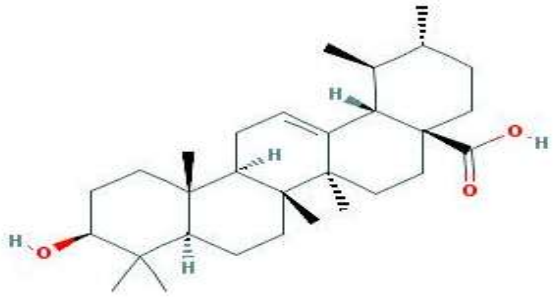
The leaves of Tulsi contain 0.7% volatile oil comprising about 71% eugenol and 20% methyl eugenol. The oil also contains carvacrol and sesquiterpine hydrocarbon caryophyllene.[7] Fresh leaves and stem of Ocimum sanctum extract yielded some phenolic compounds (antioxidants) such as cirsilineol, circimaritin, isothymusin, apigenin and rosameric acid and appreciable quantities of eugenol.[8] Ocimum sanctum has specific aromatic odour because of the presence of essential or volatile oil, mainly concentrated in the leaf. This aromatic volatile oil mainly contains phenols, terpenes and aldehydes.[9] Besides oil, the plant also contains alkaloids, glycosides, saponines and tannins. The leaves contain ascorbic acid and carotene as well.[10] The details of chemical constituents reported are shown in Table-1.

Table 1: Chemical constituents of Ocimum Sanctum

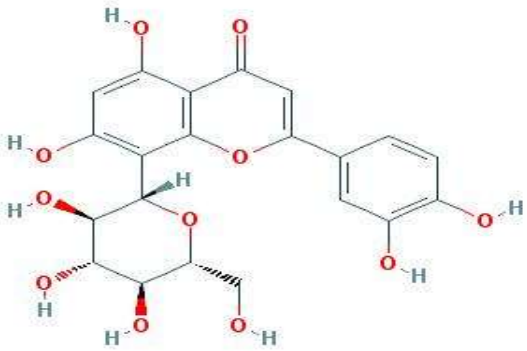
Essential oil isolated from Leaves[11]	Active constituentspresent in Alcoholicextract of leaves[12]	Fixed oil obtained from Seed[13]	Mineral Constituents
α-Thujene	Ursolic acid	Palmitric acid	Vit. C (83 mg)
Dimethyl benzene	Apgenin	Stearic acid	Carotene (2.5 mg)
Myrecene	Apignin-7-O-glucuronide	Linolenic acid	Ca (3.15%)
Ethyl benzene	Vicenin-2	Oleic acid	Zn (0.15 µg)
Limocene	Vitexin	Dilinoleno-	Ni (0.73 µg)
1,8-cineole	Gallic acid	Linolenodilinoli	Fe (2.32 µg)
Cis-β-ocimene	Gallic acid methyl ester	Hexourenicacid	Insoluble oxalate



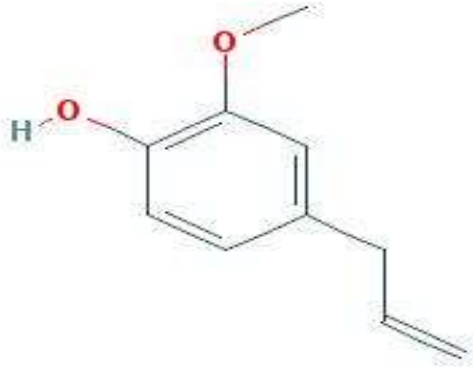
Chemical structure of Eugenol



Chemical structure of Ursolic Acid



Chemical structure of Vicenin- 2



Chemical structure of Linolenic acid

EXPERIMENTAL AND CLINICAL STUDIES

Antioxidant activity

The antioxidant activity of Ocimum sanctum has been reported by many workers. 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 per oxidation in mouse liver. OS extract has significant ability to scavenge highly reactive free radicals. Ocimum sanctum

extract has significant ability to scavenge highly reactive free radicals.[14] 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[15]

Anticancer activity

The anticancer activity of *Ocimum sanctum* has been proved and cited by several investigators. The alcoholic extract (AlE) of leaves of *Ocimum sanctum* has a modulatory influence on carcinogen metabolizing enzymes such as cytochrome P 450, cytochrome $b_{5,}$ aryl hydrocarbon hydroxylase and glutathione S-transferase (GST), which are important in detoxification of carcinogens and mutagens. The anticancer activity of OS has been reported against human fibrosarcoma cells culture, wherein AlE of this drug induced cytotoxicity @ 50 g/ml and above. Morphologically, the cells showed shrunken cytoplasm and condensed nuclei. The AlE of the leaves of *Ocimum sanctum* was shown to have an inhibitory effect on chemically induced skin papillomas in mice. 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.[17] A similar activity was observed for eugenol, a flavonoid present in many plants, including Tulsi. Oral treatment of fresh leaves paste of Tulsi may have the ability to prevent the early events of DMBA induced buccal pouch carcinogenesis. Leaf extract of *Ocimum sanctum* blocks or suppresses the events associated with chemical carcinogenesis by inhibiting metabolic activation of the carcinogen. The anticancer activity of *Ocimum sanctum* was observed in Swiss albino mice bearing Ehrlich ascites carcinoma (EAC) and S 180 tumours[18]

Table: 2 Ocimum species with Anti- cancerous effects.

Ocimum sp.	Extract	Type of cancer
Ocimum gratissimum	Caffeic acid Organic solvent extract Aqueous leaf extracts Aqueous extract	Cervical cancer Prostate cancer Breast cancer Lung adenocarcinoma
Ocimum canum	Essential Oil	Breast cancer
Ocimum basilicum	Leaf powder Organic extract Essential oil	Colon tumors Breast cancer Cervical cancer
Ocimum tenuiflorum	Leaf powder	Colon tumors

Anti-inflammatory activity

The plant *Ocimum sanctum* has been found to be anti inflammatory properties. Methanolic extract (500 mg/kg) and aqueous suspension of Ocimum sanctum 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. The aqueous and methanolic suspension of Tulsi has shown to inhibit acute as well as chronic inflammation in rats[19] This test was conducted by carrageenan induced paw edema, croton oil induced granuloma and exudates, at a dose of 500 mg/kg, bw/day. The fixed oil and linolenic acid possess significant anti-inflammatory 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. The mechanism of action of the anti-inflammatory effects of Tulsi could be the cyclo-oxygenase and lipooxygenase pathways[20] In order to compare the anti-inflammatory effects of fixed oils of various species of *Ocimum* via *Ocimum sanctum*, *Ocimum sanctum*, *Ocimum sanctum*, which possess varying proportions of unsaturated fatty acids (particularly linolenic acid) showed different response against phlogistic agent induced paw edema. Ocimum basilicum possess highest percentage of linolenic acid (21.0%) and offered maximum inhibition of paw edema (72.42%), *Ocimum sanctum* fixed oil containing 16.63% linolenic acid provided 68.97% inhibition while O. americanum offered least paw edema inhibition. Fixed oil of Tulsi can inhibit enhanced vascular permeability and leukocyte migration as evidenced by carrageenan induced inflammatory stimulus. Extract of seeds from three plants including *Ocimum sanctum* have been studied for anti-inflammatory effects of carrageenan, leukotrine and arachiodonic acid induced paw edema in rats. *Ocimum sanctum* seed oil showed maximum percentage inhibition of leukotrine induced paw edema[21]

Antihypertensive and cardioprotective activities

The transient cerebral ischemia and long term cerebral hypo perfusion (causing cellular oedema, gliosis and perivascular inflammatory infiltrate) have been prevented by *Ocimum sanctum*. 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 acids, contained in the *Ocimum sanctum* oil produce series 1 and 3 (PGE_1 and PGE_3) prostglandins and inhibit the formation of series 2 prostglandins (PGE_2). The long term feeding of *Ocimum sanctum* offers significant protection

against isoproterenol-induced myocardial necrosis in Wistar rats through enhancement of endogenous antioxidant[22,23]

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) 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, *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. *Ocimum sanctum* fixed oil (2-3 ml/kg) 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.[24]

Analgesic activity

The *Ocimum sanctum* 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.[25]

Radio protective activity

The radio protective effect of *Ocimum sanctum* was firstly reported in the year 1995. Two isolated flavonoids, viz., orienting and vicenin from Ocimum sanctum leaves showed better radio protective effect as compared with synthetic radio protectors.[26] They have shown significant protection to the human lymphocytes against the clastogenic effect of radiation at low, non toxic concentrations. The combination of *Ocimum sanctum* leaf extract with WR-2721 (a synthetic radio protector) 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[27,28]

Antiulcer activity

The fixed oil of *Ocimum sanctum* administered intraperitoneally elicited significant antiulcer activity against aspirin, indomethacin, alcohol (ethanol 50%), histamine, reserpine, serotonin

or stress-induced ulcers in rats. The fixed oil significantly possessed antiulcer activity due to its lipoxygenase inhibitory, histamine antagonistic and antisecretory effects.[29,30]

Antipyretic activity

The antipyretic activity of *Ocimum sanctum* 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.[31]

Anticoagulant activity

The *Ocimum sanctum* 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 aggregator action of oil on platelets.[32]

Antiarthritic 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 intraperitoneal administration of the fixed oil daily for 10 days, there was marked improvement in the arthritic conditions in rats. The *Ocimum sanctum* fixed oil inhibited carrageenan and inflammatory mediators (e.g., serotonin, histamine, bradykinin and PGE_2) 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.[33]

Antifertility activity

Benzene extract of fresh *Ocimum sanctum* leaves in male rats showed decreased total sperm count, sperm motility and weight of testis.[30] The long term feeding (up to 3 months) of *Ocimum sanctum* 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.[34]

Anticataract activity

The AqE of fresh leaves of *Ocimum sanctum* 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). *Ocimum sanctum* 1 and 2 g/kg delayed the onset as well as subsequent maturation of cataract significantly in both the models[35]

Toxicity

The median lethal dose (LD50) of *Ocimum sanctum* 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 sub acute toxicity study of *Ocimum sanctum* fixed oil at a dose of 3 ml/ kg/day, ip for 14 days in rats[36]

Antidiabetic Activity

Ten fractions (F1-F10) were isolated from hydroalcoholic extract of *Ocimum sanctum* 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[37,38] Hannan et al., in 2006 studied the effects of ethanol extract and five partition fractions of *Ocimum sanctum* 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. The antidiabetic effects of Ethyl acetate, Petroleum-ether, and Chloroform fractions from ethanolic extract of the leaves of *Ocimum sanctum* 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 *Ocimum sanctum* have favorable effects in bringing down the severity of diabetes together with hepatoprotectivity. 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 *Ocimum sanctum* 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 ($p < 0.05$)[39]

Antimicrobial activity

AqE of *Ocimum sanctum* showed growth inhibition for Klesbiella, E. coli, Proteus and Staphylococcus aureus; while AlE of *Ocimum sanctum* showed growth inhibition for Vibrio cholera.[40] 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. Similarly, *Ocimum sanctum* was found to be active against resistant Neisseria gonorrhea strains. *Ocimum sanctum* fixed oil showed good antibacterial activity against Bacillus pumilus, Pseudomonas aeruginosa and S. aureus. Higher content of linolenic acid in *Ocimum sanctum* fixed oil could contribute towards its antibacterial activity[41,420]

CONCLUSION

The extensive literature survey revealed that *Ocimum sanctum* is important medicinal plant with diverse pharmacological spectrum. It is remarkably evident that the Tulsi leaves and its juice effectively reduce many diseases including the digestive disorders, respiratory disorders, kidney related problems, Cardiovascular disorders and Cancer. *Ocimum sanctum* known as the “elixir of life” had proved its efficiency in treating a variety of diseases. The scientific research on *Ocimum sanctum* 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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