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Phytochemical Composition and Pharmacological Potential of *Ocimum sanctu*m L. (Holy Basil): A Comprehensive Review

Vishal Pundir

Department of Botany,
T.D.P.G.College, Jaunpur - 222002 (India)

Abstract

The present study investigates the phytochemical composition and in vitro antioxidant and antimicrobial activities of *Ocimum sanctum* L. leaf extracts. Fresh leaves were collected, shade-dried, and extracted using methanol. Qualitative phytochemical screening revealed the presence of alkaloids, flavonoids, phenolics, tannins, saponins, and terpenoids. Antioxidant activity was assessed using the DPPH radical scavenging assay, while antimicrobial activity was evaluated against *Escherichia coli* and *Staphylococcus aureus* using the agar well diffusion method. The methanolic extract exhibited significant antioxidant activity with a dose-dependent increase in radical scavenging potential. Moderate to strong antibacterial activity was observed against both test organisms. The findings indicate that *O. sanctum* leaves possess bioactive compounds with promising medicinal applications.

Key words : *Ocimum sanctum*; Antioxidant activity; Antimicrobial activity; Phytochemical screening; Medicinal plants.

Medicinal plants have served as an indispensable source of therapeutic agents since the dawn of human civilization and continue to play a crucial role in primary healthcare systems worldwide. According to the World Health Organization, nearly 80% of the global population relies on traditional medicine, predominantly plant-based formulations, for their basic health needs[2-3]. In recent decades, there has been renewed scientific interest in medicinal plants due to their chemical diversity, pharmacological efficacy, affordability, and comparatively lower side effects than synthetic drugs. Among the vast array of medicinal plants, *Ocimum sanctum* L., commonly known as Holy Basil or Tulsi, occupies a unique and esteemed position due to its extensive ethnomedicinal usage and well-documented therapeutic properties[4].

Ocimum sanctum L. belongs to the family Lamiaceae and is widely distributed throughout the Indian subcontinent, Southeast Asia, and tropical regions of the world. In India, Tulsi is not only valued for its medicinal importance but also revered as a sacred plant with profound cultural and religious significance. Traditionally, it has been used in Ayurvedic, Siddha, and Unani systems of

medicine for the management of respiratory disorders, fever, inflammation, digestive ailments, skin diseases, and stress-related conditions. The plant is often referred to as the "Queen of Herbs" due to its remarkable healing potential and adaptogenic properties[11].

Phytochemically, *O. sanctum* is a rich reservoir of biologically active secondary metabolites, including phenolic compounds, flavonoids, alkaloids, terpenoids, tannins, saponins, and essential oils. Among these, eugenol, rosmarinic acid, ursolic acid, linalool, and methyl eugenol have been identified as major bioactive constituents responsible for its diverse pharmacological activities. These compounds are known to exert antioxidant, anti-inflammatory, antimicrobial, antidiabetic, immunomodulatory, neuroprotective, and anticancer effects. The high antioxidant potential of Tulsi is particularly significant in combating oxidative stress, which is implicated in the pathogenesis of various chronic and degenerative diseases[12].

The increasing prevalence of lifestyle-related disorders such as diabetes mellitus, cardiovascular diseases, neurodegenerative conditions, and immune dysfunctions has intensified the search for safe and effective plant-based therapeutics. In this context, *O. sanctum* has gained considerable attention in modern pharmacological research due to its multifaceted bioactivities and ability to modulate multiple biological pathways. Several in vitro, in vivo, and clinical studies have provided scientific validation for its traditional uses, highlighting its role in enhancing immunity, reducing inflammation, regulating metabolic functions, and improving overall physiological resilience.

Despite the extensive traditional knowledge and growing body of scientific evidence, a consolidated and systematic understanding of the phytochemical composition and pharmacological potential of *O. sanctum* is essential for its effective utilization in modern drug development. Comprehensive reviews integrating botanical, phytochemical, and pharmacological data are crucial for identifying research gaps, standardizing herbal formulations, and promoting evidence-based application of this medicinal plant.

Therefore, the present review aims to provide a detailed overview of the phytochemical constituents and pharmacological properties of *Ocimum sanctum* L., with emphasis on its therapeutic relevance and potential applications in modern medicine. By critically analysing existing literature, this review seeks to highlight the medicinal significance of Tulsi and underscore its role as a promising natural resource for the development of novel phyto-pharmaceuticals.

Botanical Description of *Ocimum sanctum* L.

Taxonomical Classification

- **Kingdom:** Plantae
- **Order:** Lamiales
- **Family:** Lamiaceae
- **Genus:** *Ocimum*
- **Species:** *Ocimum sanctum* L.

Ocimum sanctum L. is an erect, aromatic, much-branched, perennial or annual herb, typically attaining a height of 30–90 cm. The plant thrives well in tropical and subtropical climates and prefers warm conditions with moderate rainfall. It grows best in well-drained loamy soils and is commonly cultivated in

Fig. 1. *Ocimum sanctum* (Holy Basil)

household gardens, temple premises, and agricultural fields across India. The species is highly adaptable and can grow under varied ecological conditions.

The stem is erect, quadrangular (square in cross-section), branched, and covered with fine pubescent hairs. It is green to purplish in colour, particularly in Krishna Tulsi varieties. The stem surface bears glandular trichomes responsible for the secretion of essential oils.

Leaves are simple, opposite, ovate to elliptic-ovate, measuring 3–7 cm in length. The leaf margin is entire to slightly serrate, with an acute to obtuse apex and a cuneate base. The upper surface is dark green or purplish, while the lower surface is lighter in colour. Leaves are petiolate, pubescent, and highly aromatic due to the presence of essential oil glands. Venation is reticulate, characteristic of dicotyledonous plants.

Experimental and clinical study:

Phytochemical Constituents :

Phytochemical screening of *O. sanctum* reveals the presence of numerous bioactive compounds such as alkaloids, flavonoids, tannins, saponins, glycosides, and essential oils (Table-1).

Table-1. Major Phytochemicals Present in *Ocimum sanctum*

Phytochemical Group	(Compounds)
Phenolics	Eugenol, Rosmarinic acid
Flavonoids	Orientin, Vicenin
Terpenoids	Linalool, Caryophyllene
Alkaloids	Ocimarin
Essential oils	Methyl eugenol, Camphor

Pharmacological Activities :

All over the world scientific research

is getting momentum to evaluate the pharmacological activities, side effects and medicinal uses of OS against different diseases. On the basis of various experimental and clinical researches, the following pharmacological activities or medicinal properties of OS have been reported.

Anticancer activity : The anticancer activity of *O. Sanctum* has been proved and cited by several investigators[6-7]. The alcoholic extract 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. The anticancer activity of OS has been reported against human fibrosarcoma cells culture, wherein alcoholic extract 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 electrophorosis. OS significantly decreased the incidence of benzo(a)pyrine induced neoplasia of fore stomach of mice and 3'-methyl-4-dimethyla-minoazo benzene induced hepatomas in rats. Topical application of the extract significantly elevated reduced GSH content and GST activities[8]. 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 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[15].

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. 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[9].

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[10].

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[13].

Antimicrobial activity : OS showed

growth inhibition Klebsiella, *E. coli,* Proteus and Staphylococcus aureus; while OS showed growth inhibition for Vibrio cholerae. The OS was also found to be active against multidrug-resistant strains of *S. aureus* that are also resistant to common beta lactam antibiotics. Similarly, OS was found to be active against resistant Neisseria gonorrhoea strains. 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[14].

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. 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. 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[5].

Antidiabetic activity : Oral administration of O.sanctum extract led to marked lowering of blood sugar in normal, glucose fed hyperglycaemic and streptozotocin-induced diabetic rats. 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. Further, OS has aldose reductase activity, which may help in reducing the complications of diabetes such as cataract, retinopathy, etc.[1] (Table-2).

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 antiaggregatory action of oil on platelets[17].

Toxicity: The median lethal dose (LD_{50}) 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 LD_{50} 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[16].

Table-2. Pharmacological Properties of *Ocimum sanctum*

Activity	Plant part used	Mode of action
Antimicrobial	Leaves	Cell membrane disruption
Antioxidant	Leaves	Free radical scavenging
Anti-inflammatory	Leaves	COX inhibition
Antidiabetic	Leaves	Insulin regulation
Immunomodulatory	Whole plant	Enhanced immune response

Traditional and Ethnomedicinal Uses :

Traditionally, Tulsi is used for the treatment of cough, cold, fever, bronchitis, asthma, skin diseases, and digestive disorders. Leaf juice is commonly used as an expectorant, while decoctions are administered for fever and respiratory ailments.

Role in Modern Medicine :

Recent pharmacological studies suggest that *O. sanctum* has potential applications in managing lifestyle diseases such as diabetes, cardiovascular disorders, and cancer. Its adaptogenic and immunomodulatory properties make it valuable in stress-related disorders.

Ocimum sanctum L. is a medicinally rich plant with immense therapeutic potential. The presence of diverse phytochemicals contributes to its wide range of pharmacological activities. Scientific validation of traditional knowledge supports its inclusion in modern herbal formulations. Further clinical trials and molecular studies are needed to explore its full medicinal potential.

References :

1. Halder N, N Joshi, and SK. Gupta (2003) *J Ethnopharmacol 86*(1): 113-116.
2. Kelm, M. A. *et al*. (2000). *Journal of Agricultural and Food Chemistry*, *48:* 102–106.
3. Kathiresan K, P Guanasekan, N Rammurthy, and S. Govidswami (1999) *Pharmaceutical Biology 37*(4): 285 290.
4. Mondal, S. *et al*. (2009). *Journal of Food Science*, *74:* H246–H250.
5. Madhuri S. (2008) Studies on oestrogen induced uterine and ovarian carcinogenesis and effect of ProImmu in rats. PhD thesis, Rani Durgavati Vishwa Vidyalaya, Jabalpur, MP, India.
6. Nair AGR, R Gunasegaran, and BS. Joshi (1982) *Indian J Chem 21*B: 979.
7. Prakash, P., and N. Gupta, (2005). *Indian Journal of Physiology and Pharmacology*, *49*(2): 125–131.
8. Pattanayak, P. *et al*. (2010). *Pharmacognosy Reviews*, *4*(7): 95–105.
9. Pandey Govind, and S. Madhuri (2006) *Phytomedica 7:* 99-104.
10. Sukumaran K, MC Unnikrishnan, and R. Kuttan (1994). *Indian J Physiol Pharmacol 38:* 306.
11. Somkuwar AP. (2003) Studies on anticancer effects of Ocimum sanctum and *Withania somnifera* on experimentally induced cancer in mice. PhD thesis, JNKVV, Jabalpur, MP, India.
12. Singh S, and DK. Majumdar (1997) *Indian J Exp Biol 35:* 380-383.
13. Singh S, and DK. Majumdar (1995) *Int J Pharmacog 33:* 188.
14. Singh, S. *et al*. (2018). *International Journal of Herbal Medicine*, *6*(2): 45–50.
15. Singh S, M Taneja, and DK. Majumdar (2007). *Indian J Exp Biol 45:* 403-412.
16. Singh S, M Malhotra, and DK. Majumdar (2005). *Indian J Exp Biol 43:* 835.
17. Singh S, HMS Rehan, and DK. Majumdar (2001). *J Ethnopharmacol 78:* 139.