Ocimum sanctum The Queen of Herbs with Remarkable Therapeutic Potential

Monu [1], Dr. Reenu Agarwal [2], Dr. Shilpi Rijhwani [3]
[1-3] Department of Botany, IIS (Deemed to be University), Jaipur, Rajasthan, India

Corresponding Author: **Monu**

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Abstract
Nearly 80% of the world's population uses plant-based treatments for primary healthcare, demonstrating the importance of medicinal plants in traditional healthcare systems across the globe. *Ocimum sanctum* L. (Tulsi), a member of the Lamiaceae family, is one of the most well-known of these because of its wide range of medicinal uses and cultural importance in the Indian subcontinent. This study focuses on *Ocimum sanctum*'s pharmacological characteristics, traditional use, and phytochemical makeup. The medicinal benefit of tulsi is attributed to its abundance of bioactive substances, including alkaloids, flavonoids, tannins, phenolics, essential oils, and other secondary metabolites. Its many biological actions, including as antibacterial, antifungal, antioxidant, antidiabetic, anticarcinogenic, radioprotective, wound healing, anti-stress, and immunomodulatory properties, have been shown by numerous investigations. Ayurvedic, Siddha, and Unani traditions have long used various plant parts, including leaves, stems, seeds, and roots, to treat a variety of illnesses, including fever, inflammation, respiratory conditions, and metabolic problems. The review highlights that *Ocimum sanctum* is a powerful natural medicinal agent due to the phytochemicals' synergistic activity. Its cost-effectiveness, safety, and accessibility all contribute to its significance in contemporary herbal treatment. Tulsi can therefore be regarded as a useful resource for the creation of new medications and therapeutic formulations.

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Introduction

There are numerous beneficial plants and herbs in nature for people. The majority of people worldwide in the 20th century rely on traditional medicine to treat their medical issues. any illnesses since they are harmless. Nature possesses a vast reservoir of cures for all of humanity's ailments. For their primary medical requirements, almost 80% of people on the planet rely entirely or in part on traditional medicine (Kunwar *et al*., 2005) [28].

One Approximately 80% of people in India, 85% in Burma, and 90% in Bangladesh use traditional medical practices, according to a World Health Organisation survey (Siddiqui *et al*., 1993) [49]. The vast majority of people on the planet still get their medical care from herbal remedies in developing nations. Global interest in herbal research has grown recently, and data gathered from various studies demonstrates the enormous potential of therapeutic plants.

The medicinal plants are abundant in essential oils with therapeutic value and secondary metabolites, which could be used to make medications. Alkaloids, flavonoids, phenolics, essential oils, tannins, and saponins are a few of the most significant bioactive phytochemical components found in plants (Kaul *et al*., 2005) [20]. Alkaloids, glycosides, steroids, and other relative active metabolites that are employed as pharmaceutical medications are among the many secondary metabolites found in plants referred to as medicinal plants (Sobti & Pushpangadan,1997) [53]. Plants accumulate the secondary metabolites in their roots, leaves, and other organs. Secondary metabolites are of great interest due to their possible industrial, pharmacological, and therapeutic utility, even though little is known about their biosynthetic origin and function in the plant (NR *et al*., 1992).

Medicinal plants have several significant therapeutic benefits, including being readily available, safe, affordable, and effective (Siddiqui, 1993) [49]. Although this medicinal plant has been used extensively for centuries by Indian subcontinental traditional healers to treat a variety of illnesses (Prakash & Gupta (2005) [41].

An essential part of Hindu religious tradition is the occimum. Due to its many therapeutic benefits, tulasi (sanskrit: surasa) has been used in ayurveda for thousands of years. An old ayurvedic text called the Charaka Samhita refers to it (Board, N. I. I. R. (2004) [7]. Known for its potent scent and sharp flavour, it is considered a type of "elixir of life" in Ayurveda and is thought to extend life (Puri *et al*., 2013) [42].

Tulsi, or *Ocimum sanctum*, belongs to the Lamiaceae family. Tulsi literally translates to "Matchless one." Additionally, referred to as the "Queen of Herbs"(Mahajan *et al*., 2016) [30] (unmatched one) (Babita Labh Kayastha). It is among the most sacred plants and has amazing therapeutic properties (Agarwal & Nagesh (2010) [1]; Upadhyay *et al*., 2015) [54]. There are two types of this plant: the green variety, called Rama Tulsi, and the black kind, also called Krishna Tulsi (Yadav *et al*., 2012) [56]. Both types are thought to be equivalent in terms of their chemical components. Numerous medical systems, including Ayurveda, Siddha, Greek, Roman, and Unani medicine, are covered by tulsi (Pattanayak *et al*., (2010) [39]; Siddiqui & H. H. (1993) [49].

Tulsi has been used therapeutically from 400–500 BC, according to literature. The Rigveda has the earliest mentions of Tulsi (3500-1600 BC). It is used therapeutically to treat infertility, cancer, radiation, diabetes, antioxidants, and many other serious and minor illnesses (Prakash & Gupta (2005) [41]. Tulsi is utilised to enhance health since it is adaptogenic. Ayurvedic remedies for the common cold, heart conditions, stomach issues, poisoning situations, convulsions, epilepsy, malaria, fever, bronchitis, and several inflammatory issues involve tulsi extract. As a result, Tulsi extract is also referred to as "Extract of Life" and is thought to promote longevity (Vidhani *et al*., 2016) [55].

Tulsi is a tropical and warm-weather wild plant (Kincaid, (1916) [26]. The subcontinent is where tulsi is harvested (Pooja & Ghildiyal, (2014) [40]. When fully grown, this branching, upright plant will reach a height of 30 to 60 cm (Singh, (2015) [50]. The plant has a harsh and caustic taste. It thrives in soil that is wet. Tulsi is a fragrant herb with branches and tiny, fine hairs. The herbaceous plant is between 75 and 90 cm long, with leaves that are 5 cm long with toothed margins. Simple, elliptic, oblong, and obtuse leaves with serrated or toothed margins are aromatic due to the perfumed oil they carry. Shri Tulsi is a type with green leaves, while Krishna Tulsi is a type with reddish leaves.

It has little cylindrical spikes, stiff clusters, and tiny purple-reddish blooms (Kumar *et al*., 2013) [27]. Heart-shaped bracts with cluster stalks are found at the base of every bloom. With a calyx tube bearded outside the base, the flowers are 5 mm long. The bloom tube is hairy (Kavitha & Murugan, (2014) [21]). The seeds are yellow to reddish in colour, and the fruit is tiny. It is indigenous to Iran, Egypt, France, Italy, and India. Basil can also be found in tropical areas. It is fragrant, thrives in warm areas, and ranges in colour from brilliant green to purple (Moher *et al*., 2015) [35].

Classification

- Kingdom: Plantae
- Division: Magnoliophyte
- Class: Magnoliopsida
- Order: Lamiales
- Family: Lamiaceae
- Genus: Ocimum
- Species: Sanctum

Other Names

- English name: Holy basil
- Hindi: Tulsi
- Sanskrit: Tulsi
- Gujarati: Tulsi

Hundreds of scientific investigations, including in vitro, animal, and human experiments, have examined the therapeutic qualities of tulsi. According to these studies, tulsi possesses a special set of properties, such as: antimicrobial (including antibacterial, antiviral, antifungal, antiprotozoal, antimalarial, and anthelmintic), mosquito repellent, anti-diarrheal, anti-oxidant, anti-cataract, anti-inflammatory, chemopreventive, radioprotective, hepato-protective, cardio-protective, anti-diabetic, anti-diabetic, anti-hypertensive, anti-pyretic, anti-allergic, immunomodulatory, central nervous system depressant, memory enhancement, anti-asthmatic, anti-tussive, diaphoretic, anti-thyroid, anti-ulcer, anti-emetic, anti-spasmodic, anti-arthritic, adaptogenic, anti-stress, anti-cataract, anti-leukodermal, and anticoagulant activities. (Mahajan *et al*., 2013) [29]; Mohan *et al*., 2011) [34]; Pattanayak *et al*., 2010) [39]; Mondal *et al*., 2009) [36] In addition to restoring physiological and psychological function, these pharmacological activities assist the body and mind in overcoming a variety of chemical, physical, viral, and emotional stressors.

Properties

Ayurvedic treatments for common colds, headaches, stomach problems, inflammation, heart disease, several types of poisoning, and malaria include extracts from *Ocimum sanctum* (OS), also known as tulsi. *Ocimum sanctum* L. is traditionally consumed in a variety of ways, such as fresh leaf, dried power, or herbal tea. These extracts have shown anti-inflammatory, antioxidant, immune-modulatory, and antistress qualities in a number of recent studies (Singh *et al*., 1996) [51]; Mauli *et al*., 1997) [31]; Mediratta *et al*., 2002) [32]; Sen *et al*., 1992) [44]). It has also been claimed to possess anti-carcinogenic and radioprotective properties. *Ocimum sanctum* L. has been linked to a number of therapeutic benefits (Devi and P. U. (2001) [9]; sethi *et al*., 2003) [45]. *Ocimum sanctum* L. is a general vitaliser that improves physical endurance.

Ocimum sanctum L. leaves, flowers, stems, roots, seeds, and other parts are recognised to have therapeutic properties and

have been utilised by traditional medical professionals, as hepatoprotective, hypotensive, hypolipidmic, expectorant, analgesic, anticancer, antiasthamatic, antiemetic, diaphoretic, antidiabetic, antifertility, and antistress drugs. Additionally, *Ocimum sanctum* L. has been used to treat fever, bronchitis, arthritis, convulsions, and other conditions.

Ocimum sanctum L. has been identified as an antiasthmatic and antikaphic medication with well-established therapeutic promise. Aqueous, hydro-alcoholic, and methanolic extracts of *Ocimum sanctum* leaves are used in Indian Materia Medica to treat a range of conditions, including pyrexia, rheumatism, and bronchitis (Nadkarni *et al*., 1976) [37].

Chemical composition

Ocimum sanctum L. has a very complex chemical makeup that includes a variety of nutrients and other substances with biological activity. Uncertain growth, harvesting, processing, and storage conditions have a substantial impact on the quantity of several of these components (Pattanayak *et al*., 2010) [39].

Many distinct active phytochemicals work in concert to produce the nutritional and pharmacological qualities of the whole herb in its natural form, as it has been used traditionally. Volatile oil, eugenol, urosolic acid, carvacrol, linalool, limatrol, methyl eugenol, sesquiterpine, caryophyllene, and estragol are all present in OS. Xylose and polysaccharides make up the sugars (kelm *et al*., 2000) [23]. Phytochemical analysis of OS stem and leaves has shown components such as tannins, flavonoids, saponins, and triterpenoids (Jaggi *et al*.,2003) [19]. *Ocimum sanctum* L. has chlorophyll and numerous other phytonutrients, as well as vitamins C and A and minerals like calcium, zinc, and iron (Anbarasu *et al*., 2007) [2].

Pharmacological Properties of *Ocimum sanctum*

Anti-microbial activity

Ocimum sanctum exhibits antibacterial properties. *Ocimum sanctum* L. extracts in ethanolic, methanolic, and organic solvents exhibit broad zones of inhibition against Escherichia coli, Staphylococci sp., Shigella sp., Pseudomonas aernginosa, Staphylococci sp., Salmonella typhi, Klebsiella pneumonia, Proteus, Candida albicans, Mycobacterium TB, and Micrococcus pyogenes are also inhibited by *Ocimum sanctum*. These findings demonstrate that OS is a highly effective antibacterial agent against a variety of microorganisms (Siva *et al*., 2016) [52]; Mishra and Mishra (2011) [33]; Farivar *et al*., 2006) [13].

Anti-fungal activity

One significant characteristic of *Ocimum sanctum* is its antifungal action. *Ocimum sanctum* extracts in aqueous, hexane, chloroform, butanol, and other solvents demonstrated antifungal action. *Ocimum sanctum* prevents food from biodegrading while it is being stored. Numerous plant fungus, including Alternaria tenuis and Helminthosporium sp., were found to be susceptible to *Ocimum sanctum* L. aqueous and acetone extract. Curvularia penniseli as well. Alternaria solani, Candida guillermondii, Colletotricum capsici, and Curvularia sp. were used to test the essential oil of tulsi. Helminthosporium oryzae and Fusarium solani both demonstrated favourable outcomes. Aspergillus flavus and NKDHV growth were found to be effectively inhibited by essential oil and eugenol. Therefore, *Ocimum sanctum* essential oil and eugenol can be utilised as safe plant-based preservatives to prevent food from spoiling due to fungus while being stored (Khan *et al*., 2010) [24].

Antioxidant effect

Both in vivo and in vitro, the aqueous, hydroalcoholic, and methanolic extracts of *Ocimum sanctum* L. exhibit strong antioxidant activity (Kelm *et al*., 2000) [23]. Phytochemical analyses of *Ocimum sanctum* L. leaf extract reveal flavonoids (orientin and vicenin) and phenols (eugenol, cirsilineol, isothymucin, apigenin, and vosamarinic acid).

It has been demonstrated that these pharmacophores have strong antioxidant (cyclooxygenase inhibitory) properties. When OS is fed orally, it significantly protects the liver and aortic tissue from peroxidative damage caused by hypercholesterolaemia (Kedlaya *et al*., 2004) [22].

Antidiabetic effect

When *Ocimum sanctum* L. extract was given orally to glucose-fed hyperglycaemic and streptozotocin-induced diabetic rats, blood sugar levels significantly decreased (Chattopadhyay *et al*., 1993) [8].

The physiological routes of insulin secretion are stimulated by the components of *Ocimum sanctum* L. leaf extracts, which may account for the claimed antidiabetic action (Hanan *et al*., 2006) [18]. According to a different study, *Ocimum sanctum* L. had an antiperoxidative impact and reduced the levels of cortisol and glucose in the serum. *Ocimum sanctum* L. may therefore be able to control diabetes mellitus brought on by corticosteroids (Gholap & Kar (2004) [17].

Anti-carcinogenic property

According to (Banerjee *et al*., 1996) [5] OS has anticancer properties against a variety of carcinogens (Banerjee *et al*., 1996) [5]. Fresh OS leaf juice has anticancer properties in cancer patients. The activities of cytochrome P-450, cytochrome b5, and aryl hydrocarbon hydroxylase in the liver, as well as glutathione-S-transferase (GST) and a decreased glutathione level in the liver and lung, are affected by alcoholic extracts of *Ocimum sanctum*. Each of these cofactors and enzymes is crucial to the detoxification of mutagens and carcinogens.

When *Ocimum sanctum* L. leaves were given to experimental rats for ten weeks, the incidence of haematomas and squamous cell carcinomas was considerably decreased (Aruna & Sivaramakrishnan (1992) [3]. These findings demonstrate OS's antitumor efficacy.

Radio-protective effect

Ocimum sanctum L. was first shown to have radioprotective properties by (Devi *et al*., 1995). Thirty-day lethality studies

were conducted in Swiss albino mice after treatment with single graded doses of aqueous and ethanol extracts from dried leaves of *Ocimum sanctum* L. It was discovered that the aqueous extract was more successful in boosting survival than the ethanol extract (Ganasoundari *et al*., (1997) [15]. It was discovered that the flavonoids orientin and vicenin were equally successful in protecting mouse liver against radiation-induced lipid peroxidation. Additionally, these substances considerably reduced the OH radical activity induced by the Fenton reaction in vitro (Devi *et al*., 1999) [12]. When *Ocimum sanctum* L. leaf extract is combined with WR-2721, a synthetic radioprotector, it protects bone marrow cells more and reduces WR-2721's toxicity at higher dosages. This suggests that the combination may have promising radioprotection in humans (Ganasoundari *et al*., 1998) [14].

Wound healing effect

Numerous studies demonstrated the ability to cure wounds of *Ocimum sanctum* L. The ability of cold aqueous extract of *Ocimum sanctum* L. leaves to cure wounds in conjunction with The excision model of wound repair in Wistar albino rats was used to evaluate its impact on tumour necrosis factor-Alfa (TNF-Alfa). Following the administration of the *Ocimum sanctum* L. extract, wound contraction increased along with the rate of epithelization (Shetty *et al*., 2008) [47]. Using incision, excision, and dead space wound models in albino rats, ethanolic extract of *Ocimum sanctum* L. was studied for normal wound healing and dexamethasone-depressed healing. In the incision wound model, the *Ocimum sanctum* L. extract markedly improved the wound breaking strength. When compared to control wounds, the extract-treated wounds were observed to epithelialise more quickly and to contract at a much higher rate.

Granulation tissue breaking strength, hydroxyproline concentration, and wet and dry granulation tissue weight were significantly increased in the dead space wound model. In every wound model, the extract dramatically reduces the antihealing properties of dexamethasone.

The findings showed that the leaf extract considerably accelerates wound healing and can counteract dexamethasone's inhibitory effect on wound healing. The findings were validated by histological analysis of granulation tissue to identify the collagen laydown pattern (Shetty *et al*., 2008) [47].

Anti-fertility activity

Ocimum sanctum L. has the ability to prevent infertility. Women are supposed to have an abortifacient effect from the leaves of *Ocimum sanctum* L. It has been reported that Tulsi leaves are used for antifertility purposes by Ayurvedic doctors and local women in Kerala Batta & Santhakumari, (1971) [6] ;(Khanna *et al*., 1986) [25].

It has been found that OS leaf petroleum and benzene extracts cause 60–80% of female rats to become infertile. Male rats exposed to *Ocimum sanctum* L. had higher testicular weights, sperm motility, and total sperm counts.

Antigenotoxic effect

The leaf extract of *Ocimum sanctum* L. has a protective effect against genetic damage caused by Cr Hg-1(Babu, & Maheswari, (2006) [4]. Human cell cultures treated with *Ocimum sanctum* L. extract were able to decrease the replication index, sister chromatid exchange, and experimentally induced mitotic index in a dose-dependent manner (Siddique *et al*., 2007) [48].

The mitigating impact of *Ocimum sanctum* L. aqueous leaf extract against chromium (Cr) and mercury (Hg) induced genotoxicity has been investigated using an in vitro assay in Allium cepa root tips cells. When compared to pre-treated (Cr Hg-1) samples, the roots post-treated with the leaf extract demonstrated a highly significant ($p < 0.001$) recovery in mitotic index (MI) and chromosomal aberrations (CA), and it was discovered that lower doses of the leaf extract were more effective than higher doses.

Anti-stress activity

The administration of the 70% ethonolic extract of *Ocimum sanctum* L. normalises the alteration in neurotransmitter levels caused by noise stress, highlighting the antisressor potential of this plant. *Ocimum sanctum* L. is a medicinal herb that is widely used in the Indian medical system for a variety of disorders (Ravindran *et al*., 2005) [43].

Conclusion

In conclusion, both traditional knowledge and contemporary scientific studies support the enormous therapeutic potential of *Ocimum sanctum*, or tulsi, a highly valued medicinal plant. Numerous pharmacological properties, including antibacterial, antioxidant, antidiabetic, anticancer, and anti-stress benefits, are attributed to its rich phytochemical composition, which includes essential oils, flavonoids, and phenolic compounds. For ages, the plant has been widely utilised in traditional medical systems, and it is still essential to primary healthcare, particularly in developing nations. Its efficacy in treating a range of acute and chronic illnesses is further supported by scientific research, underscoring its importance as a safe and natural substitute for synthetic medications. However, further study is needed to standardise dosage, comprehend mechanisms of action, and investigate clinical efficacy in people despite its wide range of medicinal applications. *Ocimum sanctum* has enormous potential for future medication development and integrative healthcare systems due to the growing interest in herbal therapy around the world.

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