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Review Article on Tulsi (*Ocimum sanctum* Linn.): Its Medicinal Properties and Importance in Traditional Indian Medicine

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Abstract

Ocimum sanctum, also known as Tulsi, Holy basil.Ocimum sanctum, is a highly beneficial plant revered for its sacred significance. It boasts numerous health benefits and is renowned for its medicinal properties. Worshiped as a deity, Ocimum Sanctum is hailed as the "queen of herbs" for its ability to treat various ailments such as colds, coughs, sore throats, and skin diseases. Its anti-oxidant, anti-inflammatory,anti-cancer and anti-asthmatic,anti lipidimic, effect in nervous system, immunomodulatory effect, anti-diebetic, hepatoprotective effect, cardioprotective effect, radioprotective effect, bactericidal effect, anti-fungal activity,wounds healing effect, anti microbial properties further underscore its importance. India is home to various types of basil plants, including several varieties of Ocimum Sanctum, (Tulsi) all of which are perennial. Ocimum Sanctum (Tulsi) is considered an adaptogen and is worshipped as a goddess, believed to embody the essence of Ma Lakshmi. With its antidepressant, antifertility, anti-stress, and anti-amnesic properties, Ocimum Sanctum offers a plethora of health benefits. Many medicinal formulations incorporate Ocimum Sanctum for its therapeutic value, making it an invaluable asset to one's health.Through our study of Ocimum Sanctum morphology, we've discovered its manifold benefits. Each component of the plant contributes significantly to its medicinal and traditional applications. Chemical analysis reveals the presence of various compounds such as alkaloids, flavonoids, tannins, saponins, anthocyanins, phenols, steroids, and terpenoids. Ocimum sanctum, commonly known as Tulsi, is deeply integrated into daily life for treating ailments like colds, coughs, eye conditions, and skin issues. Its extensive range of beneficial properties underscores its importance, reflected in its vernacular names and type of Ocimum Sanctum. Ocimum sanctum, plays a crucial role during the COVID-19 pandemic. Ocimum Sanctum (Tulsi), scientifically known as Ocimum sanctum, belongs to the Lamiaceae family, commonly referred to as the mint family. This family includes many aromatic plants known for their medicinal properties, such as basil, mint, and rosemary. Within the Lamiaceae family, Tulsi

stands out for its cultural, religious, and medicinal significance, making it a revered plant in various traditions and communities. Ocimum Sanctum is a highly beneficial herb known for its extensive Ayurvedic and therapeutic properties, and there is no evidence of any adverse side effects associated with its use.

Key words:-Ocimum sanctum, Tulsi, Holy Basil, Ayurvedic medicine, Lamiaceae, Medicinal attributes

• Introduction

Ocimum sanctum (Holy Basil), commonly recognized as Tulsi, stands as a perennial plant native to India, with roots tracing back to ancient Vedic eras. Also referred to as the holy basil, its botanical classification is O. sanctum or Ocimum tenuiflorum, belonging to the Lamiaceae plant family. Renowned for its myriad medicinal attributes, it has been a cornerstone of Ayurvedic medicine for millennia, addressing various health ailments. Extensive in vitro and in vivo research underscores its diverse therapeutic potential, encompassing antimicrobial, anti-inflammatory, cardioprotective, and immunomodulatory properties, with minimal adverse effects. A recent study conducted by Lopresti et al. concludes that supplementation with holy basil extract alleviates stress and enhances sleep quality.

• Medicinal effects -

Ocimum Sanctum, utilized in Ayurvedic medicine in India, is known for its diverse therapeutic applications. According to Pattanayak et al., various parts of the Tulsi plant, including leaves, stem, flowers, roots, seeds, and the whole plant itself, are recommended for treating conditions such as bronchitis, malaria, diarrhea, dysentery, skin diseases, arthritis, eye ailments, insect bites, among others. Additionally, Tulsi exhibits properties such as antifertility, anticancer, antidiabetic, antifungal, antimicrobial, cardioprotective, analgesic, antispasmodic, and adaptogenic effects. The active constituent, eugenol (1-hydroxy-2-methoxy-4-allylbenzene), plays a significant role in its therapeutic potential. These findings affirm the traditional use of Tulsi in treating various human and animal diseases.**[1]**

• Biological sources

The source of this substance is derived from the entire plant of Ocimum sanctum, also known as holy basil or tulsi, from the Lamiaceae family. Its authentication was conducted by Prof. Nawal Kishore Dubey (FNASc, FNAAS) at the Centre of Advanced Study in Botany, Institute of Science, Banaras Hindu University, Varanasi-221005.

• Vernacular Names

Here are the vernacular names of the plant:

Sanskrit: Surasa, Apetrakshasi, Bhutghni, Bahumanjari, Sulabha

Assamese: Tulasi

Bengali: Tulasi

English: Holy Basil

Gujarati: Tulasi, Tuls

Hindi: Tulasi

Kannada: Tulasi, Shree Tulasi, Vishnu Tulasi

Malayalam: Tulasi, Tulasa

Marathi: Tulas

Punjabi: Tulasi

Tamil: Tulasi, Thulasi, ThiruTheezai

Telugu: Tulasi

Urdu: Raihan, Tulsi**[2-8]**

- **Types of Ocimum Sanctum**

A. Ocimum Sanctum (Holy basil)

Known as Ocimum Sanctum, Holy Basil holds the utmost reverence in India, where it's deeply intertwined with Ayurveda and Hinduism, symbolizing wealth, health, and prosperity. With potent medicinal properties, it surpasses other species in its group. Various regional religious beliefs have led to the proliferation of different varieties, known by numerous vernacular names such as Rama Tulsi and Krishna Tulsi in Sanskrit, Trittavu in Malayalam, Tulshi in Marathi, Tulasi in Tamil, and Thulsi in Telugu, while in English, it's referred to as Holy Basil. It's important not to mistake it for Ocimum Tenuiflorum, as it's synonymous with Ocimum Sanctum. Holy Basil encompasses four popular species:-

1.Rama Tulsi (Ocimum Sanctum)

2. Krishna Tulsi (Ocimum Tenuiflorum)

3. Amrita Tulsi (Ocimum Tenuiflorum)

4. Vana Tulsi (Ocimum Gratissum)

B. MEDITERRANEAN BASIL

Also known as Sweet Basil, Mediterranean Basil reigns as the most widespread basil variety globally, thriving across Asia, Europe, the Americas, and Africa. As the most consumed herb worldwide, it goes by several monikers such as the King of Herbs, Royal Herb, Great Basil, and Saint-Joseph's-Wort. Widely utilized in culinary creations, it's a staple in various cuisines like Italian and Thai. Here are some of the diverse varieties of Mediterranean Basil:

1. Sweet Basil (Ocimum Basilicum)

2. Thai Basil (Ocimum Thyrsiflora)

3. Purple Basil (Ocimum Basilicum)

4. Lemon Basil (Ocimum Citriodorum)

5. Vietnamese Basil (Ocimum Cinnamon)

6. American Basil (Ocimum Americanum)

7. African Blue Basil (Ocimum Kilimandscharicum)

8. Italian Genovese Basil (Ocimum Basilicum)

9. Lettuce Basil

10. Green Ruffles Basil

11. Cardinal Basil

12. Greek Basil

13. Spicy Globe Basil

14. Summer Long **[9]**

- ## Classification

There are kingdoms, sub-kingdoms, Superdivisions, divisions, and phylas in the taxonomic Classification of plants.In the taxonomic classification of plants, Ocimum Sanctum (Tulsi), also known as the "Queen of Herbs," holds a specific designation. Its genus and species are evident in its binomial nomenclature. Ocimum Sanctum belongs to the Lamiales order and the Lamiaceae family. Here is a brief overview of its classification:

Kingdom: Plantae

Subkingdom: Tracheobionta

Superdivision: Spermatophyta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Asteridae

Order: Lamiales

Family: Lamiaceae

Genus: Ocimum

Species: O. Sanctum**[10-11]**

- ## Morphology

The appearance of a plant, including its roots, stems, leaves, branches, flowers, fruits, and seeds, is studied in morphology. The morphology of the Ocimum Sanctum plant reveals a dark brown exterior root system**[12]**, while the interior is violet. The leaves are hairy and sub-quadrangular, ranging from dark purple to black on the outside and cream-colored inside. The stem is herbaceous and woody with fibrous bark and short xylem. It stands erect with an elliptical or oblong shape, sometimes oblique or acute, either entire or serrated, and pubescent on both sides. The petiole Is slender, hairy, and emits an aromatic perfume with a distinct flavor. Flower pedicels are longer than the calyx, which is ovoid or bell-shaped, with bilipped lips. The upper lips are broadly oblong or suborbicular with short tips, while the lower lips are larger with four mucronate teeth. The corollas are around 4 mm long, pubescent, and aromatic, with a nectar-like substance. The fruit is subglobose or broad-elliptic, slightly compressed, pale brown or reddish, with small black marks at the thalamus, and has a powerful aromatic flavor. The nuts within the fruit are brown, mucilaginous, 0.1 cm long, slightly notched at the base, and acquire a pungent, mucus-like flavor when soaked in water.**[13-14]**

- ## Traditional and medicinal uses

Traditional uses

The historical utilization of Ocimum sanctum spans various domains including traditional medicine systems like Ayurveda and Siddha. It has been employed for treating ailments such as common colds, headaches, coughs, influenza, earaches, fevers, colic pains, sore throats, bronchitis, asthma, hepatic diseases, malaria fevers, snake bites, scorpion stings, flatulence, migraine headaches, fatigue, skin disorders, wounds, insomnia, arthritis, digestive issues, night blindness, and diarrhea. Ocimum Sanctum leaves are valued for their nerve-calming properties and memory enhancement. Revered for its immune-boosting attributes, Holy Basil safeguards against a spectrum of infections caused by viruses, bacteria, fungi, and protozoa. Recent research even suggests its potential in impeding HIV and carcinogenic cell growth. In India, plants have been integral to human and veterinary healthcare, as well as the food and textile industries. Despite many local food resources among indigenous populations being underdocumented in

nutritional literature, India holds a prominent position in herbal medicine. Ocimum sanctum, or Tulsi, is utilized in various forms—leaves, flowers, stems, roots, seeds—with recognized pharmacological activities including expectorant, analgesic, anticancer, hepatoprotective, hypotensive, hypolipidemic, and antistress properties. Additionally, it plays a significant role in managing fevers, arthritis, convulsions, bronchitis, and other conditions in traditional medical practices.

- ## Medicinal uses

Eye Care: The leaf juice of Ocimum sanctum, combined with triphala, is utilized in Ayurvedic eye drop formulations recommended for conditions like glaucoma, cataracts, chronic conjunctivitis, and other painful eye disorders. As part of daily eye care, three drops of tulsi oil mixed with honey are believed to enhance eyesight.

Malaria Fever: A decoction made from the root of the tulsi plant is administered as a diaphoretic in cases of malarial fevers. Ayurvedic remedies containing Ocimum sanctum. Allium sativum, Piper nirgum, and Curcuma longa have demonstrated antimalarial activity against Plasmodium vivax and Plasmodium falcifarum.

Heart Tonic: Ocimum sanctum is known to have an affinity for the rasa dhatu, aiding in improving circulation through the heart, particularly in cases of congestion due to high vata and kapha. Eugenol from Ocimum sanctum exhibits vasodilating effects on rabbit arterial tissue, suggesting its therapeutic value as a vasodilator. Methyl eugenol, identified as a major constituent of Ocimum sanctum oil, likely contributes to its observed larvicidal properties.

Skin Care: For conditions like ringworm or leucoderma, a paste of Ocimum Sanctum leaves is applied topically to the affected area for treatment. In cases of chickenpox, tulsi leaves are consumed with saffron to alleviate symptoms. The ethanolic extract of tulsi leaves has been shown to significantly reduce blood sugar levels in both normal glucose-fed hyperglycemic and streptozocin-induced diabetic rats.**[15]**

- ## Activity of Ocimum Sanctum

Pharmacological Activity of Holy basil

- **Antioxidant Effect**

A pioneering study investigated whether Ocimum sanctum can protect the liver from radiation-induced lipid peroxidation by enhancing the inherent antioxidant system. The results indicated that the extract of Ocimum sanctum increased levels of crucial antioxidants such as glutathione (GSH) and other enzymes significantly, while radiation decreased these values. Pretreatment with the extract prevented radiation-induced depletion of GSH and antioxidant enzymes, maintaining their levels within or above the normal range. These findings suggest that Ocimum

extract protects against oxidative damage caused by radiation-induced oxidative stress.**[16]**Additionally, studies on rats with liver injury induced by carbon tetrachloride mixed with olive oil showed that oral administration of holy basil and herbal powder exhibited significant antioxidant activity, as evidenced by increased levels of various antioxidant enzymes. Previous research on wound healing demonstrated that both alcoholic and aqueous extracts of Ocimum sanctum significantly increased wound breaking strength and antioxidant levels while decreasing lipid peroxidation.**[17]** Another study revealed that radiation increased lipid peroxidation rates, but pretreatment with Ocimum extract reduced these rates and promoted recovery to normal levels. These findings highlight the protective role of Ocimum extract against radiation-induced lipid peroxidation, with GSH and antioxidant enzymes playing crucial roles in this protection.**[16]**

- ## Anti-inflammatory activity

The essential oil derived from Ocimum sanctum, when used at concentrations of 250 µgram/mL and higher, exhibited notable anti-inflammatory properties by reducing the migration of cancer cells and suppressing the activity of Matrix Metallopeptidase 9 (MM9) in inflammatory cells induced by lipopolysaccharide. Additionally, treatment with Ocimum sanctum essential oil resulted in a dose-dependent decrease in the expression of Matrix Metallopeptidase 9. These findings suggest that Ocimum sanctum essential oil possesses potential antimetastatic and anti-inflammatory effects.**[18]** Another study revealed that the essential oil extract of holy basil demonstrated antibacterial activity, which increased with higher concentrations and longer contact periods. Furthermore, it exhibited significant anti-inflammatory effects**.[19]** Both methanol extract and aqueous suspension of holy basil were found to inhibit acute and chronic inflammation induced by carrageenan-induced pedal edema and croton oil-induced granuloma and exudate, respectively. Notably, the anti-inflammatory response of 500 mg/kg of methanol extract and aqueous suspension was comparable to that observed with 300 mg/kg of sodium salicylate.**[20]**

- ## Anti- microbial effect

The antiviral effectiveness of three different extracts from Ocimum sanctum leaves was assessed against the H9N2 virus. Results revealed significant virucidal activity for all three extracts. Additionally, therapeutic effects were observed in comparison to the virus control, with the crude extract and terpenoid extract of Ocimum maintaining this effect for a longer duration.**[21]** Another study investigated the antimicrobial properties of tulsi extract at concentrations of 6% and 8%, alongside 0.2% chlorhexidine, against A. actinomycetemcomitans. Significant differences were found between the groups, indicating that the 8% concentration of O. sanctum extract exhibited the highest antimicrobial activity against both A. actinomycetemcomitans and P. gingivtlis.**[22]**

- ## Anti- diebetic effect

A study investigated the antidiabetic properties of a component isolated from the hydroalcoholic extract of the aerial parts of Ocimum sanctum. The results showed that the bioactive fraction effectively improved glucose and lipid levels, suggesting that the tetracyclic triterpenoid isolated from Ocimum sanctum has significant potential as an antidiabetic agent.**[23]**

- ## Hepatoprotective effect

A recent study investigated the hepatoprotective effects of Ocimum Sanctum (holy basil), both alone and in combination with silymarin. The findings confirmed that alcoholic leaf extract of Ocimum sanctum exhibits significant hepatoprotective activity, especially when combined with silymarin.**[24]**Additionally, the study examined the efficacy of holy basil aqueous extract against butyl p-hydroxybenzoic acid toxicity in mice, revealing a notable reduction in hepatic lipid peroxidation with co-treatment of holy basil extracts. These results suggest a dose-dependent reduction in lipid peroxidation when Ocimum sanctum is administered alongside butylparaben, indicating its potential hepatoprotective benefits.**[25]**

- ## Anti-ulcer effect

Ocimum sanctum, commonly known as holy basil, has been shown to reduce the occurrence of ulcers and expedite their healing process. In experiments using an acetic acid-induced model, holy basil demonstrated complete ulcer healing within twenty days of treatment. This beneficial effect is attributed to its cytoprotective properties.**[26]** Further investigations in rats subjected to pyloric ligation and aspirin treatment confirmed the anti-ulcer effect of holy basil. Administration of holy basil extract reduced ulcer index, free and total acidity, both acutely and chronically. Additionally, pretreatment with the extract for seven days increased mucous secretion. These findings support the notion that holy basil extract possesses anti-ulcerogenic properties by reducing acid secretion and enhancing mucous secretion, thus protecting against experimental ulcers.**[27]**

- ## Anti-fertility Effect

The research delved Into the impact of Ocimum Sanctum (holy basil) on fertility, noting that administering a leaf extract at 250 mg/kg body weight to rats reduced total sperm count and motility, increased abnormal sperm percentage in the caudal epididymal fluid, and decreased fructose content in caudal plasma, attributed to androgen deprivation from the leaves' anti-androgenic properties.**[28]**

- ## Anti-stress Effect

Exploration of Ocimum sanctum's anti-stress potential involved subjecting rats to chronic variable stress after administering Ocimum sanctum. Results indicated inhibition of cortisol

release, suggesting its effectiveness in stress management, possibly through cortisol release inhibition and CRHR1 receptor blockade.**[29]**

- ## Anti-amnesic Effect

An Investigation into the anti-amnesic effects of various Ocimum species extracts revealed significant antioxidant and acetylcholinesterase (AChE) inhibition activity. In vivo studies with O. basilicum extract (OBE) showed reversal of scopolamine-induced memory deficit in mice, evident by reduced transfer latency time and increased step-down latency in the elevated plus maze and passive shock avoidance task, respectively.**[30]**

- ## Effect on Nervous system

The impact of Ocimum sanctum leaf extract on dietary supplementation in Parkinson's disease was studied. The results revealed that supplementing with holy basil extract led to a significant, dose-dependent delay in the loss of climbing ability and reduction in oxidative stress in the brains of Parkinson's disease model flies.**[31]**These findings suggest that holy basil extract is effective in alleviating symptoms of Parkinson's disease. Additionally, the ethanolic extract from Ocimum sanctum leaves was tested for its effects on noise-induced changes in the central cholinergic system. The results demonstrated that pre-treatment with the ethanol extract of holy basil leaves prevented noise-induced changes in two cholinergic parameters across all brain areas. This study indicates the protective properties of the plant material against the damaging effects of noise stress on brain tissues.**[32]**

- ## Immunomodulatory Effect

The potential immunotherapeutic effects of ocimum sanctum leaf extracts were explored in studies on bovine sub-clinical mastitis. Findings revealed a reduction in bacterial count alongside increased neutrophil and lymphocyte counts, suggesting enhanced immune activity.[33] Additionally, investigations on methanol and aqueous extracts of Ocimum Sanctum leaves highlighted their immunoregulatory properties, potentially elucidating the plant's adaptogenic actions. Another study indicated that holy basil extract intervention led to significant increases in IFN-γ and IL-4 levels, as well as percentages of T-helper cells and NK-cells compared to a placebo group. Furthermore, research on ocimum Sanctum seed oil showcased its ability to modulate both humoral and cell-mediated immune responses, evidenced by changes in antibody titers, histamine release, footpad thickness, and leucocyte migration inhibition.[34]

- ## Hypolipidemic Effect:

A study found that incorporating 1g and 2g of fresh Ocimum Sanctum leaves into the diet of normal albino rabbits led to significant improvements in their lipid profile. Notably, there was a decrease in serum total cholesterol, phospholipids, and triglycerides, along with an increase in HDL-cholesterol and total fecal sterol content.[35]

- **Wound Healing Effect:**

Research demonstrated that Ocimum Sanctum extract notably enhanced wound healing by increasing wound breaking strength in incision wound models. Wounds treated with the extract showed faster epithelialization and increased wound contraction compared to untreated wounds. The extract also counteracted the wound healing suppression caused by dexamethasone.[36] Additionally, the extract showed significant wound healing activity by the 14^{th} day compared to standard and control treatments. It also increased DNA fragmentation, caspase-3 activity, and decreased levels of MMP-2 and p21 proteins. Ethanol extracts of holy basil exhibited anti-metastatic activity by activating antioxidative enzymes, causing cytotoxicity against lung carcinoma cells, and inhibiting cell adhesion and invasion, as well as the activities of matrix metalloproteinase-9. Moreover, the extract significantly reduced tumor nodule formation and lung weight, confirming its inhibitory effect on metastasis.[37]

- **Cardioprotective effect**

The experiment Investigated the potential cardioprotective effects of holy basil in rats with experimental pulmonary hypertension. The findings revealed that treatment with Ocimum sanctum at a dose of 200 mg per kg improved the elevated lung weight to body weight ratio and right ventricular hypertrophy. Additionally, the treatment reduced the expression of Nox-1 and increased the Bcl2/Bax ratio. This study confirms the therapeutic potential of Ocimum sanctum in pulmonary hypertension.[38]The study examined the impact of Tulsi leaf methanolic extract on inflammation in rats with isoproterenol-induced myocardial infarction. Isoproterenol increased cardiac markers and phospholipid content, which were mitigated by pre-treatment with the extract. Elevated levels of 5-lipoxygenase, cycloxygenase-2, leukotriene B4, and thromboxane B2 in isoproterenol-treated rats were significantly reduced in extract pre-treated rats. The findings suggest that the cardioprotective effect might be attributed to the high phenolic content of the methanolic leaf extract.[39]

- **Radioprotective effect**

The study investigated the radioprotective properties of Vicenin-2, a flavonoid found in holy basil, which has been reported to possess anticancer and radiosensitizing effects. The research assessed its impact on cell viability and the expression of PTEN and Akt1 when used alone and in combination with radiation. Results indicated that Vicenin-2 reduced cancer cell survival, phosphorylated Akt levels, and increased the expression of pro-apoptotic genes while decreasing anti-apoptotic genes.[40] Additionally, the protective effects of two water-soluble flavonoids, Orientin and Vicenin, isolated from holy basil leaves against radiation-induced chromosome damage in human peripheral lymphocytes were examined. The findings confirmed that pre-treatment with either Orientin or Vicenin significantly reduced micronucleus formation in a concentration-dependent manner, with reductions ranging from 51% to 67%.[41]

- ## Anti-cancer effect

A study focused on colon cancer investigated the impact of Vicenin-2, found in Ocimum sanctum, on human colon cancer cells. The results showed that Vicenin-2 caused significant cell cycle arrest at the G2/M phase and increased the expression of proteins associated with cell death while decreasing the expression of proteins that promote cell survival. Another study evaluated the effectiveness of Vicenin-2, derived from holy basil, alone and in combination with docetaxel in prostate cancer.[42] It was found that Vicenin-2 had anti-proliferative, anti-angiogenic, and pro-apoptotic effects. When combined with docetaxel, it synergistically inhibited prostate tumor growth, suggesting its potential in combating prostate cancer progression,[43] especially in androgen-independent cases. Additionally, Vicenin-2, either alone or combined with radiation, reduced the survival of cancer cell.

- ## Insecticidal activity

In regions with warm climates, insects pose a significant nuisance and can spread diseases among plants, animals, and humans. Protecting stored goods from insect damage is crucial, leading to extensive research on insect repellents. While synthetic options often carry high toxicity and cost, there's optimism surrounding plant-based repellents, especially those sourced locally like Ocimum species. Studies have explored various plants, including Ocimum, revealing promising results. For instance, the essential oil of O. gratissimum demonstrated complete repellency against houseflies,[44] while Ocimum basilicum's oil exhibited significant repellent effects against red flour beetles.[45]

- ## Anti-Fungal activity

The antifungal properties of Ocimum leaves, extracts, essential oils, and their constituents have been extensively researched, particularly in warmer regions where protecting plants and stored crops from fungal damage is crucial. Studies have also explored the effectiveness of Ocimum oils against various dermatophytes. For instance, an ethanol extract of Ocimum sanctum was applied to ripe tomato fruits before and after inoculation with Aspergillus niger, effectively preventing rot for 5 to 7 days in the presence of Drosophila busckii.[46] Moreover, the essential oil of Ocimum Sanctum demonstrated efficacy against damping-off diseases caused by fungi such as Pythium aphanidermatum, P.debaryanum, and Rhizoctonia solani. In soil infected with P.aphanidermatum, Ocimum Sanctum controlled damping-off disease in tomatoes by up to 50%, and by up to 43% in soil infected with P.debaryanum. Remarkably, the essential oil showed no phytotoxicity and outperformed commonly used synthetic fungicides like Agrosan G.N. and Captan.[47-48]

- ## Health benefits of Tulsi in daily life

Ocimum sanctum, also known as holy basil, offers numerous health benefits for our daily lives. Its leaves serve as a nerve tonic and aid in memory enhancement. They assist in expelling

phlegm from the bronchial tubes, strengthen the stomach, and stimulate perspiration. Ocimum Sanctum seeds have mucilaginous properties. During periods of increased risk of malaria and dengue fever, consuming tulsi leaves boiled with tea can act as a preventive measure. For acute fevers, a decoction of Ocimum Sanctum leaves boiled with cardamom powder, sugar, and milk can help lower body temperature. Tulsi juice is effective in reducing fever, and consuming Ocimum Sanctum leaf extract in water every 2-3 hours can alleviate respiratory disorders. Additionally, Ocimum Sanctum (Tulsi)is a key ingredient in many Ayurvedic cough remedies.[49]

Ocimum sanctum, generally known as Tulsi or Holy basil, is widely regarded as one of the most beneficial medicinal herbs ever discovered. With its rich history of use in India spanning thousands of years, Ocimum Sanctum offers a plethora of medicinal benefits. Simply being in the presence of a Tulsi plant is believed to provide protection against various infections. Adding a few leaves to drinking water or food can effectively disinfect it by eliminating harmful germs. Even just the aroma of Ocimum Sanctum or having a potted plant at home is thought to safeguard the entire family from infections, coughs, colds, and other viral ailments. The immune-boosting properties of Ocimum Sanctum are highly revered and are said to provide defense against a wide range of infections caused by viruses, bacteria, fungi, and protozoa. Recent studies have also shown its potential in inhibiting the growth of HIV and cancer cells, further highlighting its remarkable medicinal value.

1.Healing Benefits

Ocimum sanctum, or holy basil, possesses various therapeutic properties. Its leaves act as a nerve tonic, enhancing memory, and aid in removing mucus from bronchial tubes. They also strengthen the abdomen and stimulate secretion. Additionally, the seeds are adhesive.

2.Fever and Cold Relief:

Ocimum Sanctum leaves are particularly effective against fevers. During the rainy season when diseases like malaria and dengue are prevalent, boiling tender Ocimum Sanctum (tulsi) leaves with tea can serve as a preventive measure. Tulsi juice can also help reduce body temperature.

3.Cough Relief:

Ocimum Sanctum is a key ingredient in many Ayurvedic cough syrups and helps loosen mucus in conditions like bronchitis and asthma. Chewing tulsi leaves can alleviate cold and flu symptoms.

4.Sore Throat Relief:

Boiling water with Ocimum Sanctum leaves and using it as a drink or gargle can ease sore throat infections.

5.Respiratory Disorders:

Ocimum Sanctum is beneficial in treating respiratory ailments. A decoction of its leaves with honey and ginger is effective against bronchitis, asthma, influenza, cough, and cold.

6.Kidney Stone Treatment:

Ocimum Sanctum has a strengthening effect on the kidneys. Consuming basil leaf juice with honey regularly for six months can help eliminate kidney stones through the urinary tract.

7.Heart Health:

Ocimum Sanctum can be helpful in managing cardiac conditions by reducing blood cholesterol levels.

8.Children's Health:

Pediatric issues like cough, cold, fever, diarrhea, and nausea can be alleviated with Ocimum Sanctum leaf juice. It can also expedite the healing of chickenpox blisters when combined with saffron.

9.Stress Relief:

Ocimum Sanctum leaves are considered adaptogens. Chewing 12 leaves twice a day can help prevent stress and purify the blood.

10.Oral Health:

Ocimum Sanctum leaves are effective against mouth sores and infections. Chewing a few leaves can help alleviate these conditions.

11.Skin Conditions:

Ocimum Sanctum juice, when applied topically, can treat skin diseases like roundworm infections and leucoderma.

12. Headache Relief:

Ocimum Sanctum is a natural remedy for headaches. A decoction of its leaves or a paste made with sandalwood can provide relief when applied to the forehead.

13. Eye Health:

Ocimum Sanctum juice is beneficial for sore eyes and night blindness caused by vitamin A deficiency.[50]

- ## Chemical composition

The diverse array of chemical compounds found in Ocimum sanctum varies across its different parts (Bano et al., 2017). Tulsi plant possesses a complex chemical makeup consisting of numerous nutrients and other biologically active compounds. The combined actions of various active phytochemicals in Ocimum Sanctum contribute to its nutritional and pharmacological properties, making it difficult to replicate its overall effects with isolated compounds (Kumar et al., 2013). Among the well-known active compounds identified and extracted from Ocimum Sanctum are eugenol (an essential oil) and ursolic acid (Mohan et al., 2011). The leaves of Ocimum sanctum contain approximately 0.7% volatile compounds, primarily composed of around 71% eugenol and 20% methyl eugenol (Gupta et al., 2002).

Table :- Phytochemicals present in Ocimum sanctum (M. Siva et al., 2016)[51]

Plant parts	**Phytochemicals**
Leaves	Alkaloids, flavonoids , tannis , saponins, anthocyanins , phenols, steroids, trepenoids
Seeds	Sitosterol, fatty acids
Stem	Flavonoids, phenols, tannins, saponins , anthocyanins, phenols, steroids, trepenoids
Whole plant	Alkaloids, flavonoids, saponins, phenols,tannins , flavonoids, triterpenoids anthocyanins

- **Clinical Trials:**

Recent research conducted by Lopresti et al. [52] suggests that supplementing with a Ocimum Sanctum extract may have the potential to reduce stress and improve sleep quality. However, further studies utilizing gold-standard objective sleep measures will be necessary to validate the sleep-related findings.

- **Dose-Effect and Routes of Exposure of Ocimum Sanctum (Holy Basil):**

There is a lack of systematic dose-effect studies on the ingestion of holy Ocimum Sanctum reported in the literature. Additionally, there are no reports on the effects of different routes of Ocimum Sanctum exposure.

- ## Mechanisms of Action:

No studies on the mechanism of action for Ocimum Sanctum ingestion are reported in the literature. Such studies are necessary to determine its mechanism of action. Baliga et al. [53] have speculated on possible mechanisms, suggesting that free radical scavenging, antioxidant properties, metal chelating, and anti-inflammatory effects may play a role. Furthermore, clinical studies with a limited number of patients have indicated that Ocimum Sanctum was effective as a radioprotective agent.

- ## Role of Ocimum Sanctum in Indian tradition

Ocimum Sanctum leaves are edible and have been utilized to balance kapha and vata.[54] They are employed to alleviate symptoms such as pain, diarrhea, cough, and fever, common in COVID-19. Additionally, Ocimum Sanctum is used to manage fevers, including malaria,[55] and is considered effective alongside cow ghee for pneumonia. Scientific research supports Ocimum Sanctum's antiviral properties, [56]showing efficacy against various viruses like Newcastle Disease virus, Vaccinia virus, and Infectious Bursal Disease virus.[57] Clinical trials in India have administered Ocimum Sanctum leaf extracts to patients with positive result The Ocimum Sanctum group showed increased survival and symptomatic improvement compared to the control group.[58] Studies demonstrated respiratory parameter improvement and relief from asthma symptoms after three days of Ocimum Sanctum consumption.[59]Ocimum Sanctum not only restores physiological functions but also psychological functions, attributed to its phenolic compounds and antioxidant properties. Its consumption boosts antioxidant molecules and enzymes, protecting cells from damage.[60] Tulsi also enhances immunity, observed through improved humoral and cellular immunity in animal studies, [61] possibly through modulation of the GABA pathway. Although existing literature supports Ocimum sanctum's potential in managing COVID-19 symptoms, the lack of a standard formulation hinders its widespread use. Translational research is needed to provide scientific evidence and establish a standard formulation for Ocimum Sanctum in COVID-19 management.[62]

- ## Future aspects

Future research efforts should focus on isolating and characterizing the active components of the substance, as many studies have utilized crude extracts. Understanding the structure-activity relationship is crucial. Its potential as an antioxidant and immunomodulator suggests it could be beneficial in treating various diseases like cancer, AIDS, aging, and cataract formation. Incorporating Ocimum sanctum into existing formulations may enhance therapy outcomes. Exploring its synergistic effects with other medications across different diseases warrants investigation. Prior to clinical trials, thorough preclinical pharmacological and toxicological

assessments are necessary to meet regulatory standards. Research studies should aim to validate its effectiveness in different pathophysiological conditions. Future efforts could explore selective targeting and delivery methods as well.[63]

- **Protection and detoxification**

Ocimum sanctum's physiological benefits stem from its role in aiding the body's internal maintenance and defense against toxin-related harm. This is largely attributed to its abundance of phenolic compounds and antioxidant properties, with the black/purple Krishna variety exhibiting higher levels compared to the white Vana variety.[64] Studies indicate that Ocimum Sanctum shields against chemical-induced damage by boosting antioxidant molecules like glutathione and enhancing the activity of protective enzymes such as superoxide dismutase and catalase.[65][66] Additionally, it helps prevent toxin-induced cancers by reducing DNA damage [67] and prompting apoptosis in precancerous and cancerous cells, thereby impeding tumor growth and improving survival rates.[68][69] Moreover, Ocimum Sanctum facilitates the body's detoxification process by increasing the activity of liver enzymes like cytochrome P450, which aid in deactivating and safely eliminating toxic substances.[70] These functions are crucial not only for combating natural toxins but also for addressing the multitude of pollutants, pesticides, pharmaceuticals, heavy metals, radiation, and other industrial toxins prevalent in the modern era.[71]

- **Constraint**

Several challenges have been identified in the literature regarding the effectiveness of Ocimum sanctum against fungal species. With the emergence of concerns about the development of azole-resistant fungal species and the need for chronic suppressive therapy, there is a call for new research to assess the fungicidal capabilities of Ocimum sanctum in combination with other components to ensure effectiveness. Additionally, considering the cost-effectiveness of this traditional herb could significantly impact therapy selection and treatment outcomes. Research into the effectiveness of alternative and complementary medicines and therapies for both prevention and treatment should be prioritized in future studies. A comprehensive, multidisciplinary approach involving clinical trials will provide clear evidence to confirm the antimicrobial and antifungal actions of O. sanctum.[72]

- **Conclusion**

The study reveals the myriad beneficial properties of Ocimum Sanctum , also known as Tulsi, demonstrating its healing powers and pharmacological activities. Every part of the plant, from its roots to its leaves, holds significance, with a chemical composition containing alkaloids, flavonoids, tannins, saponins, anthocyanins, phenols, steroids, and terpenoids. Its medicinal and traditional uses highlight its effectiveness in treating various ailments, including its antioxidant,

antidepressant, antimicrobial, anti-inflammatory, anti-bacterial, insecticidal effect, radioprotective effect, cardioprotective effect, anti -fungal activity,anticancer, antidiabetic, antilipidemic, hepatoprotective, and immunomodulatory effects. Tulsi is commonly employed in everyday life to alleviate colds, coughs, sore throats, eye and skin diseases, and is easily accessible. Ocimum sanctum, is believed to play a significant role in addressing the challenges posed by the COVID-19 pandemic. Ocimum Sanctum Isn't just utilized for common ailments but also for conditions like cancer due to its numerous therapeutic properties in Ayurveda. There's limited evidence of any adverse effects from Ocimum sanctum, though more research is needed to fully understand its potential benefits and risks different varieties of Ocimum Sanctum serve different purposes, with some used for culinary purposes due to their aromatic and minty properties, while others are utilized in pharmaceutical preparations and uses**.**

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