



## **Treditional And Modern Pharmacological Activities of Plant *Ocimum Sanctum* (TULSI)**

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### **ABSTRACT**

The Sanskrit term that means "the incomparable one" is the source of the name Tulsi. In addition to ayurveda medications, the tulsi plant is employed in Greek, Roman, and Unani medicine. Besides this, the Tulsi plant has several medicinal qualities since it has a number of phytochemical elements in its roots, stem, fruit, and leaves, including vallinin, gallic acid, palmitic acid, oleic acid, linoleic acid, eugenol, and many others [7]. Tulasi (*Ocimum sanctum* L.), a member of the Lamiaceae family, is a miraculous ayurvedic herb that is well-known for its amazing therapeutic qualities in both traditional folklore and the pharmaceutical system of medicines[6]. Native to the Indian subcontinent, holy basil is highly valued for its therapeutic use in both Siddha and Ayurvedic medicine [1]. Numerous research conducted on humans, animals, and in vitro have confirmed that tulsi has a variety of therapeutic benefits, including as immunomodulatory, cardioprotective, antibacterial, anti-inflammatory, and adaptogenic properties [2]. The most common kind of Candida in humans is *Candida albicans*. Most frequently linked to over 90% of severe systemic fungal infections, it is the causal agent. Despite the fact that there are many antifungal medications, new pathogen strains become resistant to them. Plant-based medications can be viewed as an alternate therapy to prevent resistance [3]. Tulasi (*Ocimum sanctum* L.), a medicinal plant, is recognized for its restorative and energizing qualities that, through regulating antioxidant components, improve resilience to stress in a variety of human and animal models. The adaptogenic potential of tulsi in stressful in vitro plant systems has not been investigated, despite the fact that these effects have been extensively studied in humans. By examining the indoleamines at various developmental phases, this work sought to clarify the adaptogenic effects of tulsi leaf extract on the in vitro regeneration of tobacco leaf explants [6]. The medicinal applications of plants are thought to be as safe, affordable, and effective as their accessibility [9].

### **INTRODUCTION**

Throughout human existence, the cells within our bodies experience mutations, and in some instances, a detrimental combination of these mutations can trigger the development of cancer. The term "cancer" encompasses a variety of diseases that can impact any organ or tissue. In the year 2020, there were approximately 19.29 million new cancer cases reported globally, resulting in 9.96 million fatalities. Cancer emerged as the foremost cause of death worldwide during that year. The rates of incidence and mortality associated with cancer have been rising rapidly on a global scale, a trend attributed to the aging and growth of the population, as well as shifts in the prevalence and distribution of significant risk factors for cancer, many of which are associated with socioeconomic progress. Natural compounds have historically served as a valuable source of therapeutic agents. Currently, over 50% of available medications incorporate natural substances or their derivatives. Specifically, around 60% of cancer treatments are based on natural products. Presently, more than 30 natural compounds are under investigation in various phases of clinical trials aimed at treating different types of cancer. Holy Basil, known as tulsi in Sanskrit, is an aromatic herb belonging to the Lamiaceae family, utilized in Ayurvedic medicine for over three millennia. Indigenous to the Indian subcontinent, Tulsi (*Ocimum sanctum* L.), often referred to as the "queen of herbs," is also found in regions of North and Eastern Africa, China, Hainan Island, and Taiwan. It is commonly regarded as an "Elixir of Life" and has been employed in the treatment of numerous health conditions [3]. Through in vitro research, a comprehensive review of studies on the use of Tulsi in a polyherbal formulation against candidal species was carried out. The purpose of this study was to review and critically analyze Tulsi in order to gauge the available data regarding the herb's effectiveness against candidal species [2]. Tulsi (*Ocimum sanctum*), known by over 350 regional names, including holy basil, is known as the "Queen of Herbs" because of its many uses in treating a variety of stressors and health issues in both people and animals. The wide variety of secondary metabolites found in the plant, particularly in the leaves, are thought to be responsible for these advantageous effects [4]. This genus's abundance of medicinal potential has led to a review of both contemporary pharmacological research and studies conducted in its traditional medical system [6]. *Ocimum sanctum*, *Ocimum gratissimum*, *Ocimum canum*, *Ocimum basilicum*, *Ocimum killimandscharicum*, *Ocimum ameicanum*, *Ocimum camphora*, and *Ocimum miranthum* are among the approximately 160 species of this plant that have therapeutic use. *Ocimum tenuiflorum*, also known as Krishna tulsi, *Ocimum sanctum*, sometimes known as Rama tulsi, and *Ocimum gratissimum*, also known as Vana tulsi, are the three varieties of tulsi that are typically regarded as the most [7]. As a result, the holy basil Tulsi helped to prevent intestinal illness and slow the growth of mosquitoes. The Tulsi plant is used for several purposes. The plant is gradually making its way into Ayurvedic infection treatment. Tulsi leaves are often used due to its ability to heal [8]. is beneficial

for treating a variety of conditions, including colds, coughs, dengue, malaria, bronchitis, asthma, sore throats, influenza, heart problems, eye conditions, tongue infections, insect bites, stress, and kidney stones [9].



**Rama tulsi (ocimum sanctum)**



**Krishna tulsi (ocimum tenuiflorum)**



**Amrita tulsi (*ocimum tenuiflorum*)**



**Vana tulsi (*ocimum gratissimum*)**



**Sweet basil (*ocimum basilicum*)**



**Thai basil (*ocimum thyrsoiflora*)**



**Purple basil (*ocimum basilicum*)**



**Lemon basil (*ocimum citriodorum*)**



**Vietnamese basil (*ocimum cinnamom*)**



**American basil (*ocimum americanum*)**



**African blue basil (*ocimum kilimandscharicum*)**



**Italian Genovese basil (*ocimum basilicum*)**

[13] [14]

**Botanical Classification of *Ocimum sanctum* [9].**

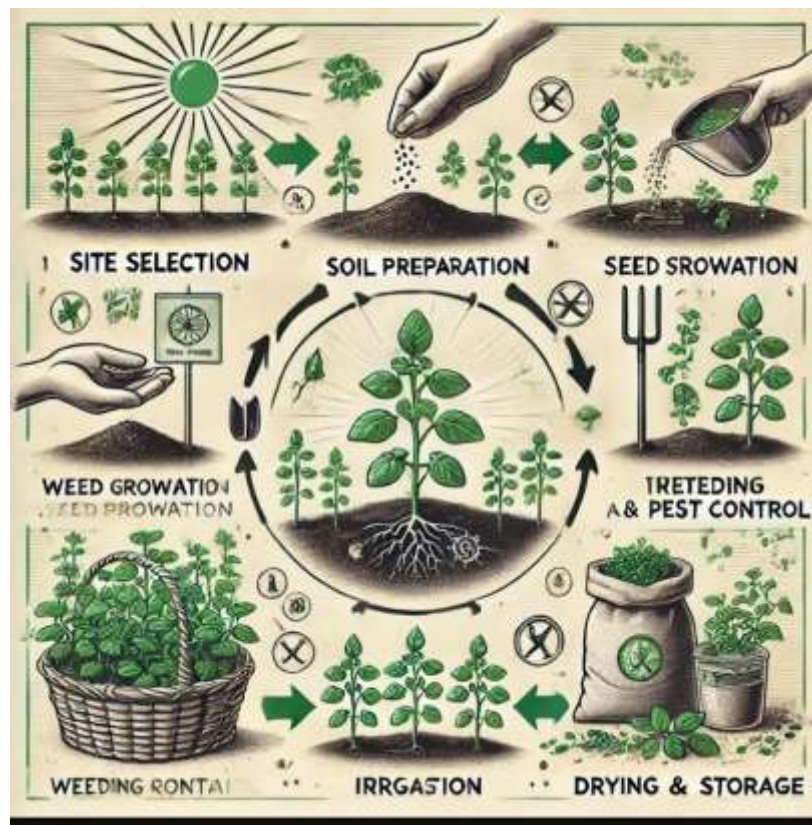
Taxonomic Rank	Taxon
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Lamiaceae
Genus	<i>Ocimum</i>
Species	<i>Ocimum sanctum</i>

**Vernacular names of *Ocimum sanctum* [7].**

Vernacular Name Region	Names
English	Basilie, Sweet Basil
Hindi	Besil, Tulsi, Jangli tulsi
Chinese	Loh lahk, Yu heung choi
Middle East, North Africa	Dohsh, Schadjant, Vasub
Armenia	Shahasbram, Rehan
Bulgaria	Bosilek

Burma	Laun, Pinzainpinzin
Denmark, Greenland	Basilikum
Netherlands, South Africa	Baziel, Koningskruid
England	Basilie, Sweet Basil
Finland, Sweden, Norway	Basilika
France	Basilic sacre, Herbe royale
Georgia	Rekhani, Rehan
Germany	Indisches Basilikum
Iceland	Basilika
Italy	Basilico
Japan	Bajiru, Kami-meboki
Cambodia	Che tak, Mareah proeu
Korea	Naruk-pul, Yangeajuk
Northeast of Thailand	Saphaa, Phak i tou thai
Malaya	Kemangi, Selasi jantan
Nepal	Tulsi patta, Bavari phul
Sri Lanka	Madurutala, Mudura tulla

## CULTIVATION



Tulsi thrives in warm, tropical climates. The plant originated in India and is now grown and supplied all over the nation. Up to 1800 meters above sea level, it is grown. From the Andaman and Nicobar islands to the Himalayas, plants are grown in India. In various parts of Africa and Asia, it is widely grown. Wet soil is ideal for its natural growth. The plant's size, shape, and therapeutic qualities are influenced by the soil type and rainfall fluctuations. The tropical regions of Asia are home to around 150 species of the *Ocimum* genus [9].

Basil typically reaches a height of 30 to 130 centimeters, characterized by its opposite, light green, silky leaves that measure between 3 to 11 centimeters in length and 1 to 6 centimeters in width. The flowers are small, white, and arranged in terminal spikes. Within the Lamiaceae family, the four stamens and the pistil are positioned above the inferior lip of the corolla, rather than being tucked beneath the upper lip. Following entomophilous pollination, four rounded achenes develop within the bilabiate calyx after the corolla has fallen away. Holy Basil thrives in hot and dry environments; however, Tulsi is particularly sensitive to cold temperatures. In the event of frost, Tulsi behaves as an annual plant. While Tulsi is best suited for outdoor cultivation, it can also be grown indoors in pots, ideally on a windowsill that faces the equator. A greenhouse or row cover is recommended for Tulsi, as it flourishes in strong sunlight and should be protected from cold drafts to prevent damage. Additionally, Holy Basil can be cultivated in a basement under fluorescent lighting [10].

## CHEMICAL CONSTITUENT

Tulsi exhibits a highly intricate chemical composition, encompassing a variety of nutrients and biologically active compounds. The botanical characteristics and inherent biochemical intricacies of Tulsi render the standardization of its active components particularly challenging. Among the most recognized active constituents of Tulsi leaves are eugenol and ursolic acid, which are key sources of its essential oil. Ursolic acid, a primary compound extracted from Tulsi, has been shown to possess antifertility properties in male mice and rats of both genders. This compound exhibits anti-estrogenic effects, leading to a reduction in sperm count and a decrease in spermatogenesis. Various parts of the Tulsi plant yield eugenol through extraction, which is a phenolic compound and a significant element of the essential oil. The therapeutic efficacy of the essential oils derived from the fresh leaves of *Ocimum sanctum* is largely attributed to its major constituent, eugenol [10].

The chemical composition of Tulsi includes a variety of components such as :

Category	Chemical Components
<b>Terpenes &amp; Essential Oils</b>	$\alpha$ -Pinene, $\beta$ -Pinene, $\alpha$ -Thujene, Sabinene, Camphene, Citronellal, Linalool, $\alpha$ -Cubebene, Eugenol, Methyl eugenol, $\beta$ -Elemene, Allo-ocimene, E-Cinnamyl, Isoeugenol, Isocaryophyllene, $\beta$ -Caryophyllene, $\alpha$ -Guaiene, $\alpha$ -Amorphene, $\alpha$ -Humulene, $\gamma$ -Humulene, Carvacrol, $\alpha$ -Terpineol, $\alpha$ -Selinene, Borneol, Isoborneol, Germacrene-D, $\beta$ -Selinene, Myrtenylformat, Geraniol, $\alpha$ -Murolene, Calamene, Caryophyllene oxide, Elemol, Humulene oxide, $\alpha$ -Guaiol, T-Cadinol, $\delta$ -Cuparene, Nerolidol, Iedol, Tetradecanal, $\alpha$ -Bisabolol
<b>Hydrocarbons</b>	Nonane, Octane, Benzene, Toluene, Dimethyl benzene, Ethyl benzene, Butyl-benzene
<b>Alcohols</b>	(Z)-3-Hexanol, 1,8-Cineole, p-Cymene, Terpinolene, Linalool, Apigenin-7-O-glucuronide
<b>Acids</b>	Ursolic acid, Palmitic acid, Linolenic acid, Stearic acid, Oleic acid, Hexourenic acid, Caffeic acid, Chlorogenic acid, Gallic acid, Gallic acid methyl ester, Vallinic acid, 4-Hydroxybenzoic acid
<b>Flavonoids</b>	Luteolin, Apigenin, Vicenin-2, Luteolin-7-O-glucuronide, Orientin, Isorientin hydrate, Molludistin, Vitexin, Isovitexin
<b>Phenolic Compounds</b>	Procatechuic acid, Aesculin, Aesculetin, Circineol, Stigmasterol, $\beta$ -Sitosterol, $\beta$ -Stigmasterol, Triacntanol ferulate, Phenylpropane glucosides, Isocaryophyllene
<b>Other Compounds</b>	Ethyl 2-methyl Butyrate, Dimethyl benzene, Terpinolene, Myrcene, Limocene, cis- $\beta$ -Ocimene, Selin-11-en-4- $\alpha$ -ol, 14-Hydroxy- $\alpha$ -humulene, (EZ)-Farnesol, Lactate, Cissessesquissainene, Stigmasterol, Triacntanol ferulate, Dilinolenol linolins, Linodilinolin

[10].

Sugars, xylose, and polysaccharides make up the mucilage. The seeds contain oils, which are made up of sitosterol and fatty acids. One of the medicinal plants, basil has antioxidants that help prevent cell damage that can result in malignant situations. It also contains vitamin C and vitamin A, which can increase the generation of antibodies that fight disease by up to 20% [10].

**Nutritional components of *Ocimum* [10].**

Nutritional components	Contents
Carbohydrate	2.3g
Calcium	25mg
Carotene	2.5µg
Chromium	2.9µg
Copper	0.4µg
Fat	0.5mg
Iron	15.1mg
Nickel	0.73µg
Phosphorus	287mg

**Phytochemicals Present in *Ocimum Sanctum* [8]**

The chemical makeup of Tulsi is notably intricate, comprising a diverse array of nutrients and biologically active compounds, the ratios of which can differ significantly among various strains and even among individual plants within the same cultivation area. Additionally, the levels of many of these components are profoundly influenced by varying conditions of growth, harvesting, processing, and storage, which remain inadequately understood. The nutritional and therapeutic attributes of the herb in its unrefined state, as traditionally utilized, arise from the synergistic interactions among numerous active phytochemicals. As a result, the comprehensive effects of Tulsi cannot be entirely replicated using isolated compounds or extracts. Due to its inherent botanical and biochemical intricacies, the standardization of Tulsi has thus far proven elusive to contemporary science.

**Volatile Oil and Other Compounds in Tulsi**

Source	Chemical Components
Volatile oil from leaves	Eugenol (1-hydroxy-2-methoxy-4-allylbenzene), Euginal (Eugenic acid), Ursolic acid (2,3,4,5,6,6a,7,8,8a,10,11,12,13,14b-tetradecahydro-1H-picene-4a-carboxylic acid), Carvacrol (5-isopropyl-2-methylphenol), Linalool (3,7-dimethylocta-1,6-dien-3-ol), Limatrol, Caryophyllene (4,11,11-trimethyl-8-methylene-bicyclo[7.2.0]undec-4-ene), Methyl carvicol (Estragol: 1-allyl-4-methoxybenzene)
Volatile oil from seeds	Fatty acids, Sitosterol
Mucilage from seeds	Sugars (Xylose, Polysaccharides)
Green leaves	Anthocyanins

The sugars consist of xylose and polysaccharides. While Tulsi is recognized as a general vitalizer that enhances physical endurance, it does not contain caffeine or other stimulants. The stems and leaves of holy basil encompass a variety of constituents with potential biological activity, including saponins, flavonoids, triterpenoids, and tannins. Furthermore, several phenolic compounds have been identified, which also demonstrate antioxidant and anti-inflammatory properties [8].

**Chemical Compounds and Their Properties [8].**

Compound Name	Properties
Rosmarinic acid	(Dihydroxyphenyl) ((2R)-2-[[[(2E)-3-(3,4-Dihydroxyphenyl)-1-oxo-2-propanoic acid), apigenin propenyl]]oxy]-3-(3,4
Apigenin	(5,7-dihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-on)
Cirsimaritin	(5,4'-dihydroxy-6,7-dimethoxyflavone)
Isothymusin	(6,7-dimethoxy-5,8,4'-trihydroxyflavone)
Isothymonin	Chemical compound
Orientin	(8-C-beta-glucopyranosyl-3',4',5,7-tetrahydroxyflav-2-en-3-one)
Vicenin	(6-C-beta-D-xylopyranosyl-8-C-beta-D-glucopyranosyl apigenin)



1.	Fixed oil	Linoleic acid, Linolenic acid, Oleic acid, Palmitric acid, Stearic acid.
2.	Essential oil	Aromadendrene oxide, Benzaldehyde, Borneol, Bornyl acetate, Camphor, Caryophyllene oxide, cis- $\alpha$ -Terpineol, Cubenol, Cardinene, D-Limonene, Eicosane, Eucalyptol, Eugenol, Farnesene, Farnesol, Furaldehyde, Germacrene, Heptanol, Humulene, Limonene, n-butylbenzoate, Ocimene, Oleic acid, Sabinene, Selinene, Phytol, Veridiflorol, $\alpha$ -Camphene, $\alpha$ Myrcene, $\alpha$ -Pinene, $\beta$ -Pinene, $\alpha$ -Thujene, $\beta$ -Guaiene, $\beta$ -Gurjunene, methyl chavicol and linalool.
3	Mineral Contents	Vitamin C, Vitamin A, Calcium, Phosphours, Chromium, Copper, Zink, Iron.

[9]

## PHARMACOLOGICAL STUDIES

### 1. Abortifacient and Antifertility Properties

- Anti-implantation and abortifacient effects: An aqueous extract at a dosage of 100 mg/kg showed these effects (Vohra et al., 1969) [6].
- Benzene extract of leaves: Demonstrated effectiveness in 80% of rats at the same dosage, while the petroleum ether extract was effective in only 60% of subjects but lacked early abortifacient activity (Batta and Santhakumari, 1971) [6].
- Pseudopregnancy in rats: Administering leaves to male and female albino rats led to pseudopregnancy, primarily due to the extract's effect on male rats (Saha and Kasinathan, 1965) [6].

### 2. Effects on Spermatogenesis and Male Fertility

- Histological and biochemical changes: Mice that consumed the leaves exhibited mild spermatogenesis impairment, lower seminal pH, decreased reducing substances, acid and alkaline phosphatases, and mucoproteins. Treated males were unable to fertilize females (Kasinathan et al., 1972) [6].
- Antispermatic properties: Administration of benzene leaf extract (100, 150, 200 mg/kg) led to reduced testicular weight and decreased sperm count and motility, with no significant changes in the epididymis, seminal vesicle, prostate, or vas deferens (Seth et al., 1981) [6].

### 3. Adaptogenic (Anti-Stress) Effects

- Stress-related ailments: The dried powder of *O. sanctum* mitigated stress-induced peptic ulcers and hyperacidity (Bhargava and Singh, 1981; Wagh, 1977; Seethalakshmi et al., 1982) [6].
- Prevention of milk-induced leukocytosis: Demonstrated non-specific protective effects against stress-induced biological changes [6].

### 4. Antituberculosis and Therapeutic Properties

- Antituberculosis properties: Documented by Gupta and Vishwanathan (1955) [6].
- Therapeutic effects: Mentioned by Gonopoti et al. (1964) [6].
- Germicidal and antiseptic characteristics: Noted by Nene et al. (1968) [6].

### 5. Antiasthmatic Effects

- Management of bronchial asthma: Claims of Tulasi leaves being effective in human bronchial asthma (Polit et al., 1983; Singh and Agarwal, 1991) [6].

### 6. Hepatitis and Liver Function

- Inclusion in Tefroli: A formulation for viral hepatitis treatment (Rajalakshmi et al., 1988) [6].
- Clearance of bilirubin: Tulasi was shown to help clear bilirubin from urine and positively influence S.G.P.T levels (Sankaran, 1980) [6].

### 7. Antibiotic and Anticancer Properties

- Therapeutic compounds: Known for antibiotic and anticancer properties (Mhaskar and Calus, 1931; George et al., 1947; Joshi and Magar, 1952; Matsushire and Nakada, 1955; Dhar et al., 1968; Hartwell, 1969) [6].

### 8. Stress Relief Research

-Indo-Soviet collaborative research: Validated stress-relieving properties of Tulasi (reported in Pafai journal, 1989). Joint research by Smolensk Medical Research Institute and Indian physicians highlighted the herb's ability to alleviate physiological stress and fatigue [6].

9. The Agar Well Diffusion Assay was used to determine the antimicrobial efficiency of *Ocimum sanctum* L. (Tulsi) gel against the Total Anaerobes. [15]

### **Clinical Studies**

#### 1. Clinical Investigation on Viral Encephalitis

- Superior survival rate: Aqueous extract of *O. sanctum* leaves demonstrated a higher survival rate in 16 patients with viral encephalitis compared to a control group of 10 patients receiving steroid treatment.

- Reduced neurological deficits: After one month, patients treated with the extract showed a notably lower occurrence of residual neurological deficits (Das et al., 1983) [6].

#### 2. Psychopharmacological Effects

- Effect on reflex loss: Ethanol extract of *O. sanctum* leaves extended the duration of reflex loss in mice induced by pentobarbital, while also reducing recovery time and the severity of convulsions caused by electroshock and pentylenetetrazole (Skina et al., 1990) [6].

- Reduction in fighting time and ambulation: The extract reduced fighting time and ambulation in open field tests following apomorphine administration [6].

- Behavioral despair model: In forced swimming tests in rats and mice, the extract significantly reduced immobility, similar to the effects of imipramine.

- This effect was inhibited by haloperidol and sulpiride, indicating a possible mechanism involving dopaminergic neurons [6].

- A synergistic effect was observed when the extract was combined with bromocriptine, a potent D2 receptor agonist [6].

### **Tulsi used as Traditional Indian Ayurvedic Medicine**

#### 1. Medicinal Properties

- Tulsi is recognized for its medicinal properties, particularly its ability to alleviate stress.

- Rich in essential oils and antioxidants, it helps mitigate the physiological impacts of stress (Organic India) [8].

#### 2. Healing Attributes

- Tulsi possesses a wide range of healing attributes and has been traditionally utilized by Hindus and Indians for its therapeutic benefits, now recognized by a broader audience [8].

#### 3. Adaptogenic Function

- As an adaptogen, Tulsi regulates various bodily processes and supports stress management.

- Its extracts are integral to both Ayurvedic and Unani medicinal systems [8].

#### 4. Treatment of Ailments

- Tulsi is used in Ayurvedic treatments for a wide range of ailments, including:

- Colds, headaches, gastrointestinal issues

- Inflammation, infections, cardiovascular diseases

- Poisoning, cataracts, and malaria [8].

#### 5. Nervous and Cardiac Health

- Tulsi positively affects the nervous system, improving its resilience.

- It also fortifies cardiac health [8].

#### 6. Digestive Benefits

- Tulsi acts as an appetite stimulant and aids digestion by promoting the secretion of digestive enzymes and reducing flatulence [8].

#### 7. Detoxifying Properties

- Known for its detoxifying properties, Tulsi helps purify the blood by eliminating toxins.

- It is believed to provide protection against radiation poisoning and may have anti-cancer properties [8].

- A common belief is that consuming a Tulsi leaf daily can protect against cancer [8].

#### 8. Longevity and Medicinal Use

- Often referred to as the "elixir of life" due to its contribution to longevity.

- Tulsi extracts are used to prevent and treat various ailments, including:

- Common colds, headaches, digestive disorders
- Inflammation, heart disease, poisoning, and malaria [8].

#### 9. Essential Oil Applications

- The essential oil from karpoora Tulsi is mainly used for medicinal purposes and recently in the production of herbal toiletries [8].

#### 10. Topical Applications

- Tulsi has been applied topically in Ayurvedic medicine for treating skin conditions like:

- Eczema, ringworm, insect bites
- It is also used to:
  - Alleviate fevers, enhance lung function
  - Improve digestion, mitigate cold symptoms, eliminate toxins
  - Prevent bacterial infections (MHRA, UK) [8].

### **Tulsi in Modern Medicine**

#### 1. Promising Therapeutic Option

- Recent studies suggest Tulsi may help treat ulcers, elevated cholesterol levels, Type 2 diabetes, obesity, and conditions linked to weakened immune systems such as cancer and AIDS [8].

#### 2. Anti-inflammatory and Antioxidant Properties

- Tulsi varieties contain essential oils with eugenol, an anti-inflammatory compound.

- They also possess acids that have antioxidant and anti-inflammatory properties, supporting Ayurvedic claims of its effectiveness in treating various ailments [8].

#### 3. Domestic Use and Cultivation

- Beyond its medicinal benefits, Tulsi is also a valuable culinary herb that enhances flavors and makes an excellent base for tea.
- It is visually appealing, safe for pets, and easy to cultivate as a houseplant or garden herb [8].

#### 4. Potential Benefits for Diabetes

- Researchers propose that Tulsi leaves may improve the functionality of pancreatic beta cells, enhancing insulin secretion.

- A small study revealed that participants with Type 2 diabetes who consumed 2.5 grams of powdered Tulsi had lower fasting blood glucose levels compared to a placebo group (diabeteshealth.com) [8].

#### 5. Drug Interactions and Caution for Diabetics

- While no major drug interactions with Tulsi have been documented, diabetics taking insulin or insulin secretagogues (e.g., glyburide, glipizide, Amaryl, Prandin, or Starlix) should consult their healthcare provider before using Tulsi supplements [8].

Tulsi's medicinal potential continues to be explored in modern medicine, showing promise for managing chronic conditions and supporting overall health.

### **Therapeutic Uses of *Ocimum sanctum***

Numerous papers discuss the utilization of natural resources, including honey, fungi, bacteria, yeast, and plants. Another well-known source for contemporary or herbal formulations is *Ocimum sanctum*. Numerous investigations (such as in-vitro and in-vivo) have been conducted about Tulsi's medicinal use. These published studies are displayed below:

**Analgesic:** The oil derived from the *Ocimum sanctum* plant has been shown to have analgesic properties. Mice were used in this investigation, and acetic acid-induced writhing, tail flick, tail clip, and tail immersion were used. The findings demonstrated that the oil's inhibitory action is caused by the combined inhibitory effects of prostaglandin, histamine, and acetylcholine [7].

**Antioxidant:** *O. sanctum*'s antioxidant activity was demonstrated in an experimental investigation using streptozocin-induced diabetic mice. According to reports, the hydroalcoholic extract found in this plant's leaves is what gives it its antioxidant qualities. When streptozocin-induced diabetic rats were given *O. sanctum* leaves for 30 days, it was shown that the antioxidant enzyme catalase was more active and that the plasma level of thiobarbituric acid in the liver and kidneys was lower [20].

**Anti-ulcer:** The *O. sanctum* plant has been shown to exhibit antiulcer properties against histamine, aspirin, reserpine, serotonin, aspirin, and indomethacin in rats. The aqueous extract of *O. sanctum* was found to protect against ethanol-induced stomach ulcers in an experiment conducted on Wistar rats [7].

**Anti-arthritis:** The oil produced from *O. sanctum* seeds has anti-arthritis effect against turpentine oil-induced joint pain, according to an experiment done in a mouse model to determine its anti-arthritis activity [7].

**Anti-pyretic activity:** The oil derived from the plant was shown to have antipyretic properties when tested against pyrexia in rats generated by the typhoid-paratyphoid A/B vaccine [7].

**Antitussive:** When tested on guinea pigs, the *OS* plant's aqueous and methanolic extracts were found to have antitussive properties [7].

**Hepatoprotective:** When tested against albino rats' liver damage caused by paracetamol, it was shown that the plant's leaf extract, *O. sanctum*, had strong hepatoprotective properties [17].

**Anti-stress:** Research on rabbits revealed that *O. sanctum* leaves have anti-stress properties [7].

**Memory Enhancer:** Rats were used to test the antimentia and anticholinesterase properties of an alcoholic and aqueous extract of *O. sanctum* leaves. Dementia was triggered by electroshock, cyclosporine, and atropine. According to reports, memory was evaluated using the inactive restriction [7].

**Immunomodulatory:** When examined in mice, *O. sanctum* leaves were found to enhance the synthesis of red blood cells, white blood cells, hemoglobin, and antibodies without influencing other biochemical processes [7].

**Chemopreventive:** According to multiple investigations, oil derived from *O. sanctum* seeds exhibited chemopreventive efficacy against Swiss albino mice's fibrosarcoma tumors caused by subcutaneous injections of 20 methylcholanthrene. Swiss albino mice were given injections of methylcholanthrene, which caused fibrosarcoma tumors. It was discovered that mice treated with seed oil had a higher survival rate and a slower rate of tumor spread, demonstrating its chemopreventive properties [7].

**Antidepressant and Antianxiety:** Swiss mice were used to evaluate the ethanolic extract of *O. sanctum* for its antidepressant and antianxiety properties. It was discovered that the plant extract has antidepressant and antianxiety qualities and can be used as a medication to treat these conditions [7].

**Antiemetic:** Tulsi leaves are said to have antiemetic qualities and are used to treat diarrhea and vomiting [7].

**Anti-fertility:** It has been reported that tulsi leaves contain antifertility properties. Albino rats were used in the experiment, and the model was given a tulsi leaf benzene extract for 48 days. Sperm motility and count decreased, according to the results [7].

**Anti-inflammatory:** The fatty acids found in tulsi plants have anti-inflammatory properties. Because it can block the cyclo-oxygenase and lipoxygenase pathways, linoleic acid is the primary fatty acid that has anti-inflammatory properties [19].

**Antithyroidic:** When examined in male mice, it was found that tulsi leaf extract has antithyroid properties that alter the concentration of T3, T4, and T4 [7].

**Antihelminthic:** The in vitro investigation demonstrated that the essential oil and eugenol content of tulsi leaves have antihelminthic qualities. In the model of *Caenorhabditis* [7].

**Antihyperlipidemic and Cardio-protective:** When tested in high-fat (HF) rats, the published study demonstrated that fixed oil of *OS* has cardioprotective and antiatherogenic effects against hyperlipidemia in addition to lowering high serum lipid concentrations [7].

**Antifungal:** Linalool and methyl chavicol, which were derived from the essential oil of tulsi leaves, were found to have antifungal properties against clinically isolated dermatophytes [16].

**Snake and Insect Bites:** Tulsi oil is a natural antiseptic and anti-inflammatory, according to Plantcultures.org. Botanical.com states that when all portions of the plant are consumed or combined with other plants to create a paste that is applied to the bite site, tulsi can effectively treat snake bites, particularly those caused by dangerous snakes. Because insects dislike the smell, people from the Asian subcontinent frequently add tulsi leaves to bath water and bowls of water outside their homes to keep them away [8].

**Antibacterial Activity:** The antibacterial properties of the oil, alcoholic, chloroform, and aqueous extracts made from *Ocimum sanctum* leaves were investigated against *S. aureus*, *P. aeruginosa*, *S. typhimurium*, and *E. coli*. *Ocimum sanctum* extract was found to be equally effective against harmful gram-positive and gram-negative bacteria [18].

**Anticoagulant Activity:** The anticoagulant properties of *Ocimum sanctum* fixed oil (3 ml/kg, ip) were investigated. The response was similar to that obtained with aspirin (100 mg/kg), and a longer blood clotting time was noted. The impact seems to be caused by oil's ability to prevent platelets from aggregating [9].

**Anti-plasmodial Activity:** In a 2012 study of three distinct *Ocimum* species, Inbaneson et al. found that *Ocimum sanctum* leaf, root, stem, and flower extracts had outstanding anti-plasmodial activity. Alkaloids, glycosides, flavonoids, phenols, saponins, triterpenoids, proteins, resins, steroids, and tannins may be the cause of the in vitro anti-plasmodial action in the ethanolic extracts of the plants under examination [9].

**Toxicant Stress:** Radiation, heavy metals, and chemicals are examples of toxic stressors. Experimental research has demonstrated that Tulsi can stop the harmful effects of toxins that harm cells, the immune system, and genes. Tulsi guards against the harmful effects of radiation as well as a variety of pharmaceutical medications, heavy metals, and industrial pollutants. Holy basil reduces oxidative cellular and chromosomal damage exacerbated by radiation and eliminates free radicals. In experimental animals, post-radiation survival will rise and organ damage will decrease [10].

**Physical stress:** the harmful effects of radiation and chemicals cause physical stress. excessive noise, exertion, excessive cold, and stress on the body and metabolism are all examples. Tulsi increases aerobic metabolism, reduces damaging oxidative stress, and maintains the physiological and biochemical parameters that are impacted by physical stress, among other effects. According to earlier research, oxidative stress can harm cells and tissues [10].

**Antidiabetic Activity:** *O. Sanctum* Linn's ethanolic extract reduced blood glucose, glycosylated hemoglobin, and urea in streptozotocin-induced diabetic mice while simultaneously increasing glycogen, hemoglobin, and protein. The extracted bioactive molecule is identified as a tetracyclic triterpenoid by means of a thorough spectroscopic data analysis. The antidiabetic properties of many *Ocimum* species were investigated and contrasted [10].

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## CONCLUSION

Tulsi is known as the "Elixir of Life" due to its numerous pharmaceutical and nutraceutical properties, which include the ability to treat a wide range of illnesses when taken whole or in its constituent components, particularly its leaves [3]. It is mostly used as a herbal tea and for medical purposes. Greek, Roman, Sidha, Ayurvedic, and Unani medical systems all employ it [7]. Without a doubt, this small plant is a great source of healing qualities. It has been shown and confirmed that it is safe to eat tulsi in any building following extensive and comprehensive research. Modern science has widely recognized and respected all of these therapeutic benefits. In the current shallow and unsatisfactory way of life, tulsi is the plant that cures humanity of all chances. It is regarded as the herb of India's supremacy [8]. Hindu mythology states that Tulsi is the most sacred plant that may improve health and cure illnesses. It is considered to be one of the 14 "Ratnas (gems or treasures)" that come from the ocean. Because of its unparalleled qualities, tulsi is referred to as the Queen of Herbs. It is used as a home treatment for a number of ailments in Ayurveda [9]. This particular plant is unique due to its nutritional, spiritual, and therapeutic qualities. The primary phytoconstituents that give Tulsi its pharmacological effects are ursolic acid and eugenol. be a result, Tulsi is referred to be the mother of natural medicine and The Incomparable One [10]. In addition to lowering the chance of developing resistance to important antibiotics, early treatment or preventative measures may stop the progression of an infection that would otherwise require systematic antibiotic therapy [11].

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