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Multiple health benefits of Tulsi plants

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Abstract

Ayurveda's focus on healthy lifestyle practices and the regular consumption of adaptogenic herbs can address many of the major causes of global morbidity and mortality. Ayurvedic practitioners highly regard tulsi (*Ocimum sanctum* Linn), and scientific research has confirmed its benefits. With its unique combination of pharmacological actions, tulsi has demonstrated its ability to address physical, chemical, metabolic, and psychological stress. There is evidence that tulsi protects organs and tissues against chemical and physical stress resulting from prolonged physical exertion, ischemia, physical restraint, excessive noise, and cold exposure. In addition to its beneficial effects on memory and cognitive functions as well as its anxiolytic and antidepressant properties, tulsi can counter metabolic stress, lowering blood glucose, blood pressure, and oxidized cholesterol levels. Due to its broad-spectrum antimicrobial activity, including activity against human and animal pathogens, tulsi can be used in treating wounds, animal rearing, preserving food and herbal raw materials, and traveller's health as well as hand sanitizers, mouthwashes and water purifiers. Plants grown for tulsi have spiritual significance and practical value, allowing growers to tap into nature's creative powers. Organic cultivation enables farmers to address food security issues, rural poverty, hunger and environmental degradation. Using ancient knowledge, tulsi is considered a symbol of wisdom in Ayurvedic medicine. Additionally, the Tulsi plant's roots, stem, fruit, and leaves have several phytochemical constituents that impart different therapeutic properties. Eugenol, vallinin, gallic acid, palmitic acid, oleic acid, and linoleic acid are some of these constituents. Many diseases can be treated with these phytochemicals extracted from plants. Tulsi is reported to have anti-ulcer, antioxidant, anti-inflammatory, anti-cancer, anti-diabetic, anti-arthritis, analgesic, anti-stress, anti-asthmatic, antifertility, Immunomodulation, and neuroprotective properties.

Keywords: Tulsi, *Ocimum sanctum* Linn, ayurveda, immunomodulation, antioxidant, anti-inflammatory, anti-cancer

1. Introduction

Tulsi (*Ocimum sanctum* L.), widely referred to as holy basil in English and Tulasi in Sanskrit, is an enormously popular culinary and therapeutic plant from the Lamiaceae family that is native to the Indian subcontinent and has been employed in Ayurvedic medicine for over three thousand years. Tulsi is widely referred to as a "Solution of Life" in the Ayurvedic tradition for its healing properties and has been used to treat a variety of common health issues. Tulsi leaf separates are shown as treatments for bronchitis, illness, and pyrexia in the Indian Materia Medica. In India, it is regarded to be a ubiquitous plant. In India, it is thought of as a ubiquitous plant. A member of the Lamiaceae family, it is a fragrant plant. With fuzzy stems and basic, inverted green, strongly scented leaves, it is an upright, greatly stretched sub-shrub that is between 30 and 60 cm tall. In our everyday lives, tulsi plays an important role and is revered as the ruler of all living things. It is the most well-known family plant in India, and Hindu tradition holds great reverence for it. The significance, qualities, and applications of tulsi are explained in numerous Hindu stories. The erect, fragrant tulsi shrub can grow to a height of three to five feet. It typically grows on the edges of sanctuaries and in gardens. It has a flavourful aroma and a powerful taste. It is the only plant with this astoundingly long carbon dioxide retention capacity. It releases oxygen in the morning, which is beneficial for people with respiratory illnesses.

Due to its intricate restorative benefits, the tulsi plant is extremely important to humanity. There is the widespread use of tulsi leaves in the preparation of Ayurvedic medications. It is well known that it lengthens life expectancy. Extractions from the plant are frequently used to treat a variety of ailments, including the common cold, itchiness, intestinal illness, coronary illness, migraines, stomach problems, kidney stones, heart problems, and more. Tulsi, Indian basil, also aids in cleaning up the environment.

The Tulsi plant serves as an excellent insect repellent for dealing with flies, mosquitoes, and other creepy crawlies (Warrier 1995) ^[69]. It is crucial in the fight against malarial fever. It is said that at the time of the establishment of the Victoria farms in Bombay (now Mumbai), the workers developed an unending case of jungle fever and became survivors of mosquito bites. Some of the Hindu managers proposed growing Tulsi plants at the nursery after observing the workers' plight. Their advice was followed, and positive results were obtained.

Due to its numerous medical characteristics, it has contributed significantly to science both from ancient times and in modern studies. According to descriptions, tulsi comes in two varieties: Vanya (wild) and gramya (grown in homes). The former has darker leaves despite having the same usage. Tulsi is a well-known natural treatment for a wide range of illnesses, including wounds, bronchitis, liver conditions, catarrhal fever, otalgia, lumbago, hiccough, ophthalmia, stomach disorders, genitourinary disorders, skin diseases, diverse drug overdoses, psychosomatic stress disorders. Furthermore, it exhibits traits that are aromatic, stomachic, carminative, demulcent, diaphoretic, diuretic, expectorant, alexiteric, vermifuge, and febrifuge.

2. Botanical classification of *Ocimum sanctum*

Table 1: scientific classification of tulsi plant

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

3. Plant type and morphology

Ocimum sanctum belongs to the family Lamiaceae/Labiates. Tulsi is an erect, branched, fragrant plant with a height that reaches up to 30-60cm when completely mature. The leaves of Tulsi are simple, inverse, elliptical, ovoid, dense, or acute with a full margin. The leaves grow up to 5cm long. It has a small phyllotaxy and the petiole is 2-5 cm long, slender and pubescent. The leaves of the plant mainly possess medicinal properties. They are also pubescent on both sides with tiny glands. The stomata are normally found on the lower surface of the leaf but are rarely found on the upper surface. A verticillaster inflorescence with varying colours can be found on this plant. Simple or branched flowers can reach a height of 5- 30 cm. T Sessile, ovate, caduceus, hermaphrodite, and with a pedicel that is 1-4 mm long and spreading or slightly curved, the bracts are sessile, ovate, and caduceus. The flowering process began after 136 days and continued for 195 days. The seeds matured after 259 days. Contains 4 seeds covered by the persistent calyx; the outer pericarp does not turn into mucilaginous in water, long up to 1.5mm, brown, with a rugose outer surface. It produces black seeds. The stem is green in newly born plants and becomes woody when ageing (Sembulingam K *et al.*, 1997; Warrier PK *et al.*, 1995; Kothari SK *et al.*, 2005; Godhwani S *et al.*, 1988) ^[61, 72, 38, 20]. In figure 1, you can see the roots of the *Ocimum sanctum*, which contain essential oils such as Eugenol.



Source: <https://images.app.goo.gl/MktiPbfP5rRGpXkM7>

Fig 1: (*Ocimum sanctum* Linn)

4. Geographical description

O. sanctum is reported across the whole of Asia's tropical and subtropical regions. The plant is native to India, including the Himalayas, Malaysia, the Caribbean, the Pacific, and parts of Africa. It is grown in almost every state in India (Rana L *et al.*, 2020) ^[55]. It is found near holy sites and places of worship due to certain holy beliefs. There is currently no information available on specific habitats where the species has been found naturally (Awogbindin IO *et al.*, 2014) ^[7].

5. Phytochemical constituents of tulsi plants

Ocimum sanctum leaves were a rich source of volatile oil, containing 71% eugenol and 20% methyl eugenol. Carvacrol and sesquiterpene hydrocarbon caryophyllene are also present in the volatile oil. Other chemical components include phenolics, flavonoids, terpenoids, and fatty acids. The plant's seeds are high in a fixed oil (18-22%), polysaccharides, mucilage, and sitosterol. Linoleic acid is thought to be the primary component of seed oil. (Naji-Tabasi S *et al.*, 2017) ^[47]. The following chemicals are also present:

5.1 Phenolics

The phenolic content of the OS plant contains chlorogenic acid, vanillic acid, *Ocimum naphthanoic* acid, caffeic acid, and methyl salicylic glucoside, which are extracted from the plant's aerial parts (Skaltsa H *et al.*, 1999) ^[68]. The presence of gallic acid ethyl ester, protocatechuic acid, 4-hydroxybenzoic acid, gallic acid methyl ester, vanillin, and 4-hydroxybenzaldehyde was confirmed by HPLC (Nörr H *et al.*, 1992; Ahmad A *et al.*, 2012) ^[3, 50].

5.2 Flavonoids

Flavonoids are the important components of the OS plant, which include methoxy flavonoids and their glycosides (circimartin, isothymusin, luteolin), Cglycosides flavonoids (vicenin, isovitexin, isoorientin, and orientin), and orientin (Kelm MA, *et al.*, 2000) ^[33]. Circumaritin, crisilineol, isothymusin, gardening, apigenin, eupatorium, and salvigenin are among the other flavones identified using atmospheric pressure chemical ionisation mass spectrometry (APCI-MS). (Grayer RJ *et al.*, 2001) ^[21].

5.3 Neolignans

The methanolic extracts of the OS plant contain Neolignans constituents such as Tulsinol A to Tulsinol G, which are formed through the polymerization of eugenol content (Suzuki A *et al.*, 2009) ^[70].

5.4 Coumarins

Aeculetin, aesculin, and ocimarin are three coumarin

components extracted from the tulsi plant (Singh D *et al.*, 2014)^[64].

5.5 Steroids

The steroid components extracted from the stem and leaves of OS are β -sitosterol, β -sitosterol-3-O β -Dglucopyranoside, stigmasterol and campesterol. (Gupta P *et al.*, 2007)^[23].

5.6 Essential oil

The essential oil extracted from the leaves of the OS plant is primarily made up of terpenoids, such as phenolic acid, esters, aliphatic aldehydes, bicyclic terpenoids, acyclic monoterpenoids, and sesquiterpenoids. The chemical composition varies by region based on cultivation, harvesting, and climatic conditions. The main phytochemicals found in essential oils are eugenol or methyl eugenol and methyl chavicol, which have antimicrobial and anthelmintic properties (Joshi S *et al.*, 2013)^[26]. Other constituents of the essential oil include caryophyllene, caryophyllene oxide, and germacrene D. (Saharkhiz MJ *et al.*, 2015)^[59].

6. Medicinal uses

Holy basil, also known as tulsi (*OS* Linn), has been utilised around the world to heal a variety of diseases (Dhandayuthapani S *et al.*, 2015)^[18]. In Southeast Asia, plants are used extensively in several traditional and folk medical systems. Tulsi extracts and a heated combination cleanse, purify, and detoxify the body on the inside as well as the outside. Slurry made from finely minced leaves is beneficial for the skin and can be used topically. Additionally, it is used to treat ringworm and other skin conditions as well as itching. Its leaf extract, fresh green leaves, uncooked, powdered, paste, and herbal supplements are all used to make teas.

Due to its ability to prolong life, tulsi is frequently referred to as "the elixir of life." As an antidote for snake bites and scorpion stings, flatulence, migraine headaches, fatigue, skin conditions, wounds, insomnia, arthritis, digestive disorders, night blindness, diarrhoea, and influenza, various plant parts are utilised in the Ayurvedic and Siddha Systems of Medicine for the prevention and treatment of numerous diseases and common ailments. These include the common cold, headache, cough, flu, earache, fever, colic pain, sore throat, bronchitis, and asthma the leaves help to calm the nerves and improve memory. Tulsi leaf chewing also treats oral infections and ulcers (Prajapati ND *et al.*, 2003)^[53].

Asthma and chronic bronchitis are effectively treated with tulsi tea, also known as kara. It reduces stress, helps the body heal, and boosts digestion and immunity. Numerous phytonutrients, EO, and vitamins A and C are found in plant leaves. Tulsi leaf eating regularly can help to balance numerous body functions. It reduces excessive blood sugar and is extremely helpful for people with diabetes, cancer, and chronic bronchitis. It assists in controlling the body's uric acid levels, reducing the likelihood of producing kidney stones.

Basil has stomachic, carminative, galactagogue, antispasmodic, and appetiser properties. It is used to treat nausea, vomiting, intestinal catarrh, constipation, and enteritis in addition to stomach pains. It had occasionally been used as an antispasmodic for whooping cough. Tulsi lowers blood sugar levels and has antioxidant effects. Thus, diabetics can benefit from it (Chatterjee *et al.*, 2001)^[14]. Total cholesterol levels are decreased by tulsi. For those struggling with heart problems, it is helpful (Claus *et al.*, 2003)^[16]. Blood pressure is lowered with tulsi.

7. Pharmaceutical activity

Contains a variety of phytochemicals with a range of biological and pharmacological properties, according to *OS* Linn (Bhattacharyya P *et al.*, 2013)^[13]. Following are a few crucial pharmacological activities:

7.1. Anticancer activity

The tulsi plant has been proven to be very useful in preventing and treating cancer because it has both chemo preventive and radio protective properties (Baliga MS *et al.*, 2013)^[8]. *OS* is a nutritional plant famous for its many advantageous pharmacologic qualities, including its anti-cancer potential (Nangia-Makker P *et al.*, 2013)^[48]. Plants have anti-cancer properties and can be utilised to treat and prevent human cancer. *OS* L. or *OT* L. contains phytochemicals like eugenol, rosmarinic acid, apigenin, retinal, luteolin, -sitosterol, and carnosic acid to mediate these effects by increasing antioxidant activity, altering gene expression, inducing apoptosis, and inhibiting angiogenesis and metastasis in chemically induced skin, liver, oral, and lung cancers (Baliga MS *et al.*, 2013)^[9]. It has been demonstrated that Tulsi's aqueous extract and its bio-organic components, flavonoids, orintin, and vicenin, shield mice against radiation illness and lower mortality. It shields the healthy tissues only from the radiation's tumour-improving effects. It has also been demonstrated that several significant phytochemicals, including eugenol, rosmarinic acid, apigenin, and carnosic acid, protect DNA against radiation-induced damage (Baliga MS *et al.*, 2013)^[10].

7.2 Antioxidant activity

Ocimum basilicum var. *Purpurascens*, *Ocimum basilicum*, *OG*, *Ocimum micranthum*, and *OT* (*syn. OS*) leaves displayed a range in the yield of EOs and chemical constituent types (Trevisan MT *et al.*, 2006)^[71]. Additionally, these chemotypes' differences reveal a varied potential for antioxidants and free radical scavenging (Trevisan MT *et al.*, 2006)^[71]. In contrast to the strong negative association ($r = 0.77$, $p > 0.1$) with other major volatiles, antioxidant capacity was favourably linked ($r = 0.92$, $P 0.05$) with a large percentage of molecules bearing a phenolic ring, such as eugenol (Trevisan MT *et al.*, 2006)^[71]. Eugenol and methyl eugenol are two key elements of the propanoid chemicals found in *OS* L. leaves, which lower serum lipid profiles in both healthy and diabetic rats. Additionally, it exhibits anti-oxidative and anti-hyperlipidaemia effects against hypercholesterolemia (Suanarunsawat T *et al.*, 2010)^[69]. With no discernible impact on the high serum levels of aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase in rats fed with an HC diet, tulsi EO reduced the high serum lipid profile, atherogenic index, lactate dehydrogenase, and creatine kinase MB component. Additionally, it was discovered that EO reduced high levels of thiobarbituric acid reactive substances (TBARS), glutathione peroxidase (GPx), and superoxide dismutase (SOD) in the cardiac tissue without having an impact on catalase (CAT), while it reduced high levels of TBARS in the liver without having a significant impact on GPx, SOD, and CAT (Suanarunsawat T *et al.*, 2010)^[69]. Thai herb *Ocimum canum* exhibits anti-tyrosinase and antioxidant activity (Saeio K *et al.*, 2011)^[58].

7.3 Antidiabetic activity

OT or *OS* L. displays an anti-diabetic (Khan V *et al.*, 2012; Kamyab AA *et al.*, 2013)^[35, 29]. Blood glucose levels in

induced hyperglycemic tilapia (*Oreochromis niloticus*) are reduced by OT aqueous extract (Arenal A *et al.*, 2012) ^[5]. Due to their ability to suppress glucose hydrolyzing enzymes, both floral and leafy sections of plants can be employed in alternative nutritional therapy, particularly for the management of diabetes (Mahomoodally MF *et al.*, 2012) ^[41]. Tetracyclic triterpenoids ([16-hydroxy-4, 4, 10, 13-tetramethyl-17-(4-methyl-pentyl)-hexadecahydrocyclopenta[a]phenanthren-3-one] isolated from aerial portions of OS) have been shown to have comparable anti-diabetic effect (Patil RS *et al.*, 2012) ^[52]. When compared to untreated diabetic rats, the aerial portion of OS test substances dramatically lowers elevated levels of serum glucose and also causes to reverse the values of cholesterol, triglycerides, low-density lipoprotein (HDL), and high-density lipoprotein (LDL) (Patil RS *et al.*, 2012) ^[52]. The status of the antioxidant enzymes catalase, SOD, and GPx in crucial organs like the liver and kidney was improved by the administration of OS to streptozocin-induced diabetic rats for 30 days (Muralikrishnan G *et al.*, 2012) ^[46]. OS acts in both hypoglycemic and hyperglycemic action, restoring glucose levels, and is utilised in the treatment of metabolic diseases associated with diabetes (Narendhirakannan RT *et al.*, 2005) ^[49]. (Grover JK *et al.*, 2002) ^[22]. OT (L.) has shown the ability to inhibit both glucosidase and the inhibitory effect of amylase (Bhat M *et al.*, 2011) ^[12]. For one month, normal and diabetic rats were given tulsi leaf powder at a concentration of 1%, which significantly reduced fasting blood sugar, uronic acid, total amino acids, total cholesterol, triglycerides, phospholipids, and total lipids. Total cholesterol, triglycerides, and total lipids were all dramatically reduced in the liver. The kidney showed a marked reduction in total lipids. Total cholesterol and phospholipids were found to have significantly decreased in the heart. Animals treated with Tulasi leaf powder exhibit reduced blood sugar and cholesterol levels.

7.4 Antimicrobial activity

Unripe OT fruit extract from the Lamiaceae family was discovered to be extremely efficient against a resistant strain of *Staphylococcus aureus* (Mahomoodally MF *et al.*, 2010) ^[42]. Its leaf extract has potent antibacterial properties against drug-resistant *S. enterica serovar Typhi* when combined with chloramphenicol (C) and trimethoprim (Tm) (*S. typhi*). When combined with C and Tm, EET, OS, and leaf TLE demonstrated synergistic efficacy for *S. typhi* isolates (Mandal S *et al.*, 2012) ^[45]. The active ingredient discovered in OS L., eugol (1-hydroxy-2-methoxy-4-allylbenzene), is substantially responsible for the antibacterial therapeutic potential of tulsi (Prakash P *et al.*, 2005) ^[55]. Tulsi (OS) extract was found to be active against *Streptococcus mutans*, whereas elevated levels (6.25-25 mg/ml) were obtained against the multi-drug resistant isolates of *Klebsiella pneumonia* and *Escherichia Coli*. Solvents and water extracts of Tulsi have shown antibacterial activity against multi-drug resistant *S. aureus* (Dahiya P *et al.*, 2012) ^[17]. (Agarwal P *et al.*, 2010) ^[1]. Along with TEO Tulsi (OS Linn.) oils, eugenol, methyl eugenol, linalool, and 1, 8-cineole exhibited remarkable cytotoxicity to *Candida* species (Khan A *et al.*, 2010) ^[34].

7.5 Immunomodulation

Consumption of Tulsi leaf (OS Linn.) on empty stomach increases immunity (Mondal S *et al.*, 2011) ^[45]. Its alcoholic leaf extract shows an Immunomodulation effect (Mondal S *et*

al., 2011) ^[45]. Tulsi is used for immune-based therapies mainly for treating diseases, control of ecto-and endo-parasites, fertility enhancement, bone setting, and poor mothering management. It also shows immune-modulatory effects such as modulation of cytokine secretion, histamine release, immunoglobulin secretion, class switching, cellular co-receptor expression, lymphocyte expression, and phagocytosis (Mahima *et al.*, 2012) ^[40]. Tulsi leaf extract (DTLE) is protective against genotoxicants (Dutta D *et al.*, 2007) ^[19].

7.6 Anti-inflammatory

Seeds of OS contain oil that possesses anti-inflammatory activity due to dual inhibition of arachidonate metabolism supplemented by antihistaminic activity (Singh S *et al.*, 2007) ^[65]. The seed oil also possesses antipyretic activity due to prostaglandin inhibition and peripherally acting analgesic activity. It also shows hypotensive, anticoagulant and Immunomodulation activities. Lipoxygenase inhibitory, histamine antagonistic and ant secretory activities of the oil contribute toward antiulcer activity (Singh S *et al.*, 2007) ^[66]. Methanolic extract of OS (Tulsi) leaves showed an anti-inflammation effect in isoproterenol (ISP) induced MI in rats (Kavitha S *et al.*, 2015) ^[32]. Tulsi leaf (OS Linn.) consumption on an empty stomach boosts immunity (Mondal S *et al.*, 2011) ^[45]. An Immunomodulation action is demonstrated by its alcoholic leaf extract (Mondal S *et al.*, 2011) ^[45]. Tulsi is mostly employed in immune-based therapy for the management of poor mothering, ecto- and endo-parasite control, fertility improvement, and bone setting. Furthermore, it exhibits immune-modulating properties, including changes in cytokine secretion, histamine release, immunoglobulin secretion, class switching, cellular co-receptor expression, lymphocyte expression, and phagocytosis (Mahima *et al.*, 2012) ^[40]. The DTLE from tulsi leaves protects against genotoxicants (Dutta D *et al.*, 2007) ^[19].

7.7 Anti-stress activity

Fresh leaves of OS reduced oxidative stress, which resulted in a smaller loss of plasma SOD (23.14%) and reduced glutathione (28.80%) in rabbits treated with OS. The antioxidant properties of OS contribute to its anti-stress action (Jyoti S *et al.*, 2007) ^[28].

7.8 Hepatopancreatic activity

According to (Lahon K *et al.*, 2011) ^[39], the OS alcoholic leaf extract has considerable hepato protective efficacy and synergism with silymarin. By boosting glutathione peroxidase and catalase levels in the liver, EO and OS extracts could reduce oxidative stress and hepatic steatosis (Gupta SK *et al.*, 2002; Lahon K *et al.*, 2011) ^[24,39]. Eugenol, carvacrol, ursolic acid (UA), -caryophyllene, and rosmarinic acid, some of its principal biochemically active ingredients, demonstrated anti-inflammatory, gastrointestinal, and hepato protective activities (Kamyab AA *et al.*, 2013) ^[30] OS L. Due to a dual suppression of arachidonate metabolism and the addition of antihistaminic action, the oil has anti-inflammatory properties. Due to prostaglandin inhibition and analgesic activity that acts peripherally, the oil has antipyretic properties. Animal studies have shown that the oil is beneficial in preventing joint swelling and arthritis caused by turpentine oil and formaldehyde adjuvants (Singh S *et al.*, 2007) ^[65].

7.9 Analgesic

Analgesic OS L. or OT L (Baliga MS *et al.*, 2013) ^[10]. Due to

a dual suppression of arachidonate metabolism and the addition of antihistaminic action, the oil has anti-inflammatory properties (Singh S *et al.*, 2007) ^[65]. The active ingredient discovered in OS L., eugol (1-hydroxy-2-methoxy-4-allylbenzene), is substantially responsible for the medicinal potentials of tulsi (Prakash P *et al.*, 2005) ^[55]. Mice have analgesic efficacy when exposed to the alcoholic leaf extract of OS. OS exerts its analgesic effects both centrally and peripherally, interacting with several neurotransmitter systems in the process (Khanna N *et al.*, 2003) ^[36].

7.10 Anti-arthritis

Animal studies have shown that OS Linn. oil is efficient in preventing joint swelling and arthritis caused by turpentine oil and formaldehyde adjuvants (Singh S *et al.*, 2007) ^[65]. In addition, it is utilised to treat arthritis and skin conditions (Prakash P *et al.*, 2005) ^[55].

7.11 Radio protective effect

At harmless amounts, OS Linnwater-soluble's organic components flavonoids, orientin, and vicenin shield experimental animals from radiation illness and mortality (Baliga MS *et al.*, 2016) ^[9].

7.12 Anthelmintic activity: The *Caenorhabditis elegans* model indicated that the OS and eugenol EO tested had strong anthelmintic efficacy. According to Agrawal P *et al.* (1996), ^[2] eugenol might have an ED of 62.1 microg / ml. The primary component of EO, eugenol, is postulated as the probable anthelmintic principle (OS). (Asha MK *et al.*, 2001) ^[6]. Moreover, the leaf has anthelmintic properties against gastrointestinal nematodes in ovines (Kanojiya D *et al.*, 2015) ^[31].

7.13 Antiaging effect

Oleanolic acid (OA) and uracil (UA) are two primary components of tulsi OS Linn., and they are accountable for many of the plant's healing properties. For the quick detection of UA, OA, and their oxidation byproducts in Tulsi leaves, methods have been devised. These acids aid in reducing cell division and proliferation (Sarkar D *et al.*, 2012) ^[60].

7.14 Larvicidal activity

Ocimum americanum, *O. basilicum*, *O. basilicum* fa. *Citratum*. OG and OT extracts have larvicidal and repellent properties against mosquitoes (Chokechajaroenporn O *et al.*, 1994) ^[15]. Both actions were visible in all the oils. While OG showed the longest duration of action for its mosquito repellent effect, *O. Basilicum* demonstrated the greatest larvicidal activity (EC (50) = 81, EC (90) = 113 ppm) (more than 2 h). Known insect repellents found in tulsi plants include camphor, caryophyllene oxide, cineole, methyleugenol, limonene, myrcene, and thymol (Chokechajaroenporn O *et al.*, 1994) ^[15]. *O. canum* and OS leaf ethyl acetate extracts were reported to be larvicidal against fourth instar larvae of the Japanese encephalitis vector, *Culex tritaeniorhynchus* Giles, and the malaria vector, *Anopheles subpictus* Grassi (Diptera: Culicidae). *Aedes aegypti* and *Culex quinquefasciatus* fourth instar larvae were tested using leaf and flower extracts of OS in acetone, chloroform, ethyl acetate, hexane, and methanol. The leaf extract of OS was shown to have the highest larval mortality rates when tested on *Aedes aegypti* and *C. quinquefasciatus* larvae.

7.15 Antifertility activity

Fresh OS leaf benzene extract reduced total sperm count, sperm motility, and testis weight in male rats (Seth SD *et al.*, 1981) ^[62]. Adult male and female albino rats were fed OS leaves for a prolonged period (up to 3 months) combined with a normal diet, which resulted in decreased sperm count, sperm motility, and weight of the male reproductive organs (Khanna S *et al.*, 1986) ^[37].

7.16 Memory enhancer activity

Mice's ageing-induced memory impairments and the amnesic impact of scopolamine (0.4 mg / kg) were both lessened by the AIE of the dried entire plant of OS. The exteroceptive behavioural model used was called the passive avoidance paradigm. Step-down latency (SDL) and acetyl cholinesterase inhibition were dramatically increased by OS extract. To treat cognitive diseases like dementia and Alzheimer's disease, OS can be used (Joshi H *et al.*, 2006) ^[27].

7.17 Anti-cataract activity

In experimental models of cataracts (galactosemic cataract in rats by 30% galactose and naphthalene cataract in rabbits by 1 g/kg naphthalene), the AqE of fresh leaves of OS delayed the progress of cataract genesis. Significantly delaying the onset and subsequent maturation of cataracts in both models was achieved with OS 1 and 2 g / kg (Gupta SK *et al.*, 2002) ^[24].

8. Tulsi in traditional Indian Ayurvedic medicine

A medicinal plant from ancient times, tulsi (*Ocimum sanctum*) is widely known for its health benefits. Literature indicates that plants have been used medicinally since 4000-5000 BC. Chinese herbalists were the first to prepare medicines based on natural herbs. The Tulsi plant was used in India to make medicine between 3500-1600 BC. Ancient physicians studied and recorded the therapeutic uses (Sirkar NN, 1989) ^[67]. There are religious beliefs associated with the plant worldwide, especially in India. The Bible does not mention basil (Simon JE *et al.*, 1990) ^[63], but Meyers M. *et al.* (2003) ^[44] say the plant grew at Christ's crucifixion site. There is a great deal of sanctification associated with it in Hindu folklore. Having been raised from her embers, the plant is a manifestation of the divine goddess. In addition to promoting longevity, Tulsi is often referred to as "the elixir of life." There are many benefits associated with its use. Ayurveda and Siddha prescribe it as a therapy. It is one of the oldest herbs known to humanity, used for treating a variety of ailments, including colds, headaches, coughs, cases of flu, earaches, fever, colic pain, sore throats, asthma, hepatic diseases, malaria fever, wound insomnia, arthritis, digestive disorders, and night blindness. The intake of the leaves of Tulsi recovers lesions and acts as a memory enhancer (Prajapati ND *et al.*, 2003; Pandey G *et al.*, 2010) ^[53, 51].

9. Tulsi in future medicine

Tulsi may be a useful treatment for ailments like ulcers, high cholesterol, Type 2 diabetes, obesity, and weakened / suppressed immune systems, according to research in contemporary medicine (from conditions like cancers and AIDS). According to Plant Cultures, the traditional uses of Tulsi in Ayurveda may be attributable to some inherent qualities in many varieties of Tulsi, such as essential oils containing the anti-inflammatory compound eugenol and various acids with antioxidant and anti-inflammatory properties that could support the claims of Tulsi being a treatment for so many conditions, according to Ayurveda.

Using tulsi at home: Like other herbs, the tulsi plant is a delightful method to improve the flavour of your meal or prepare a superior tea. This sub-shrub is not toxic to animals, rather simple to grow, and looks quite lovely in a decorative pot. Even without its therapeutic benefits, the Tulsi plant may be a wonderful addition to your home, either in your garden or spice rack. Western medicine and diabetes: Researchers have hypothesised that holy basil (tulsi) leaves may promote insulin secretion by enhancing pancreatic beta cell function, according to diabeteshealth.com. According to the website, a tiny research study of people with type 2 diabetes revealed that those who consumed 2.5 grammes of powdered tulsi had lower blood glucose fasting levels than those who consumed a placebo. Tulsi has not been associated with any pharmacological interactions, according to Diabeteshealth.com, but certain interactions may occur in people who take insulin or insulin secretagogues like sulfonylurea (glyburide, glipizide, Amaryl), Prandin, or Starlix. As a result, diabetics who are thinking about using tulsi should see their doctors first.

10. Conclusion

For the current age, being fit has become a religion, and taking allopathic drugs nonstop to improve immunity has become fashionable, albeit it can sometimes be fatal. The rising expense of medications and their adverse effects has become a major public health concern in developing nations. This encourages the use of natural medicines and has provided new avenues for pharmacological research. Therefore, there is no obligation for anyone to choose a natural product (like herbs), which will not only be advantageous to health but also economical and decrease fatality. There are many other herbal plants in the world, but *O. sanctum* has maintained the title of Queen of the Herb for generations due to the superior therapeutic potential it possesses. It has been a long-standing Indian tradition and history to plant a Tulsi sapling in every home. It is unquestionably regarded as a natural energizer. Investigations have occasionally been conducted to purify different plant components, which were then characterised in terms of their chemical makeup and bio-pharmacological effects. Increased stress on the body can have serious implications, thus Tulsi is helpful since its phytochemicals (such as alpha-linolenic acid) give antioxidant, anti-infective, and immunological benefits. The numerous plant extracts, whether they are aqueous or alcoholic, have a wide range of pharmacological properties and may be healthy due to their relative lack of toxicity. Thus, it can be used often to treat infections and a variety of diseases that affect essential organs (like the liver, pancreas, heart etc.). The plant is the only one that possesses anti-inflammatory, anti-ulcer, and antibacterial capabilities in a single entity (i.e. fixed oil) together with essential anticancer activities. However, additional research is undoubtedly needed to make a more certain statement in this regard. This plant will eventually be very helpful in addressing several health issues and may even prove profitable commercially. This will therefore change people's preferences for natural medicines, offering up new avenues for pharmaceutical research.

11. Reference

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