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A Review on Health Benefits of Tulsi

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Abstract: *The emphasis of Ayurveda on maintaining healthy lifestyle habits and the consistent intake of adaptogenic herbs has the potential to mitigate numerous significant factors contributing to global morbidity and mortality. Ayurvedic medicine places significant importance on tulsi (Ocimum sanctum Linn), a plant whose benefits have been substantiated by scientific research. This herb exhibits a distinctive array of pharmacological properties that enable it to mitigate various forms of stress, including physical, chemical, metabolic, and psychological stressors. Research indicates that tulsi offers protective effects for organs and tissues against the adverse impacts of prolonged physical activity, ischemia, physical restraint, excessive noise, and exposure to cold environments. Furthermore, tulsi has been shown to enhance memory and cognitive functions while also possessing anxiolytic and antidepressant effects. It effectively counters metabolic stress by reducing blood glucose levels, blood pressure, and oxidized cholesterol. The plant's broad-spectrum antimicrobial properties make it valuable in treating wounds, supporting animal husbandry, preserving food and herbal materials, and promoting traveler health, as well as in the formulation of hand sanitizers and mouthwashes. Beyond its practical applications, tulsi holds spiritual significance, allowing cultivators to connect with nature's creative forces. Organic farming practices involving tulsi can contribute to addressing food security, alleviating rural poverty, combating hunger, and mitigating environmental degradation..*

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

I. INTRODUCTION

Tulsi (*Ocimum sanctum L.*), commonly known as holy basil in English and Tulasi in Sanskrit, is a highly esteemed culinary and medicinal herb belonging to the Lamiaceae family. This plant is indigenous to the Indian subcontinent and has been utilized in Ayurvedic medicine for over three millennia. In Ayurvedic practices, Tulsi is often referred to as the "Solution of Life" due to its numerous healing properties, and it has been employed to address a wide range of health concerns. The Indian Materia Medica highlights the use of Tulsi leaves in the treatment of bronchitis, fevers, and various ailments. In India, Tulsi is considered a ubiquitous presence, characterized by its aromatic qualities. This upright, perennial sub-shrub typically reaches heights of 30 to 60 cm and features fuzzy stems along with simple, inverted green leaves that emit a strong fragrance. Tulsi holds significant cultural importance, revered as the sovereign of all living beings within Hindu tradition. Its significance, characteristics, and uses are elaborated upon in various Hindu narratives. The erect and aromatic Tulsi shrub can attain heights of three to five feet, often found flourishing at temple peripheries and in domestic gardens. Its distinctive aroma and robust flavor contribute to its popularity. Notably, Tulsi is recognized for its remarkable ability to retain carbon dioxide, releasing oxygen during the morning hours, which is particularly advantageous for individuals with respiratory conditions.

The tulsi plant holds significant importance for humanity due to its complex restorative properties. Its leaves are commonly utilized in the formulation of Ayurvedic medicines, and it is renowned for its potential to enhance longevity. Various extracts derived from the plant are regularly employed in the treatment of numerous health issues, such as the common cold, skin irritations, gastrointestinal disorders, cardiovascular diseases, headaches, digestive problems, and kidney stones, among others. Additionally, tulsi, also known as Indian basil, contributes to environmental purification.

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Fig.1: (Ocimum sanctum Linn)

The Tulsi plant is recognized as an effective insect repellent, particularly against flies, mosquitoes, and various other pests (Warrier 1995). It plays a significant role in combating malarial fever. Historical accounts suggest that during the establishment of the Victoria farms in Bombay (currently Mumbai), the laborers suffered from persistent jungle fever and were frequently afflicted by mosquito bites. In response to this situation, several Hindu managers recommended the cultivation of Tulsi plants in the nursery after witnessing the challenges faced by the workers. This recommendation was implemented, leading to favorable outcomes.

Botanical classification of Ocimum sanctum

Taxonomic Rank	**Taxon**
Kingdom	Plantae
Division	Mangnoliophyta
Class	Mangnoliopsida
Order	Lamiales
Family	Lamiaceae
Genus	*Ocimum*
Species	*Ocimum sanctum*

Plant type and morphology

Tulsi is a robust, branched, aromatic herb that can attain a height of 30 to 60 centimeters upon reaching full maturity. The leaves of Tulsi are characterized as simple, inversely arranged, elliptical to ovoid in shape, and can be either dense or pointed, with a complete margin. Each leaf can grow up to 5 centimeters in length. The plant exhibits a compact phyllotaxy, and its petioles measure between 2 to 5 centimeters in length, being slender and covered in fine hairs. The leaves are primarily recognized for their medicinal attributes and are pubescent on both surfaces, featuring minute glands. Stomata are typically located on the lower leaf surface, with a rare occurrence on the upper side. The plant produces a verticillaster inflorescence that displays a range of colors. The flowers, which can be either simple or branched, may reach heights of 5 to 30 centimeters. They are sessile, ovate, and hermaphroditic, with pedicels measuring 1 to 4 millimeters in length, often spreading or slightly curved. The bracts are also sessile, ovate, and caduceus in form. The flowering phase initiates approximately 136 days after germination and persists for a duration of 195 days.

Geographical description

O. sanctum is documented throughout the tropical and subtropical areas of Asia. This species is indigenous to India, encompassing regions such as the Himalayas, as well as Malaysia, the Caribbean, the Pacific Islands, and certain areas

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of Africa. It is cultivated in nearly every Indian state (Rana L et al., 2020) [55]. The plant is often located in proximity to sacred sites and places of worship, attributed to various religious beliefs. Presently, there is a lack of detailed information regarding the specific natural habitats where this species has been observed (Awogbindin IO et al., 2014).

Phytochemical constituents of Tulsi plants

The leaves of Ocimum sanctum serve as a significant source of volatile oil, comprising 71% eugenol and 20% methyl eugenol. Additionally, the volatile oil contains carvacrol and the sesquiterpene hydrocarbon caryophyllene. Other notable chemical constituents include phenolics, flavonoids, terpenoids, and fatty acids. The seeds of the plant are characterized by a high content of fixed oil (18-22%), along with polysaccharides, mucilage, and sitosterol. Linoleic acid is believed to be the predominant component of the seed oil. (Naji-Tabasi S et al., 2017) Other chemical constituents are also identified.Other chemical constituents are as follows:

Phenolics

The phenolic content of the OS plant contains chlorogenic acid, vanillic acid, Ocimumnaphthanoic acid, caffeic acid, and methyl salicylic glucoside, which are extracted from the plant's aerial parts. The presence of gallic acid ethyl ester, protocatechuic acid, 4-hydroxybenzoic acid, gallic acid methyl ester, vanillin, and 4 hydroxybenzaldehyde was confirmed by HPLC.

Flavonoids

Flavonoids represent significant constituents of the OS plant, encompassing methoxy flavonoids and their glycosides, such as cirsimartin, isothymusin, and luteolin. Additionally, C-glycoside flavonoids, including vicenin, isovitexin, isoorientin, and orientin, are also present. Other flavones identified through atmospheric pressure chemical ionization mass spectrometry include cirsumaritin, crisilineol, isothymusin, gardening, apigenin, eupatorium, and salvigenin.

Neolignans

The methanolic extracts derived from the OS plant encompass Neolignan constituents, specifically Tulsinol A through Tulsinol G, which are produced via the polymerization of eugenol compounds.

Coumarins

Aeculetin, aesculin, and ocimarin represent three distinct coumarin compounds derived from the tulsi plant.

Steroids

The steroid constituents obtained from the stems and leaves of OS include β-sitosterol, β-sitosterol-3-O-β-D-glucopyranoside, stigmasterol, and campesterol.

Essential oil

The essential oil derived from the leaves of the OS plant predominantly consists of terpenoids, including phenolic acid, esters, aliphatic aldehydes, bicyclic terpenoids, acyclic monoterpenoids, and sesquiterpenoids. The chemical profile of this oil is influenced by various factors such as the region of cultivation, harvesting practices, and climatic conditions. Key phytochemicals present in the essential oils are eugenol or methyl eugenol and methyl chavicol, both of which exhibit antimicrobial and anthelmintic activities. Additionally, the essential oil contains other components such as caryophyllene, caryophyllene oxide, and germacrene D.

Health Benefits

Holy basil, scientifically known as Ocimum sanctum, or tulsi, has been employed globally for its therapeutic properties in addressing a wide range of ailments. In Southeast Asia, this plant is integral to various traditional and folk medicinal practices. Extracts of tulsi, along with a heated mixture, serve to cleanse, purify, and detoxify the body both internally and externally. A paste created from finely chopped leaves is advantageous for skin health and can be applied topically. Furthermore, it is utilized in the treatment of ringworm and other dermatological issues, as well as alleviating itching.

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The preparation of teas can involve its leaf extract, fresh leaves, raw forms, powdered versions, pastes, and herbal supplements.

Often referred to as "the elixir of life" due to its life-extending properties, tulsi is recognized in the Ayurvedic and Siddha Systems of Medicine for its efficacy as an antidote for snake bites and scorpion stings, as well as for conditions such as flatulence, migraines, fatigue, skin ailments, wounds, insomnia, arthritis, digestive issues, night blindness, diarrhea, and influenza. The plant's various parts are utilized to prevent and treat numerous diseases and common health complaints, including the common cold, headaches, coughs, flu, earaches, fevers, colic, sore throats, bronchitis, and asthma. Additionally, the leaves are known to soothe the nervous system and enhance cognitive function, while chewing tulsi leaves can effectively address oral infections and ulcers.

Pharmaceutical activity

This text encompasses a diverse array of phytochemicals that exhibit various biological and pharmacological properties, as noted by OS Linn. The subsequent section outlines several significant pharmacological activities.

Anticancer activity

The tulsi plant has demonstrated significant efficacy in both the prevention and treatment of cancer, attributed to its chemo-preventive and radio-protective characteristics. Ocimum sanctum, commonly known as tulsi, is recognized for its numerous pharmacological benefits, particularly its potential in combating cancer. Various plants exhibit anti-cancer properties and can be employed in the prevention and treatment of malignancies in humans. The phytochemicals present in Ocimum sanctum, such as eugenol, rosmarinic acid, apigenin, retinal, luteolin, β-sitosterol, and carnosic acid, contribute to these effects by enhancing antioxidant activity, modifying gene expression, promoting apoptosis, and inhibiting both angiogenesis and metastasis in chemically induced cancers of the skin, liver, oral cavity, and lungs. Research has shown that the aqueous extract of tulsi, along with its bioactive components like flavonoids, orintin, and vicenin, provides protection to mice against radiation sickness and reduces mortality rates. Furthermore, it selectively protects healthy tissues from the tumor-promoting effects of radiation. Additionally, several key phytochemicals, including eugenol, rosmarinic acid, apigenin, and carnosic acid, have been found to safeguard DNA from damage induced by radiation.

Antioxidant activity

Ocimumbasilicum var. purpurascens, Ocimumbasilicum, OG, Ocimummicranthum, and OT (syn. OS) leaves exhibited variability in the yield of essential oils (EOs) and the types of chemical constituents present. The differences among these chemotypes indicate a diverse potential for antioxidant activity and free radical scavenging. Notably, antioxidant capacity demonstrated a strong positive correlation ($r = 0.92$, $p < 0.05$) with a significant proportion of compounds containing a phenolic ring, such as eugenol, while showing a strong negative correlation ($r = 0.77$, $p > 0.1$) with other predominant volatiles. Eugenol and methyl eugenol are critical components of the propanoid compounds found in OS L. leaves, which have been shown to improve serum lipid profiles in both healthy and diabetic rat models. Furthermore, these compounds exhibit antioxidative properties and anti-hyperlipidemic effects against hypercholesterolemia. Tulsi essential oil was found to lower elevated serum lipid profiles, atherogenic index, lactate dehydrogenase, and creatine kinase MB component in rats on a high-cholesterol diet, without significantly affecting serum levels of aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase. Additionally, the essential oil was effective in reducing elevated levels of thiobarbituric acid reactive substances (TBARS), glutathione peroxidase (GPx), and superoxide dismutase (SOD) in cardiac tissue, while not influencing catalase (CAT) levels. In the liver, it also decreased TBARS levels without significantly affecting GPx, SOD, and CAT. The Thai herb Ocimumcanum has been noted for its anti-tyrosinase and antioxidant properties.

Antidiabetic activity

The aqueous extract of OT or OS L. exhibits anti-diabetic properties, effectively lowering blood glucose levels in hyperglycemic tilapia (Oreochromis niloticus). The floral and leafy components of various plants can serve as alternative nutritional therapies for diabetes management, primarily due to their capacity to inhibit glucose-hydrolyzing

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enzymes. Tetracyclic triterpenoids, specifically [16-hydroxy-4, 4, 10, 13-tetramethyl-17-(4-methyl-pentyl) hexadecahydrocyclopenta[a]phenanthren-3-one], isolated from the aerial parts of OS, have demonstrated similar anti-diabetic effects. In comparison to untreated diabetic rats, the aerial portions of OS significantly reduce elevated serum glucose levels and positively influence cholesterol, triglycerides, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) levels. The administration of OS to streptozocin-induced diabetic rats over a 30-day period enhanced the activity of antioxidant enzymes such as catalase, superoxide dismutase (SOD), and glutathione peroxidase (GPx) in vital organs, including the liver and kidneys. OS exhibits both hypoglycemic and hyperglycemic actions, aiding in the restoration of glucose levels and serving as a treatment for metabolic disorders related to diabetes. Additionally, OT (L.) has been found to inhibit glucosidase and amylase activity. A study involving the administration of tulsi leaf powder at a concentration of 1% to both normal and diabetic rats over one month resulted in significant reductions in fasting blood sugar, uronic acid, total amino acids, total cholesterol, triglycerides, phospholipids, and total lipids.

Antimicrobial activity

Unripe fruit extract from the Lamiaceae family has been identified as highly effective against a resistant strain of Staphylococcus aureus. The leaf extract exhibits significant antibacterial activity against drug-resistant S. enterica serovar Typhi when used in conjunction with chloramphenicol (C) and trimethoprim (Tm). Notably, when combined with C and Tm, extracts such as EET, OS, and leaf TLE displayed synergistic effects against S. typhi isolates. The active compound found in OS L., eugenol (1-hydroxy-2-methoxy-4-allylbenzene), plays a crucial role in the antibacterial therapeutic properties of tulsi. Furthermore, tulsi (OS) extract has demonstrated activity against Streptococcus mutans, with effective concentrations ranging from 6.25 to 25 mg/ml against multi-drug resistant strains of Klebsiella pneumoniae and Escherichia coli. Both solvent and water extracts of tulsi have shown antibacterial effects against multi-drug resistant S. aureus. Additionally, essential oils from Tulsi (OS Linn.), including eugenol, methyl eugenol, linalool, and 1,8-cineole, have exhibited significant cytotoxicity against Candida species.

Immunomodulation

The consumption of Tulsi leaves (Ocimum sanctum Linn.) on an empty stomach has been shown to enhance immune function. The alcoholic extract of these leaves exhibits immunomodulatory properties. Tulsi is utilized in immune-based therapeutic approaches, particularly for the treatment of various diseases, management of ecto- and endoparasites, enhancement of fertility, bone healing, and addressing issues related to maternal care. Additionally, it demonstrates immune-modulatory effects, including the regulation of cytokine production, histamine release, immunoglobulin synthesis, class switching, expression of cellular co-receptors, lymphocyte activation, and phagocytic activity. Furthermore, Tulsi leaf extract (DTLE) provides protection against genotoxic agents.

Anti-inflammatory

The consumption of Tulsi leaves (Ocimum sanctum Linn.) on an empty stomach is associated with enhanced immune function. The alcoholic extract of its seeds contains oil that exhibits anti-inflammatory properties through the dual inhibition of arachidonate metabolism, complemented by antihistaminic effects. Additionally, the seed oil demonstrates antipyretic properties by inhibiting prostaglandin synthesis and possesses peripheral analgesic activity. It also reveals hypotensive, anticoagulant, and immunomodulatory effects. The oil's lipoxygenase inhibitory, histamine antagonistic, and antisecretory activities contribute to its antiulcer potential.Research indicates that the methanolic extract of Tulsi leaves has anti-inflammatory effects in isoproterenol-induced myocardial infarction in rats. The consumption of Tulsi leaves on an empty stomach is known to enhance immunity, with the alcoholic leaf extract exhibiting immunomodulatory actions. Tulsi is frequently utilized in immune-based therapies for addressing issues such as inadequate maternal care, control of ecto- and endoparasites, enhancement of fertility, and bone setting. Furthermore, it demonstrates immune-modulating effects, which include alterations in cytokine secretion, histamine release, immunoglobulin production, class switching, expression of cellular co-receptors, lymphocyte activity, and phagocytic function. The distilled Tulsi leaf extract (DTLE) has been shown to offer protection against genotoxic agents.

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Anti-stress activity

The application of fresh leaves of OS mitigated oxidative stress, leading to a diminished reduction in plasma superoxide dismutase (SOD) levels (23.14%) and a decrease in glutathione levels (28.80%) among rabbits administered with OS. The antioxidant characteristics of OS play a significant role in its capacity to alleviate stress.

Hepatopancreatic activity

According to Lahon et al. (2011), the alcoholic leaf extract of OS exhibits significant hepatoprotective properties and works synergistically with silymarin. The EO and OS extracts may alleviate oxidative stress and hepatic steatosis by enhancing the levels of glutathione peroxidase and catalase in the liver (Gupta et al., 2002; Lahon et al., 2011). Key bioactive compounds such as eugenol, carvacrol, ursolic acid, β-caryophyllene, and rosmarinic acid have been shown to possess anti-inflammatory, gastrointestinal, and hepatoprotective effects (Kamyab et al., 2013). The oil's anti-inflammatory effects arise from a dual mechanism that suppresses arachidonate metabolism and provides antihistaminic action. Additionally, the oil exhibits antipyretic properties through peripheral analgesic activity and inhibition of prostaglandin synthesis. Research involving animal models indicates that the oil is effective in mitigating joint swelling and arthritis induced by turpentine oil and formaldehyde adjuvants.

Analgesic

Analgesic OS L. or OT L. demonstrates anti-inflammatory characteristics attributed to its dual action on arachidonate metabolism, alongside antihistaminic properties. The principal active ingredient found in OS L., eugol (1-hydroxy-2-methoxy-4-allylbenzene), is crucial to the therapeutic advantages linked to tulsi. Studies have shown that the alcoholic extract of OS leaves exhibits analgesic effectiveness in mouse models. The analgesic properties of OS are facilitated through both central and peripheral pathways, engaging with multiple neurotransmitter systems.

Anti-arthritis

Research involving animal models has demonstrated that OS Linn. oil is effective in mitigating joint inflammation and arthritis induced by turpentine oil and formaldehyde adjuvants. Furthermore, it is employed in the management of arthritis and various dermatological disorders.

Radio protective effect

At non-toxic levels, the organic constituents of OS Linn water-soluble, specifically flavonoids such as orientin and vicenin, provide protection to experimental animals against radiation-induced illness and mortality.

Anthelminthic activity

The Caenorhabditis elegans model demonstrated that both the OS and eugenol essential oil exhibited significant anthelmintic activity. As reported by Agrawal P et al. (1996), eugenol may possess an effective dose (ED) of 62.1 micrograms per milliliter. The principal constituent of the essential oil, eugenol, is hypothesized to be the likely anthelmintic agent (OS). Additionally, the leaves are recognized for their anthelmintic effects against gastrointestinal nematodes in sheep.

Antiaging effect

Oleanolic acid (OA) and uracil (UA) are two key constituents of Tulsi (Ocimum sanctum Linn.), contributing significantly to the plant's therapeutic effects. Various methods have been developed for the rapid identification of UA, OA, and their oxidative derivatives in Tulsi leaves. These acids play a crucial role in inhibiting cellular division and proliferation.

Larvicidal activity

Ocimumamericarnum, O. basilicum, and O. basilicum var. citratum exhibit notable larvicidal and repellent properties against mosquitoes, as evidenced by the efficacy of both OG and OT extracts. These effects were consistently observed across all tested oils. Notably, OG demonstrated the most prolonged mosquito repellent action, while O. basilicum

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exhibited the highest larvicidal potency, with effective concentrations (EC) of 81 ppm for 50% mortality and 113 ppm for 90% mortality, lasting over two hours. The insect-repelling compounds identified in tulsi plants include camphor, methyleugenol, caryophyllene, limonene oxide, myrcene, cineole, and thymol. Additionally, extracts of O. canum and OS leaves have been reported to possess larvicidal activity against the fourth instar larvae of Culex tritaeniorhynchus, a vector for Japanese encephalitis, as well as Anopheles subpictus, a malaria vector (Diptera: Culicidae). Furthermore, the fourth instar larvae of Aedes aegypti and Culex quinquefasciatus were subjected to testing with leaf and flower extracts of OS in various solvents, including acetone, chloroform, ethyl acetate, hexane, and methanol. Among these, the leaf extract of OS demonstrated the highest mortality rates in Aedes aegypti and C. quinquefasciatus larvae.

Antifertility activity

The extract of fresh OS leaves containing benzene led to a decline in total sperm count, sperm motility, and testicular weight in male rats. Adult male and female albino rats were administered OS leaves over an extended duration of up to three months alongside a standard diet, which ultimately resulted in a reduction in sperm count, sperm motility, and the weight of male reproductive organs.

Memory enhancer activity

Age-related memory deficits in mice, as well as the amnesic effects induced by scopolamine (0.4 mg/kg), were significantly mitigated by the aqueous extract of the whole dried plant of OS. The behavioral assessment employed was the passive avoidance paradigm. The administration of OS extract resulted in a marked increase in step-down latency (SDL) and inhibition of acetylcholinesterase activity. Consequently, OS shows potential as a therapeutic agent for cognitive disorders such as dementia and Alzheimer's disease.

Anti-cataract activity

In experimental cataract models, specifically the galactosemic cataract induced in rats through a 30% galactose diet and the naphthalene cataract induced in rabbits via 1 g/kg naphthalene, the aqueous extract (AqE) of fresh leaves from OS demonstrated a capacity to postpone the development of cataracts. The administration of OS at dosages of 1 and 2 g/kg significantly hindered both the initial onset and the subsequent progression of cataract formation in these models.

II. CONCLUSION

The various restorative components present in Tulsi render it an essential element for a balanced and tranquil life. This modest plant is undeniably a remarkable source of therapeutic benefits. Extensive and rigorous research has confirmed its safety for consumption in all forms. The medicinal attributes of Tulsi are widely recognized and esteemed by contemporary science. It serves as a natural remedy for humanity, addressing the challenges posed by modern, often superficial lifestyles. Regarded as the "queen of herbs" in India, Tulsi is predominantly utilized in Ayurvedic medicine. It possesses both healing and cosmetic properties. Tulsi is commonly cultivated in nearly every Indian household. Infusing water with Tulsi leaves provides relief for sore throats and can also be used as a mouthwash. Chewing Tulsi leaves is effective in alleviating symptoms of colds and flu. Consuming Tulsi leaves in the morning aids in blood purification. The dried leaves can be ground into a powder for use as a natural toothpaste. Additionally, Tulsi supports the health of the entire respiratory system. Its numerous cosmetic benefits make it a popular ingredient in herbal shampoos and body scrubs, and it is effective in managing dandruff. Tulsi oil, when combined with coconut oil, can also be employed to combat dandruff. Furthermore, a mixture of Tulsi leaf juice and ginger juice is beneficial for treating stomach aches, cramps, and providing relief from intestinal worms.

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