

Tulsi (*Ocimum sanctum*): A Potent Adaptogen

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Abstract

Tulsi or holy basil is a dedicated plant of India. It is a pungent plant in the family Lamiaceae which is mother to the Indian subcontinent and widespread as a cultivated plant throughout the Southeast Asian tropics. Tulsi is considered to be an adaptogen, balancing different processes in the body, and helpful for adapting to stress. Tulsi, one with a purple-colored leaf or dark variety, commonly known as the *Shyama* or *Krishna Tulsi* and the second type with a green-colored leaf or light variety known as *Rama Tulsi* or *Sri Tulsi*. The chemical composition of Tulsi is highly complex, containing many nutrients and other biologically active compounds. Tulsi also helps to check cancers caused by toxic compounds by reducing DNA damage. Tulsi has also been shown to boost defenses against infective threats by intensify immune responses in non-stressed and stressed animals and healthy humans. The *O. sanctum* fixed oil elongate clotting time, response being similar to aspirin. Basil juice is an effective medicament for sore eyes and night-blindness, which is generally caused by deficiency of vitamin A.

Keywords: eugenol; basil; oleanolic acid; linoleic acid; apoptosis; toxic agents; anti-bacterial; insecticidal properties; tulsi; GABA; food-borne pathogens; herbal raw materials

Introduction

Tulsi or Tulasi or Vaishnavi or holy basil is a dedicated plant of India which has a noble religious, medicinal and therapeutic value in Hindu belief [1]. Hindus interpret it as an earthly manifestation of the goddess Tulsi; she is regarded as a great worshipper of the god Vishnu [2]. Tulsi is a pungent plant in the family Lamiaceae which is indigenous to the Indian subcontinent and global as a cultivated plant throughout the Southeast Asian tropics [3]. Plant kingdom is known to incorporate approximately 500,000 plant species which are found worldwide, of which only 1% has been phyto chemically explore with an illimitable inherent for discovering novel bioactive amalgam mainly in medicinal plants [4]. Patel [5] described in his review that in Ayurveda, tulsi is known as “The Incomparable One”, “Mother Medicine of Nature” and “The Queen of Herbs”. Plant-based natural ingredient can be derived from any part of the plant like bark, leaves, flowers, roots, fruits, seeds and so on, that is any part of the plant may contain dynamic components [6]. They also reported that the advantageous medicinal effects of plant materials usually result from the combinations of marginal products present in the plant and the research on the medicinal plants should be elongated with the identification of the active principles in the plants. Tulsi is regarded to be an adaptogen, balancing different processes in the body, and helpful for alter to stress [7]. Sai et al. [8] reported that its strong aroma and sharp taste, it is regarded in Ayurveda as a kind of ‘elixir of life’ and believed to nurture longevity. Patnayak et al. [2] also updated in his literature that *Ocimum sanctum* L. (Tulsi) is an erect, much branched

sub-shrub 30–60 cm tall, with simple opposite green or purple leaves that are strongly scented and hairy stems. It is endemic throughout the world tropics and widespread as a cultivated plant and an escaped weed. It is cultivated for religious and medicinal purposes and for its essential oil. Srinivas et al. [4] mentioned in his review that there are three types of Tulsi, one with a purple-colored leaf or dark variety, commonly known as the *Shyama* or *Krishna Tulsi* and the second type with a green-colored leaf or light variety known as *Rama Tulsi* or *Sri Tulsi*. Rama Tulsi is consistently used for worshiping and is more common of the three types. A third type, commonly known as *Vana Tulsi* (or forest Tulsi), is *O. gratissimum*. They also reported that it is a good source of vitamin A, Vitamin C, Calcium, Zinc, Iron, Chlorophyll and it possess anti-bacterial, insecticidal properties, and its leaves have capabilities to purify adulterate water. The pharmaceutical studies reported in the present review confirm the therapeutic value of *O. sanctum* L.

Botanical Classification

Kingdom : Planta
Divison : Magnoliaphyta
Class : Magnoliopsida
Order : Lamiales
Family : Lamiaceae
Genus : *Ocimum*
Species : *Sanctum*

Active Components of Tulsi

Prakash et al. [9] reported that eugenol is recognized as one of the extensive active constituent and is reported to possess multitude benefits. They also noted that the chemical composition of Tulsi is highly multiplex, containing many nutrients and other biologically active compounds, the part of which may vary significantly between strains and even among plants within the same field. Bano et al. [10] reported that the different parts of *Ocimum sanctum* contain different types of fragment in varying amounts. The leaves contain a high content of essential oils which include Toluene, Camphene, Octane, Benzene, Citronellel, Sabinene, Limocene, Ledol, Dimethylbenzene, Ethyl-2- methylbutyrate, Eugenol, Terpinolene, β -elemene, Isocaryophyllene, Iso-eugenol, α -amorphene, α -guaiene, α -humulene, α -terpeneol, Borneol, Calamine, Nerolidol, Carvacrol, Geraneol, Humulene oxide, Elemol, Tetradecanal, (EZ)-famesol, α -bisbolol, Cissesquisainenehydrate, Selin-11-en-4- α -ol, α -murolene, 14-hydroxy- α -humulene. The removal of fresh leaves and stem provide phenolic compounds like Apigenin, Circimaritin, Isothymusin, Eugenol and Rosameric acid [10]. They also updated that *O. sanctum* is also a provenance of monoterpenes and ssesquiterpenes like Neral, Campene. Cholesterol and stigma sterol. Vitamin A and Vitamin C are also found in this herb which refreshing antibody production up to 20% to provide protection against diseases.

Protection and Detoxification

Cohen [11] reported that many of the corporal benefits of Tulsi can be allocate to its ability to assist with the body's internal housemaid and protection of the body from toxin-induced recompense. These functions are often allocate to Tulsi's high content of phenolic compounds and anti-oxidant properties, with Krishna Tulsi (black/purple variety) having a higher phenolic content and anti-oxidant magnitude than white Vana (wild) Tulsi. Lobo et al. [12] reported that Tulsi secure against toxic chemical-induced injury by increasing the body's levels of anti-oxidant bit such as glutathione and enhancing the activity of anti-oxidant enzymes such as super oxide dismutase and catalase, which protect integral organelles and membranes by swab up damaging free radicals caused by lack of oxygen and other toxic agents. Wang et al. [13] reported that Tulsi also helps to intercept cancers caused by toxic compounds by reducing DNA damage and inducing apoptosis in precancerous and cancerous cells, thereby reducing the growth of experimental tumors and boost survival. Cohen [11] also reported that Tulsi not only protects against the damage caused by toxic compounds, but also validate he body to more effectively transform and eliminate them by amplify the activity of liver detoxification enzymes such as the cytochrome P450 enzymes, which make inactive toxic chemicals and enables them to be safely excreted.

Immunomodulatory Activity

Catanzarot et al. [14] reported that the modulation of immune response using Ayurvedic herbal remedy as a possible therapeutic measure supplement the immune response of an organism against a microorganism by non-specifically activating the immune system using immune modulatory agents derived from the plant parts is contemplate as one of the most potent tools in the governance of health and disease by modern medicine. Mediratta et al. [15] reported that Tulsi reinforce the immune response by intensify both cellular and humoral immunity by boosting the cell-mediated immune responsiveness and gamma aminobutyric acid (GABA) ergic pathways. Mukherjee et al. [16] reported that immunotherapeutic prospective of aqueous extract of *O. sanctum* L. leaf in bovine sub-clinical mastitis (SCM) was look over after intra mammary infusion of aqueous extract. The results disclose that the aqueous extract of *O. sanctum* L. therapy reduced the total bacterial count and increased neutrophil and lymphocyte counts with enhanced

phagocytic activity and phagocytic index. Mediratta et al. [15] also reported that the immunomodulatory effect of *O. sanctum* L. seed oil was appraise in both non-stressed and stressed animals. *Osimum sanctum* L. seed oil assemble a significant increase in anti-sheep red blood cells antibody titer and a decrease in percentage histamine release from abdominal mast cell of sensitized rats (humoral immune responses) and decrease in food pad thickness and percentage leucocyte migration inhibition (cell-mediated immune responses).

Anti-Inflammatory Activity

Godhwani et al. [17] reported that the methanol selection and aqueous suspension of *O. sanctum* is known to have analgesic, anti pyretic and anti-inflammatory effects in acute and chronic inflammation in rats. Singh and Majumdar [18] reported that the fixed oil and linolenic acid possess significant anti-inflammatory activity against prostaglandin E2, leukotriene and arachidonic acid by integrity of their amplitude to block both the lipoxxygenase and cyclooxygenase pathways of arachidonic acid consumption. Bravo et al. [19] updated in his review that the oils processed from fresh leaves and seeds of *O. sanctum* have leak anti-inflammatory effects on inventive animals induced by carrageenan, histamine, serotonin and prostaglandin E2 according to some studies. Kelm et al. [20] reported that compounds isolated from *O. sanctum* L. extract, Civsilineol, Civsimavatine, Isothymonin, Apigenin, Rosavinic acid and Eugenol were observed for their anti-inflammatory activity. A methanolic extract and an aqueous moratorium of *O. sanctum* L. reluctant acute as well as chronic inflammation in rats as tested by carrageenin-induced pedal edema and craton oil-induced granuloma and exudates, respectively [21].

Infection Protection

Yamani et al. [22] described that tulsi has anti-bacterial, anti-viral and anti-fungal activity that includes activity against many pathogens supervise for human infections. Cohen [11] reported that the Tulsi has also been shown to boost defenses against infective threats by enhancing immune responses in non-stressed and stressed animals and healthy humans. Deca [23] reported that Tulsi may help in the cure of various human bacterial infections including urinary tract infections skin and wound infections, typhoid fever, cholera, tuberculosis, gonorrhoea, acne, herpes simplex, leishmaniasis, various pneumonias and fungal infections, as well as mosquito-borne diseases such as dengue, malaria and filariasis. Sadgir et al. [24] reported that Tulsi has also been shown to be active against many animal pathogens, and this has led to Tulsi being used in animal rearing to reduce infections in cows, poultry, goats, fish and silkworms. Tulsi's venture against water-borne and food-borne pathogens further suggests that it can be used in the continuation of food stuffs and herbal raw materials.

Antimicrobial Activity

Tulsi is known to possess antimicrobial activity against various bacteria, the most common being *Candidaalbicans*, *Staphylococcus aureus*, *Escherichia coli* by its phyto constituents isolated from various parts [25]. They noted that the oil quell antibacterial activity against *S. aureus*, *Bacillus pumius*, and *Pseudomonas aeruginosa*, where *S.aureus* was the most sympathetic organism. Pattanayak et al. [26] reported that on comparing alcoholic and aqueous extract, the aqueous extract of *O. sanctum* L. (60 mg/kg) showed wide zones of inhibition against *Klebsiella*. Singh et al. [27] reported that giant content of linoleic acid in *O. sanctum* L. fixed oil could supply towards its antibacterial activity. The oil show good antibacterial activity against *Staphylococcus aureus*, *Bacillus pumius* and *Pseudomonas aeruginosa*, where *S. aureus* was the most sensitive organism. They also noted that Tulsi essential oil could be a treasure topical antimicrobial agent for management of skin infections caused by these organisms.

Anticoagulant Activity

Singh et al. [28] reported that the *O. sanctum* fixed oil protract clotting time, response being homogeneous to aspirin. The effect appears to be due to the anti-aggregator action of oil on platelets. Srinivas et al. [4] reported that linolenic acid present in the *O. sanctum* fixed oil is metabolized to eicosa pentaenoic acid (EPA). EPA through cyclooxygenase pathway produces PGI₃ and thromboxane A₃ (TXA₃) inhibiting the production of TXA₂. Unlike TXA₂, TXA₃ has reduced pro aggregatory property on platelets, and PGI₃ possesses anti platelet aggregation activity [4].

Anticancer Activity of *Ocimum Sanctum*

Cancer has been an utmost cause of death in the developing countries. Amendment in standards of living and food habits and the availability of restorative treatment for many infectious diseases, cancer is surpassing other ailments as a principle cause of mortality even in developing countries. Surgery, radiotherapy, and chemotherapy - the established treatment modalities for various cancers are costly, disfigure, and have various side effects. Pandey and Madhuri [29] described in his review that in Ayurveda, various plants are used as a potential source of anticancer and antitumor properties. *O. sanctum* (Tulsi) is an herbal plant that has antimicrobial, anticancer, and antiulcer effect against the activity of many microorganisms. Ponugoti [30] reported that Tulsi has been intimate to possess an excellent anticancer activity. They noted that detoxification of carcinogens and mutagens which is carried out by enzymes such as glutathione-S-transferase, cytochrome b5 and cytochrome P450, and aryl hydrocarbon hydroxylase is temper by the alcoholic extract (AIE) of leaves of *O. sanctum*. Venkatachalam and Muthusamy [31] described in his review that management of Tulsi has been shown to decrease cell proliferation, invasion, angiogenesis, and apoptosis. They also noted that studies also suggest that the leaf extract chunk or suppresses the biochemical events associated with chemical carcinogenesis by preventing metabolic activation of the procarcinogen to carcinogen. Manikandan et al. [32] reported that Tulsi also causes a decrease in the 7, 12-dimethylbenz[*a*] anthracene-induced genotoxicity, as estimated by the micronuclei formation in bone marrow cells in mice. They noted that Tulsi possesses anti-genotoxic effects, and all these might have supply to the reduction of chemical carcinogenesis and decreased the declaration of cutaneous γ -glutamyl transpeptidase (GGT), a marker of tumor progression, and glutathione-S-transferase-P, which is increased in chemically-induced hepatic tumors. The heat shock protein, which is altered during carcinogenesis, has also shown a alter in its concentration [32]. Application of Tulsi extract decreased the activity of ornithine decarboxylase, an enzyme involved in the regulation of cell accretion and development of cancer [31].

Treatment in Respiratory and Mouth Infections

Sethi and Bhadra [33] described in his review article that the herb is convenient in the treatment of respiratory system disorder. A liquor of the leaves of Tulasi with honey and ginger is an effective antidote for bronchitis, asthma, influenza, cough and cold. They also mentioned that a liquor of the leaves, cloves and common salt also gives speedy relief in case of influenza. They should be boiled in half a liter of water till only half the water is left and add then taken. The leaves are quite effective for the ulcer and infections in the mouth. A few leaves chewed will cure these conditions [33].

Treatment in eye disorders

Basil juice is an effective cure for sore eyes and night-blindness, which is generally caused by deficiency of vitamin A. Two drops of black basil juice are put into the eyes daily at bed time [34].

Antianging Effect

Upadhyay [1] discussed in his review that Tulsi contains UA and oleanolic acid (OA) as major constituents which account for many medicinal activities of the plant. Methods have been developed for rapid detection of UA, OA and their oxidation products from Tulsi leaves which are helpful is slow down of cell division and growth [1].

Hepatoprotective Activity

Singh et al. [35] reported that the oil possesses anti-inflammatory activity due to binary inhibition of arachidonate metabolism widen by antihistaminic activity. They also noted that oil dominate antipyretic activity due to prostaglandin inhibition and outlying analgesic activity which is very effective against formaldehyde or adjuvant induced arthritis and turpentine oil induced joint edema in animals.

Antifertility Property

Plants were chief sources of novel pharmacologically active compounds, with many supernova drugs being derived directly or indirectly, which have been found *in vitro* to have anti fertility activity and aborti-facient properties may act through rapid ejection of the fertilized ova from the fallopian tube, inhibition of implantation due to a disruption in estrogen - progesterone balance, fetal abortion, perhaps due to lack of supply of nutrients to the uterus and the embryo, and also on the male side through affecting sperm count, motility and viability [36]. They reported that the compounds isolated from the plant extracts with allocated fertility regulating ability are classified as (a) phyto constituents with anti-implantation activity, (b) phyto constituents with aborti facient activity, and (c) phyto constituents with contraceptive activity. Singh et al. [37] reported that one of the major constituents of the Tulsi leaves is the ursolic acid and it is reported that it possesses anti fertility effect. This effect has been impute to its anti-estrogenic activity which may be accountable for arrest of spermatogenesis in males and due to inhibitory effect on implantation of ovum in females. Singh et al also reported that Tulsi leaves reduce spermatogenesis by slow down the activity of Sertoli cells in males. Deshmukh et al. [38] reported that the leaves of Tulsi have shown to possess anti-implantation activity in experimental rats because ursolic acid is responsible for its anti-sterility property. They also noted that Tulsi leaves have antiandrogenic property as well.

Antidiabetic

Diabetes is an international problem and is strongly recommended to carry out phytochemical and clinical research work on the discovered plant species to prove and validate the traditional herbal therapies of the rural people. These plants should be studied for their active compounds supervise for the hypoglycemic activities. Pattanayak et al. [26] reported that the intake of *O. sanctum* also outstandingly increases the level of superoxide dismutase, reduced glutathione, and also shows marked reduction in peroxidized lipid levels as compared to the untreated control group. They also noted that it has a therapeutic role in in diabetes related treatment of diabetes-related metabolic disorders and act both in hypoglycemic and hyperglycemic activity and restore glucose level. Hannan et al. [39] reported that OS leaf extracts bracing insulin secretion from per fused pancreas, isolated islets, and clonal pancreatic beta-cells hypoglycemic effect. Salehi et al. [40] reported that the ethanolic extract of *O. sanctum* L. significantly decreases the blood glucose, glycosylated hemoglobin and urea with a resultant increase in glycogen, hemoglobin and protein in streptozotocin-induced diabetic rats. This extracts also resulted in an increase in insulin and peptide levels and glucose toleration. The constituents of *O. sanctum* L. leaf extracts have stimulatory effects on physiological pathways of insulin secretion, which may prime its reported antidiabetic action [40].

Gastroprotective

Peptic ulcers are a customary disorder of the overall gastrointestinal tract. They occur mainly in the stomach and the proximal duodenum. They can also occur in the esophagus, jejunum and gastric anastomotic site. A peptic ulcer results from a disproportion between some endogenous aggressive factor(s) [hydrochloric acid, pepsin, refluxed bile, leukotrienes, reactive oxygen species and cytoprotective factors, which include the function of the mucus-bicarbonate barrier, surface active phospholipids, prostaglandins (PGs), mucosal blood flow, cell renewal and migration, nonenzymatic and enzymatic antioxidants and some growth factors. The interception or cure of peptic ulcers is one of the most predominant challenges confronting medicine nowadays, as it is certainly a major human illness affecting nearly 8 to 10 % of the global population and of these 5% suffer from gastric ulcers. Goel et al. [41] reported that the standardized methanolic extract of leaves of *O. sanctum* L. given in doses of 50–200 mg/kg orally twice daily for five days showed dose-dependent ulcer protective effect against cold-restraint stress-induced gastric ulcers. Highest effective dose (100 mg/kg) of OSE showed significant ulcer protection against ethanol and pyloric ligation induced gastric ulcer but was ineffective against aspirin-induced ulcer. Kaniganti et al. [42] reported the anti ulcerogenic property of *O. sanctum* L. in pyloric-ligated and aspirin-treated rats. The extract of reduced ulcer index, free and total acidity on acute and chronic regulation increased the mucus secretion also. So it may be concluded that *O. sanctum* L. extract has anti-ulcerogenic property against experimental ulcers and it is due to its potentiality reduces acid secretion and increase mucus secretion.

Antioxidant activity

Khan et al. [43] described in his article that antioxidant activity is a superb example of a functional benefit that plant extracts can convey and they are known to contain a variety of natural antioxidants that protect and protect their physical and metabolic honesty. Many of these extracts and compounds from plants are emerging as candidates for subside the effects of the aging process on skin by restrain biochemical consequences of oxidation [43]. They also noted that compounds such as vitamin C, vitamin E and rosmarinic acid (RA) are commonly used in foods as well as cosmetics for their potent antioxidant activity that aids in product stability. Devi et al. [44] reported that the antioxidant activity of the flavonoids (orientin and vicenin) *in vivo* was expressed in a significant reduction in the radiation-induced lipid peroxidation in mouse liver. They noted that OS extract has significant ability to forage highly reactive free radicals. It provides significant protection against cadmium-induced toxicity in Wistar albino rats by improving antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), reduced glutathione (GSH), and vitamin C (ascorbate) levels. Kelm et al. [45] reported that the phenolic compounds, viz., cirsilinoleol, cirsimaritin, isothymusin, apigenin and rosmarinic acid, and appreciable quantities of eugenol (a major component of the volatile oil) from OS extract of fresh leaves and stems possessed good antioxidant activity.

Conclusion

It is evident that Tulsi is a medicinal plant of great importance because of its varied application in medicine, and hence can be corroboratively called the “Queen of Herbs.” By this review, it is clear that a lot of work has been carried out in the field of medicine to utilize the properties of Tulsi in allopathic medicine. After in depth and rigorous research it has been proved and certified that it is safe to consume Tulsi in any form. All these remedial properties are well accepted and honored by modern science. Tulsi is the herb that cures the mankind from all odds naturally in today’s superficial not-so good lifestyle. It has got medicinal properties as well as cosmetic properties.

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Conflict of Interest

There are no financial conflicts of interest to report.

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