

A REVIEW ON: THE MAJOR CONSTITUENTS OF TULSI (*OCIMUM SANCTUM*) AND THEIR ANTIMICROBIAL AND ANTIOXIDANT ACTIVITIES AGAINST DIFFERENT MICROBES

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ABSTRACT

This review article explains the antimicrobial and antioxidant activities of *Ocimum sanctum*. Plants are used for medicinal purpose since times immemorial. In Ayurveda, tulsi has been observed as greatest healing herb with high therapeutic potential. Tulsi plant has been proven health promoting effect through modulation of various biological activities. Tulsi provide wide range of therapeutic applications like cardiopathy, asthma, homeopathy, leukoderma, bronchitis, catarrhal fever, otalgia, hepatopathy, vomiting, lumbago, hiccups, ophthalmia, gastropathy, genitourinary disorders, ringworm, verminosis, and skin disease. Effective evidences have been provided by modern scientific research that tulsi reduces stress, enhance stamina, relieves inflammation, lowers cholesterol, eliminates toxins, protects against radiation, gastric ulcer, improve digestion and also provides antioxidants and other nutrients. Tulsi have been proven effective in supporting the heart, blood vessels, liver and lungs and also regulates blood pressure and blood sugar. Tulsi has a complex chemical structure. The main active compounds that have been identified and extracted are eugenol (an essential oil) and ursolic acid. There are many clinical conditions like fever, chronic cough, bronchitis, in which tulsi is used either alone or in combination with others.

Keywords: *Ocimum Sanctum*, Ayurvedic Medicine, Antimicrobial, Antioxidant, Eugenol, Ursolic Acid.

I. INTRODUCTION

From ancient times, many plant parts like leaves, stems etc. are used for medicinal purposes (Pandey *et al.*, 2010). The Indian Himalaya serves as the home for more than 8000 vascular plants, from which 1748 are well known for their medicinal properties (Joshi *et al.*, 2017). *Ocimum sanctum* is considered as 'Queen of herbs' because it is one of the most precious medicinal plants in India (Pandiri *et al.*, 2018). *Ocimum sanctum* is also known as Holy basil (in English), and Tulsi (in Hindi) (Akhilanand Chaurasia, 2015). It belongs to the plant family *lamiaceae* (Pandey *et al.*, 2010). The meaning of "tulsi" is the "incomparable one" in Sanskrit. In India, tulsi is known by different names like Tulasi, Surasah, Ajaka, Manjari, and Haripriya. Tulsi has been well documented in Ayurveda for its therapeutic potential and described as Dashemani Shwasaharni (antiasthemic) and antikaphic drug. In traditional medicines the stem, leaves, flowers, roots, seeds and even whole plant of *Ocimum sanctum* Linn can be used (Akhilanand Chaurasia, 2015). The extraction of essential oils is mainly done from leaves and flowering tops of the tulsi plant (Pandiri *et al.*, 2018). Along with Ayurveda and Siddha, tulsi plant also attributed several medicinal properties in Greek, Unani and Roman system of medicine.

Due to indiscriminate use of commercial antimicrobial drugs that are commonly used in the treatment of many microbial infections, multiple drug resistance has been developed in modern world. Hypersensitivity, immune suppression and allergic reactions are some of the adverse effects of antibiotic drugs on host that forced scientists to search for new therapeutic substances (Saranraj *et al.*, 2014). *Ocimum sanctum* have been found to have anti-stress, antioxidant, anti-malarial, anti-viral, anti-pyretic properties with a wide margin of safety. Traditionally, tulsi can either be used alone or in combination with others. (Nigam *et al.*, 2014).

II. PLANT PROFILE OF *OCIMUM SANCTUM*

Ocimum sanctum is a prophylactic shrub and it is growing to about 75 cm. this plant is commonly found near temples and homes. It is worshiped daily by Hindus (Joshi *et al.*, 2017). A length of 5 cm is possessed by leaves of tulsi. The leaves of tulsi are simple elliptic and aromatic because they contain scented oil in them (Tewari *et al.*, 2012). Tulsi increases longevity of life that's why it is also known as "elixir of life" (Pandey *et al.*, 2010).

Many Hindu believes that the healing properties of tulsi were given by lord himself, and the plant can be used as medicine. (Tewari *et al.*, 2012).

There are three varieties of tulsi: -

- Rama Tulsi (*Ocimum sanctum*)
- Shyama Tulsi (*Ocimum sanctum*)
- Vana Tulsi (*Ocimum gratissimum*)

III. SCIENTIFIC CLASSIFICATION OF OCIMUM SANCTUM

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Magnoliopsida
- Order: Lamiales
- Family: Lamiaceae
- Genus: *Ocimum*
- Species: *O. tenuiflorum*
- Binomial name: *Ocimum tenuiflorum* or *Ocimum sanctum* (M. Siva *et al.*, 2016)

Table 1: Synonyms of Tulsi in Indian language (Kadian *et al.*, 2012)

S. No.	Name	Language
1.	Tuloxi, Tulasii	Assamese Assam
2.	Tulsi, Kalotulsi	Kural Bengali
3.	Sabje, Talasi	Gujarati
4.	Tulsi, Niyan	Posh Dogri
5.	Karitulasi, Tulasiya	Kannada
6.	Oachaha, Kunnakam	Malayalam
7.	Mayangton, Naoshek	Manipuri
8.	Sabja, Tulasia	Marathi
9.	Dhala tulasi	Oriya
10.	Tulsi	Punjabi
11.	Tulsi, Manjari, Ajaka	Sanskrit
12.	Tirrutizhai, Tiviragandam	Tamil
13.	Oddhi, Rudrajada	Telugu
14.	Tulsi, Jangalitulsi	Urdu

Table 2: Nutritional composition of Tulsi extract (Raghav *et al.*, 2018, Anbarasu *et al.*, 2007)

Principle	Nutrient value
Energy	23 K cal
Carbohydrate	2.65 g
Protein	3.15 g
Total fat	0.64 g
Cholesterol	0 mg
Dietary fiber	1.60 g
Vitamins	
Folates	68 µg

Niacin	0.902 mg
Pantothenic acid	0.209 mg
Pyridoxine	0.155 mg
Thiamin	0.034 mg
Vitamin A	5275 IU
Vitamin C	18 mg
Vitamin E	0.80 mg
Vitamin K	414.8 µg
Minerals	
Calcium	177 mg
Copper	385 mg
Iron	3.17 mg
Magnesium	64 mg
Manganese	1.15 mg
Zinc	0.81 mg

PROPERTIES OF AYURVEDIC HERBS

The properties that can easily define Ayurvedic herbs are as follows: -

1. The Ayurvedic herb can be categorized according to; easy to digest or difficult to digest: Guna
2. According to taste? sour, sweet, salty, pungent, bitter and astringent: Rasa
3. The process of digestion, metabolism, assimilation of herb: Vipaka
4. According to effectiveness of herb on stomach: Virya
5. What kind of action in the body does the food stimulate: Karma (Tewari *et al.*, 2012)?

GENERAL PROPERTIES OF *Ocimum sanctum*

- In Ayurveda, tulsi has been used in hundreds of different formulations for the treatment of wide range of disorders involving mouth and throat, lungs, heart, blood, liver, kidney, and the digestive, metabolic, reproductive and nervous system (Akhilanand Chaurasia, 2015).
- Tulsi has been taken in many forms traditionally as dried powder, fresh leaf, herbal tea and mixed with honey or ghee (Tewari *et al.*, 2012).
- The dried leaves of tulsi can be mixed with stored grains to repel insects (Tewari *et al.*, 2012)
- Tulsi is very helpful in the management of oral disease and dentistry (Akhilanand Chaurasia, 2015).
- As described in Charaka and Sushruta, tulsi is also used in the treatment of snake-bite and scorpion sting (Sa, Almatroodi *et al.*, 2020)
- The external application of tulsi leaves of swollen area are helps in reducing the swelling (Kulkarni *et al.*, 2018).
- The leaves of *Ocimum sanctum* acts as nerving tonic, cardiac tonic and purifies blood (Kulkarni *et al.*, 2018).
- On human body, a wide range of action is played by tulsi as a sweat inducer, a cough alleviator and a mitigator of indigestion and anorexia (Sharma *et al.*, 2010)
- Acne, pimples and scars can be reduced with the help of extracts of tulsi leaves (Kulkarni *et al.*, 2018).
- Tulsi's extract are used in Ayurvedic remedies as expectorant, analgesic, anticancer, antiasthemic, antidiabetic, antifertility, hepatoprotective and anti- stress agent (Akhilanand Chaurasia, 2015).

CHEMICAL COMPOSITION

The different type of chemical compounds are present in different parts of *Ocimum sanctum* (Bano *et al.*, 2017). Tulsi plant have a highly complex chemical composition containing many nutrients and other biologically active compounds. The synergistic interactions of many different active phytochemicals of tulsi results into its nutritional and pharmacological properties, that's why overall effects of tulsi can't be fully duplicated with

isolated compounds (Kumar *et al.*, 2013). The best known of active compounds that have been identified and extracted from tulsi are eugenol (an essential oil) and ursolic acid (Mohan *et al.*, 2011). The leaves of *Ocimum sanctum* contains about 0.7% volatile compounds, comprising about 71% eugenol, and 20% methyl eugenol (Gupta *et al.*, 2002).

Table 3:- Phytochemicals present in *Ocimum sanctum* (M. Siva *et al.*, 2016)

Plant parts	Phytochemicals
Leaves	alkaloids, flavonoids, tannins, saponins, anthocyanins, phenols, steroids, terpenoids
Seeds	Sitosterol, fatty acids
Stem	Flavonoids, phenols, tannins, saponins, triterpenoids
Whole plant	alkaloids, flavonoids, saponins, phenols, tannins, flavonoids, triterpenoids, anthocyanins

Table 4: - Primary active constituents of *Ocimum sanctum* (Raghav *et al.*, 2017, Pattanayak *et al.*, 2010, Chiang *et al.*, 2005, Douglas *et al.*, 2005, R.M.U.S.K. Rathnayaka 2013)

S.N o.	Name of the constituents	Chemical formula	Properties
1.	Eugenol	C10H12O2	Anti-microbial, anticancer, anti-diabetic, cardio protective, hepatoprotective agent
2.	Ursolic acid	C30H48O3	Anti-tumor, activities, hepatoprotective, anti-inflammatory (oral and topical), anti-ulcer
3.	Linalool	C10H8O	Anti-cancer, anti-viral, anti-bacterial, anti-fungal
4.	Carvacrol	C10H14O	Anti-cancer, anti-insecticidal, anti-oxidant, anti-microbial,
5.	Caryophyllene	C15H24	Anti-cancer, antioxidant, anti-malarial, anti-viral
6.	Rosmarinic acid	C18H16O8	Anti-viral, anti-cancer, anti-inflammatory, immunomodulatory,
7.	Estragol	Estragol	Anti-stress, anti-diabetic
8.	Circismaritin	C17H10O6	Anti-ulcer, cardio-protective, anti-stress
9.	Apigenin	C15H10O5	antimicrobial, anti-viral, antioxidant,

MECHANISM OF ACTION OF *Ocimum sanctum*

The different part of tulsi plant holds different constituents such as saponins, triterpenoids, flavonoids, and tannins and leaf volatile oil contains eugenol. Pivotal role in disease cure and diseases management through modulating various biological activities have been shown by these constituents. The mechanism of action of tulsi in disease curing management is described below: -

The generation of oxidative stress and damage of macromolecule to cause pathogenesis is done by higher concentration of reactive oxygen. Neutralization of free radical potentiality is performed by antioxidant activity of tulsi plant, in the other hand, the plant acts as a scavenger of free radical. The chief mechanism through which tulsi protect against the cellular damage is by free radical scavenging. In addition, hydrogen peroxide, hydroxyl radical and superoxide radical scavenging methods determined that extracts with concentration 100 µg/ml have hydrogen peroxide (20.12%), hydroxyl radicals (12.68%) and superoxide radicals (21.68) scavenging activity respectively (Almatroodi *et al.*, 2020).

By modulating various genes, tulsi may help to reduce inflammation and acts as anti-inflammatory agent. The remedy for antibacterial drug resistance is much needed because it is a major health problem. A significant role in inhibition of bacterial growth or killing of bacteria by rupturing of cell wall is played by natural compound. Anti-gonorrhoeal efficacy against multi resistant strains of *Neisseria gonorrhoea* and clinical isolates of beta-lactamase producing methicillin resistant *Staphylococcus aureus* are well established in tulsi plant (Almatroodi *et al.*, 2020).



Fig: - *Ocimum sanctum*

PHARMACOLOGICAL PROPERTIES OF *Ocimum sanctum*

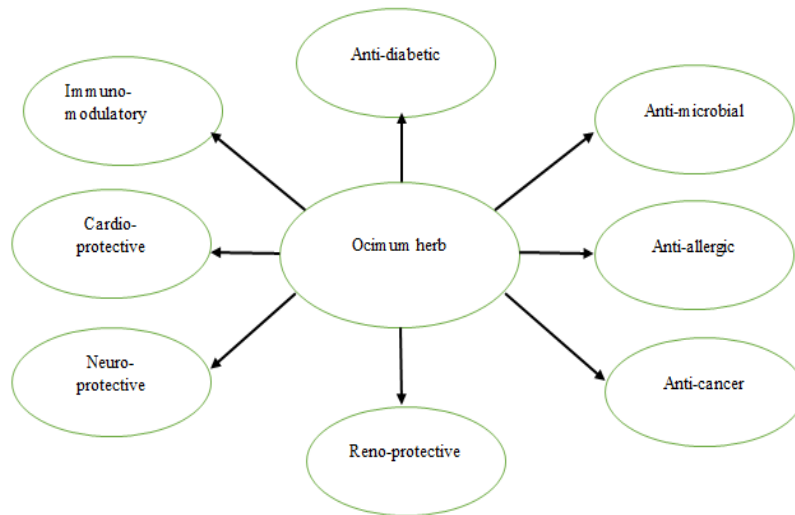


Fig. therapeutic uses of *Ocimum sanctum* (Pandiri *et al.*, 2018).

ANTIMICROBIAL ACTIVITIES OF *Ocimum sanctum*

The property of inhibition of growth of pathogenic micro-organisms such as bacteria, virus and fungi are shown by tulsi (*Ocimum sanctum*) (Raghav *et al.*, 2018). The remedy for antimicrobial drug resistance is much needed because it is a major health problem. A significant role in inhibition of bacterial growth or killing of bacteria by rupturing of cell wall is played by natural compound (Almatroodi *et al.*, 2020). In India, *Ocimum sanctum* have been found to have higher antimicrobial properties as compared to other commonly available species i.e., *O. canum*, *O. grassitissimum*, and *O. basilicum*. The antimicrobial properties against enteric pathogens are exhibit by the alcoholic extract, seed oil, and aqueous extract of *Ocimum sanctum*. The anti-microbial properties against some clinical isolates of *Neisseria gonorrhoea* is shown by tulsi extract (Raghav *et al.*, 2018).

Table 6:- Antimicrobial properties of tulsi (*Ocimum sanctum*) (Prمود *et al.*, 2018):-

S. No.	Types of Extract	Micro-organisms	Results	References
1.	Tulsi (Aqueous extract)	<p>Bacteria: - Gram positive and gram-negative bacteria.</p> <p>Virus: - <i>White spot syndrome virus (WSSV)</i>, <i>Buffalo pox virus (GTPV)</i>, <i>Rhinotracheitis virus (IBR)</i>.</p> <p>Fungi: - <i>Fusarium solani</i>, <i>Candida albicans</i>, <i>Aspergillus flavus</i>, <i>Aspergillus repens</i></p>	Positive	<p>Chandra <i>et al.</i>, 2011</p> <p>Ali & Dixit 2012</p> <p>Kumar <i>et al.</i>, 1986</p> <p>Singh <i>et al.</i>, 2005</p> <p>Geeta <i>et al.</i>, 2001</p> <p>Pasha <i>et al.</i>, 2009</p> <p>Joshi <i>et al.</i>, 2011</p>

				Kaya <i>et al.</i> , 2005 Sharma 2010 Williamson 2002 Joseph <i>et al.</i> , 2008 Balasubramanian <i>et al.</i> , 2007 Bhanuprakash <i>et al.</i> , 2008a, 2008b.
2.	Tulsi leaves (Aq., Methanolic & Acetone extract)	Gram positive and gram-negative bacteria.	Positive	Devi <i>et al.</i> , 2015
3.	Tulsi leaves extract (Aqueous Chloroform, Alcoholic extract and oil)	Gram positive Bacteria and gram- negative bacteria	Positive	Ratnayaka 2013
4.	Tulsi extract	<i>Aspergillus fumigatus</i> , <i>Candida albican</i> , <i>Aspergillus niger</i> .	Positive	Dharmagadda <i>et al.</i> , 2005 Sharma 2010
5.	Tulsi leaves (Methanolic extract)	Bacteria: -Gram positive and gram-negative bacteria. Fungi: - <i>Fusarium solani</i> , <i>Candida crusei</i> .	Positive	Tantry <i>et al.</i> , 2016 Kumar <i>et al.</i> , 2011 Kaya <i>et al.</i> , 2005
6.	Tulsi leaves (Alcoholic extract)	Bacteria: - Gram positive and gram-negative bacteria Fungi: - <i>Candida albicans</i> .	Positive	Joshi <i>et al.</i> , 2011 Geeta <i>et al.</i> , 2001
7.	Tulsi leaves (Essential oil)	Gram positive and Gram-negative bacteria.	Positive	Sharma <i>et al.</i> , 2014. Yamini <i>et al.</i> , 2016.

ANTIBACTERIAL PROPERTIES OF *Ocimum sanctum*

The antibacterial activities against many bacterial strains are shown by alcoholic extract, aqueous extract, chloroform extract and oil obtained from leaves of *Ocimum sanctum*. The equal effectiveness of tulsi leaves extract was observed against the gram positive and the gram-negative bacteria (Kulkarni *et al.*, 2018). The antibacterial activity of *Ocimum sanctum* is contributed by the fixed oils that contains higher content of linoleic acid. The effectiveness of fresh leaves extracts of *Ocimum sanctum* against bacterial strains is more than the dried leaves extract (Raghav *et al.*, 2018).

Tulsi can inhibit in vitro growth of *Mycobacterium tuberculosis* (Joshi *et al.*, 2017). The extract of *Ocimum sanctum* was found active against *Streptococcus mutans*. The essential oils show sensitivity to the bacterial species *Bacillus subtilis*, *S. aureus*, *P. aeruginosa*, *S. aureus*, *S. mutans*, and *Enterococcus faecalis* (Upadhyay 2017). *O. sanctum* leaves extract contains phenolic constituents like Rosmarinus acid, eugenol, cirsineol. The efficiency of Methanolic extract of *Ocimum sanctum* leaves against pathogens was found to be less than aqueous extract. *O. sanctum* also contains active constituents which shows strong effects against strain of *S. aureus*, *Bacillus pulmulis* and *P. aeruginosa* are responsible for spoilage of vegetables, fruits, food products; and they cause serious health problems in humans (Raghav *et al.*, 2018). *O. sanctum* are provided with chloramphenicol and trimethoprim, & shows synergistic antibacterial activity against *Salmonella Typhi* (Upadhyay *et al.*, 2017).

ANTIFUNGAL PROPERTIES OF *Ocimum sanctum*

The antifungal activity is shown by alcoholic fraction and Methanolic fraction of *Ocimum sanctum* against dermatophyte fungi like *T. rubrum* etc. The anti-dermatophytic activity is better shown by aqueous fraction than the methanolic fraction (Kulkarni *et al.*, 2018). The anti-fungal activity is chiefly shown by chloroform,

aqueous, hexane, and other solvent extract of tulsi. *O. sanctum* also acts against bio-deterioration of food stuffs during their storage. The positive results were shown by tulsi, when it was tested on *Alternaria solani*, *Fusarium solani* (M. Siva *et al.*, 2016).

ANTI-VIRAL PROPERTIES OF *Ocimum sanctum*

The Linalool, Eugenol, Ursolic acid, Apigenin etc. are some secondary metabolites that are produced by tulsi plant and these secondary metabolites acts as anti-viral agents against some viruses. The evaluation of the aqueous extract and the essential oil was done for patients suffering from viral encephalitis (Raghav *et al.*, 2018). The anti-viral activities against some viruses like *New Castle Disease Virus*, *Herpes Virus (HSV)*, *Hematopoietic Necrosis Virus*, *Polio Virus type 3*, *Hepatitis B virus* is shown by different extracts of tulsi. The tulsi plant also shows broad spectrum anti-viral activity against Adenovirus and DNA like RNA virus. (Bano N. *et al.*, 2017).

ANTIOXIDANT PROPERTIES OF *Ocimum sanctum*:-

Tulsi is used to prevent the oxidation of lipids, sugars, and proteins and DNA that can generate aldehydes, ketones, esters and other products that can be harmful to living system (Upadhyay *et al.*, 2017). In various clinical conditions, tulsi can be used either alone or in combination with other compounds (Nigam *et al.*, 2014). Propanoid compounds including eugenol and methyl eugenol are present in the leaves of tulsi as major constituents which decrease serum lipid profile in normal and diabetic animals. Antihyperlipidemic and antioxidative actions against hypercholesterolemia are also shown by tulsi (Upadhyay *et al.*, 2017).

In a study it was found that *Ocimum* extract (OE) protects against radiation induced lipid peroxidation and that protects the reduction of GSH and other antioxidant enzymes. A significant role is played by *Ocimum sanctum* in providing protection from oxidative damage induced by oxidative stress (Kulkarni *et al.*, 2018). Ursolic acid present in tulsi provide remarkable protection against lipid peroxidation in isolated liver and heart microsomes in-vitro. A mild protection as compared to strong protection is also provided by oleanolic acid against Adriamycin induced lipid peroxidation (Gupta *et al.*, 2002).

IV. CONCLUSION

Now-a-days, natural medicinal plants and their products are used widely over chemical products because they cause lesser side effects in human body. *Ocimum sanctum* is more economic and have lesser side effects. The leaves of *Ocimum sanctum* are used in various Ayurvedic medicine preparations for treatment of many diseases and disorders. Due to its matchless properties, tulsi is known as "Queen of herbs". A huge spectrum of pharmacological properties is shown by *Ocimum sanctum*. In Ayurveda, crude extracts of various parts of tulsi plants have been used for their anti-diabetic, antioxidant, anti-stress, anti-hypolipidemic and antibacterial properties. The different parts of tulsi plant shows beneficial properties excluding any side effects, these beneficial properties made this plant distinctive from others. The leaves extract of tulsi contains some active components which acts as an antimicrobial agent. Scientists have shown their interest in this plant because of its qualities like it is easily available and non-toxic in nature. The fruits and vegetables are coated with tulsi extract to control bacterial and fungal spoilage. The tulsi extract can also be used as herbal edible coating material on nutraceutical. The modern approaches to drug development may explore regarding bioactivity, pharmacotherapeutics clinical trials, mechanism of action, safety evaluation after proper standardization and clinical trials. Furthermore, sacred basil should be emphasized for control of various disease.

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