



Review Article

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ANTIMICROBIAL ACTIVITY OF TULSI (*OCIMUM SANCTUM* LINN): A SYSTEMATIC REVIEW

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ABSTRACT

Tulsi or *Ocimum sanctum* Linn. is a popular healing herb in Ayurvedic medicine. Its antimicrobial properties are widely used to treat several systemic diseases. In this review, we have given an up-to-date overview of the anti-infective properties of the Tulsi plant, with a particular focus on its antibacterial and antifungal activity. Published articles relevant to the research questions were searched in their database (PubMed, Scopus, Web of Science). 27 out of 350 articles were selected through online and snowballing literature searches. Of these 27 articles, 20 were original research articles, and 7 were systematic reviews. The included articles were assessed on quality reporting, and results were presented using descriptive analysis. In the existing scenario of the high prevalence of bacterial diseases in developing countries like India, the emergence of multi-drug resistance amongst the prevalent pathogens has made it imperative to explore alternate preventive and treatment strategies to combat this problem. This study highlights the hidden antimicrobial potential of the phytochemicals and bioactive compounds derived from traditional medicinal plants like Tulsi as a good alternative.

Keywords: Tulsi, *Ocimum sanctum* Linn, Plant extract, Antimicrobial, Anti-bacterial, Antifungal.

INTRODUCTION

The Tulsi plant (*Ocimum sanctum* Linn.) is one of the most valued holistic medicinal plants in traditional India. Its herbal derivatives have been used as a household remedy for several ailments since time immemorial. This plant, considered sacred, holds a special place in Indian culture. It has been used to prepare several ayurvedic herbal medicaments since ancient times. Tulsi has been delineated as 'Queen of Herbs' and 'Mother of Nature' thanks to its enormous health benefits.^{1,2}

This plant is growing well everywhere in India and some South-East Asia countries. *O. sanctum* is often referred to as Tulsi in India.³

Compared with synthetic drugs, plant-derived medicines have been preferred worldwide due to their potent pharmacological activities, low toxicity, and economic viability. One World Health Organization (WHO) survey reports that more than 80% of the world's population still depends upon traditional medicines for various diseases.⁴

The plant extracts and phytochemicals, with known antimicrobial properties, could be a potential alternative to antibiotics in managing common infections. The secondary metabolites of plants were found to be a source of various phytochemicals that could be directly used as intermediates for producing new drugs. One of the possible strategies is the rational localization of bioactive phytochemicals with antibacterial activity.⁵

Ocimum sanctum L. (also known as *Ocimum tenuiflorum*, Tulsi), which has been used in Ayurvedic medicine to manage several

systemic diseases, is known to exhibit remarkable antimicrobial properties.⁵

Tulsi, the Queen of herbs, the legendary 'Incomparable-one in India, is among the holiest and most cherished of the numerous healing and health benefitting herbs of the oriental world. The sacred basil, Tulsi, is famed for its spiritual and religious holiness and its vital role within the ancient Ayurvedic and Unani systems of holistic herbal medicine. Charaka mentions its medicinal properties within the Charaka Samhita, which is the foundational text of Ayurvedic medicine.⁶

Tulsi is considered an adaptogen, balancing different processes in the body and helpful for adapting to stress. It is regarded as the 'elixir of life in Ayurveda and is believed to promote longevity. Tulsi extracts are employed in Ayurvedic remedies for common colds, headaches, abdomen disorders, inflammation, cardiopathy, numerous sorts of poisoning, and protozoal infection. Tulsi is usually taken in several forms, such as tea, dried powder, or raw freshly picked leaves. Since ancient times, the dried Tulsi leaves were mixed with stored household grains to repel insects.⁷

Tulsi has been India's pillar of the Ayurvedic holistic health care system. Since time immemorial, various plant parts have been used extensively in treating several systemic diseases like upper respiratory infections, bronchitis, skin diseases, malaria, etc. Several investigators have tested the antimicrobial properties of Tulsi extracts and oil against various bacterial and fungal pathogens.⁸

The extract and essential oil of *Ocimum sanctum* possess insecticidal and bactericidal activity. In recent years, Tulsi has

been employed in numerous forms in Indian medicines like the aqueous extract of leaves (fresh and dried powder) or oil extract.⁴

Tulsi extract is often used therapeutically to treat many diseases like fever, headache, malaria, heart diseases, and inflammation. The antimicrobial properties of Aqueous extract of Tulsi leaves and essential oil of Tulsi seed have been utilized in 'Food Preservation' to inhibit the bacterial and fungal infestation.^{9,10}

In the past few years, it has become difficult to manage skin and soft tissue infections (SSTIs) due to the increasing prevalence of multidrug-resistant pathogens. To avoid the spread of multidrug-resistant pathogens in clinical settings, it is essential to identify SSTIs that need antibiotic treatment. A recent European survey has reported that a large proportion of physicians use systemic antibiotics only when it is imperative to treat conditions like MRSA colonized ulcers or broken skin surfaces.¹¹

In this review, we have given an up-to-date overview of the anti-infective properties of the Tulsi plant, with a particular focus on its antibacterial and antifungal activity.



Figure 1: Tulsi plant (*Ocimum sanctum* Linn.)

This systematic review was prepared following the PRISMA (Preferred Reporting Items for Systematic Reviews) guidelines.¹²

Search strategy

An initial search with predefined keywords was performed, and a detailed search strategy was developed later. We searched Medline/PubMed, Scopus, Google Scholar, Embase, and Cochrane databases for eligible original reports. Articles published between Jan 2005 to Dec 2021 were included for assessment in this systematic review (most articles were chosen from the last 15 years). Bibliographical references of potentially related articles were checked and searched for additional articles.

Study Selection

Two reviewers independently screened the retrieved titles and abstracts of articles for relevance after duplicates were removed. The third reviewer performed a full-text screening. The articles were excluded after the mutual consensus of the reviewers. Any differences were resolved through discussion with a fourth reviewer. Final eligible articles were selected for data extraction.

Data extraction: Data was extracted in standardized Microsoft excel format. All authors reviewed and verified the data. Discrepancies were rectified through in-depth discussions and revisiting the full text of case reports if needed.

Summary measures and statistical analysis: Articles were estimated and summarized descriptively.

Search results and Study characteristics

27 out of 350 articles were selected through online and snowballing literature searches. Out of these 27 articles, 20 were original research articles, and 7 were systematic reviews after removing the duplicates and non-eligible studies. Most of the original articles analysed were from India, followed by Saudi Arabia.

Antimicrobial properties

Tulsi (*Ocimum sanctum*) is the most sacred and valued medicinal plant used to treat bacterial, viral, fungal, and arthropod-borne diseases since ancient times globally, especially in the Indian subcontinent. *Ocimum sanctum* has many medicinal properties which are beneficial to human health without any significant toxic effect reported in its routine use. Thus, these valuable properties make this plant unique from others.

Tulsi extract exhibits antibacterial effects against *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Bacillus pumilus*. These microbes are responsible for food spoilage, poisoning, and other human infections. Tulsi extract and oil have shown inhibitory effects against *Mycobacterium tuberculosis*. Essential oil of Tulsi has 1/10th anti-tubercular potency of streptomycin and 1/4th that of Isoniazid.⁴

The best characteristic feature of the *Ocimum sanctum* plant is its easy availability and its non-toxic nature. Because of these qualities, scientists have shown their interest in this plant. Many Scientists have reported that the Tulsi (*Ocimum sanctum*) leaves extract and essential oil are good antimicrobial agents. Essential oil and extract of Tulsi leaves could be a prospective alternative to the synthetic preservatives used in food industries. Tulsi extract is a coating material applied to fruits and vegetables, controlling bacterial and fungal spoilage. It is an edible coating for fruits and vegetables and a nutraceutical.⁹

In their study, Singh *et al.*, suggested that higher linoleic acid content in *Ocimum sanctum* fixed oil could contribute to its antibacterial activity. The oil showed good antibacterial activity against *Staphylococcus aureus*, *Bacillus pumilus*, and *Pseudomonas aeruginosa*, where *S. aureus* was the most sensitive organism.¹³

Geeta *et al.*, reported that the aqueous extract of *Ocimum sanctum* (60 mg/kg) showed wide inhibition zones compared to alcoholic extract against *Klebsiella pneumoniae*, *E. coli*, *Proteus spp.*, *S. aureus*, and *Candida albicans* by agar disk diffusion method. The alcoholic extract showed a wider zone of inhibition for *Vibrio cholerae*.¹⁴

Studies have shown that the essential oils and biologically active compounds in fresh leaves of *Ocimum sanctum* Linn. are effective against bacteria like *E. coli*, *Shigella spp.*, *Salmonella typhi*, *B.anthraxis*, and *P.aeruginosa*.¹⁰

The oils are known to exhibit in vitro growth inhibitory effects on *M. tuberculosis*.^{15,16}

A study conducted in Lahore, Pakistan, found that essential oils from fresh *Ocimum sanctum* Linn. leaves displayed marked antibacterial efficacy against *Pseudomonas aeruginosa*, *E.coli*, *Klebsiella spp.*, *Proteus mirabilis*, and *Staphylococcus aureus*.¹⁷

The aqueous extract, seed oil, and alcoholic extract of *Ocimum sanctum* exhibited antimicrobial properties against enteric pathogens.¹⁸

In another research, the investigators found that the aqueous extract of Tulsi leaves showed antifungal and antibacterial activity against *Candida albicans*, *E. coli*, *Proteus spp.*, *S. Aureus*, *Shigella spp.*, *P.aeruginosa*, *Aeromonas hydrophila*, *Enterococcus faecalis*, and *Klebsiella pneumoniae*. Alcoholic extract of Tulsi leaves possesses an inhibitory effect against *Vibrio cholerae*.¹⁹

A study done by Devi et al., investigated that the *Ocimum sanctum* leaves extract is an excellent antimicrobial agent; it is highly effective against Gram-positive and Gram-negative bacteria such as *Staphylococcus aureus*, and *Klebsiella pneumoniae*, *P.putida*, *B.subtilis*, and *E.coli*.²⁰

Tulsi extract has also shown significant antimicrobial properties against some of the multidrug-resistant clinical isolates of *Neisseria gonorrhoeae*.²¹

Phadke SA et al., have found that the crude extract of freshly picked leaves of *Ocimum sanctum* and oil is more effective against bacterial strains than the dried leaves extract.²²

Agarwal et al., reported a high antibacterial potential of Tulsi leaves extract against *Streptococcus mutans*. Some other researchers had reported significant antibacterial properties of Tulsi extracts against *Staphylococcus aureus*, *Streptococcus mutans*, and *E. faecalis*.²³

According to Singh E et al., higher content of linoleic acid in the fixed oil of Tulsi extract is responsible for the significant antibacterial properties of the extract against *P.aeruginosa*, *Bacillus pumilus*, and *S. aureus*.²⁴

Tantry et al., and Kumar et al., found that the ether extract of Tulsi leaves contains good antibacterial properties against *M. tuberculosis*, *Staphylococcus aureus*, and *E. coli*.^{25, 26}

One relevant review article has attributed some crucial components like camphor, eucalyptol, eugenol, and β -caryophyllene to the antimicrobial activity of Tulsi oil, against the major pathogens causing Skin and soft tissue infections (SSTIs) like *S.aureus* (including MRSA), *P.aeruginosa*, and *E.coli*. Tulsi essential oil could find its place as an effective topical antimicrobial agent and as an ingredient in wound dressing for the prevention and treatment of skin infections. These alternative measures may halt the progression to more severe infections and reduce the risk of developing drug resistance to routine antimicrobial therapy.²⁷

CONCLUSION

From time and again, various studies conducted globally in diverse backgrounds have reported that the different crude extracts of *Ocimum sanctum* Linn. is popularly known as Tulsi in the Indian subcontinent, have exhibited remarkably significant antimicrobial activity esp. against the common bacterial and fungal pathogens. By reviewing some of the studies relevant to this aspect, we tried to explore the hidden herbal treasure of folklore medicines. Our findings indicate an immense potential of the exploratory studies for deriving the bioactive phytochemicals from the Tulsi extracts, which could be utilized at least partially in developing and delivering pharmaceutical products which could be used either as an alternative to conventional antimicrobial therapy or synergistically as an adjuvant along with the standard antimicrobials. This strategy could help tackle the growing menace of the rapidly emerging multidrug resistance amongst the pathogens wherein most antibiotics will be rendered

ineffective, paving the way for a new group of herbal antimicrobials.

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