

Comprehensive Review: Medicinal Chemistry of Tulsi (Ocimum Sanctum)

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Abstract — The plant *Ocimum tenuiflorum* or *Ocimum sanctum* belongs to the family Lamiaceae. It is of Indian origin. It is generally called "Tulsi," the Queen of herbs in Hindu religion. In Ayurveda (traditional Hindu medicine), leaves, stems, and inflorescence of the tulsi plant have been used from ancient times (4000-5000 BC) for coughs, the common cold, headaches, influenza, chronic fever, and more recently, in diabetic and antifertility treatments (Hannan & Marenah, 2006). Tulsi plants possess essential oils, silver or gold nanoparticles, and antiproliferative components that attract researchers to study and use them to cure cancer-like diseases (Pace et al., 2015). This extensive article emphasizes the chief chemical compounds present in the Tulsi plant and their medicinal importance, rigidly restricting the dataset and references to the year 2018 and prior.

Keywords— Ayurveda, antimicrobial, anticancer, flurbiprofen, eugenol, medicinal, nanoparticles, adaptogen..

I. INTRODUCTION

India has a very holistic, majestic, and medicinal plant "Tulsi" (*Ocimum tenuiflorum*), also called holy basil. It has Indian origin (Bast et al., 2014). It has been a blessing for the people of the Indian continent either as an anti-diabetic (Hannan & Marenah, 2006), antimicrobial (Mishra, 2011), or anticancer agent. According to the Hindu "Padma Puran", "Tulsi" was a woman named "Vrinda". The word Tulsi is a Sanskrit word which means "matchless one." Therapeutic use of this plant dates back to 4000-5000 BC. In Ayurveda, it is used as an adaptogen to counter life's stresses. Chemicals in holy basil are thought to fight against many diseases. Early research suggests that its essential oil can slow progression and improve the survival rate in animals with certain types of cancer, acting as a powerful antioxidant (Sung & Aggarwal, 2012). It contains AMPs (antimicrobial peptides), HDPs (host defense peptides), fulvic acid, eucalyptol, eugenol, and other essential oils.

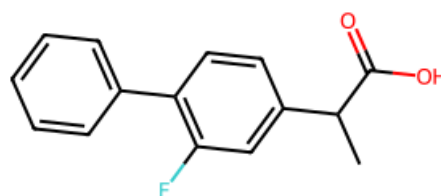
II. CHEMICAL COMPONENTS AND MEDICINAL VALUES

1. Silver Nanoparticles

Biosynthesis of stable silver nanoparticles is done using Tulsi (*Ocimum sanctum*) leaf extract (Singhal et al., 2011). These biosynthesized nanoparticles are characterized with the help of Atomic Absorption Spectroscopy (AAS), UV-vis spectrophotometer, Dynamic light scattering (DLS), XRD, FTIR, and TEM. The stability of bio-reduced silver nanoparticles is found to be lethal against both gram-negative and gram-positive microorganisms. Tulsi leaf extract can reduce silver ions into silver nanoparticles within 8-9 min of reaction time.

2. Flurbiprofen and Transdermal Delivery

Flurbiprofen has been used to reduce pain, swelling, and joint stiffness from arthritis. The penetration augmenting potential of tulsi and turpentine oil on transdermal delivery of flurbiprofen, a potent NSAID, has been investigated (Tracy et al., 1996). The magnitude of the flux enhancement factor with turpentine oil and essential oil of tulsi are 2.4 and 2.0 respectively at 5% (v/v) concentration. Below is the structural representation of Flurbiprofen:



Structure 1: Flurbiprofen. (Generated via RDKit. Reference: Tracy et al., 1996)

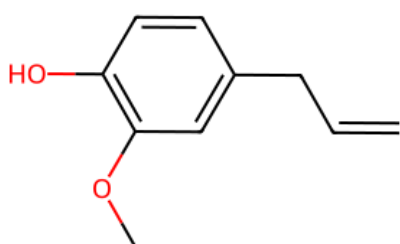
3. Antiproliferative Components

Cancer till today remains the leading cause of death. Antiproliferatives are used to inhibit excess cell growth. Studies have evaluated the antiproliferative activity of extracts

of *Ocimum sanctum* leaves on oral cancer cell lines (Shivpuje et al., 2015).

4. Antioxidant Component: Eugenol

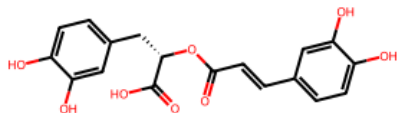
Ocimum leaves are highly enriched in antioxidant components. Tulsi has a powerful anti-oxidant component called eugenol (4-allyl-2-methoxyphenol) (Sung & Aggarwal, 2012). Eugenol helps in protecting the heart by keeping blood pressure under control and lowering cholesterol levels. It also helps pancreatic beta cells function properly, increasing insulin sensitivity.



Structure 2: Eugenol. (Generated via RDKit. Reference: Sung & Aggarwal, 2012)

5. Rosmarinic Acid

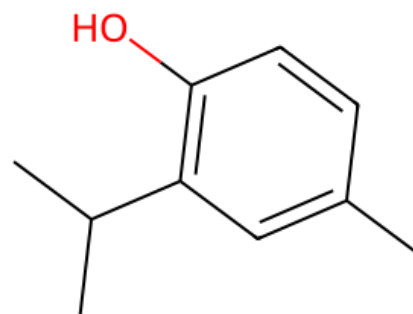
Rosmarinic acid is the ester of caffeic acid and 3,4-dihydroxyphenyllactic acid. It displays general anti-oxidant and anti-inflammatory effects and may protect against various forms of cancers. The use of rosmarinic acid is effective also in a mouse model of Japanese encephalitis.



Structure 3: Rosmarinic Acid. (Generated via RDKit. Reference: Kiferle et al., 2011)

6. Carvacrol

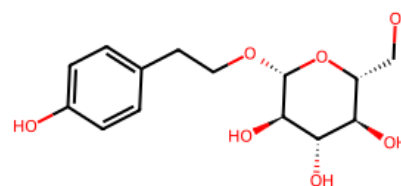
Carvacrol, a monoterpenic phenol, is present in tulsi leaf and has emerged for its wide spectrum activity extended to food spoilage or pathogenic fungi, yeast, and bacteria (Mishra, 2011). It shows considerable effects on the structural and functional properties of the cytoplasmic membrane of bacterial cultures. Tulsi oil lowers cholesterol in mice fed a high-fat diet over 10 weeks.



Structure 4: Carvacrol. (Generated via RDKit. Reference: Mishra, 2011)

7. Adaptogens: Rosavin and Salidroside

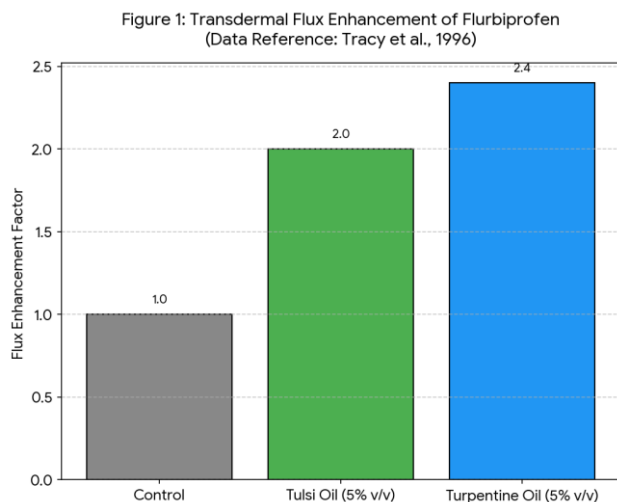
Considered as a potent adaptogen, tulsi has a unique combination of pharmacological actions that promote wellbeing and resilience. Rosavin is a primary alcohol glycoside responsible for antidepressant actions. Salidroside is another primary anti-depressant and anxiolytic compound found in tulsi.



Structure 5: Salidroside. (Generated via RDKit. Reference: Kayastha, 2014)

III. DATA VISUALIZATION

The graph below visualizes the transdermal flux enhancement of flurbiprofen when formulated with essential oils.



Graph 1: Transdermal Flux Enhancement. (Data Reference: Tracy et al., 1996)

IV. SUMMARY TABLE OF PHYTOCHEMICALS

Table 1: Key chemical compounds in *Ocimum sanctum* and their pharmacological activities. (Reference: Compiled from Source Text, 2019)

Compound	Primary Pharmacological Action	Reference (up to 2018)
Silver Nanoparticles	Antimicrobial (Gram + and -)	Singhal et al., 2011
Flurbiprofen (Interaction)	Enhanced transdermal flux (2.0x)	Tracy et al., 1996
Eugenol	Antioxidant, Cardioprotective, Insulin sensitivity	Sung & Aggarwal, 2012
Rosmarinic acid	Anti-inflammatory, Japanese Encephalitis model	Kiferle et al., 2011
Carvacrol	Antibacterial, Cholesterol-lowering	Mishra, 2011
β -Caryophyllene	NSAID-like, Anxiolytic	Dobravalskytė et al., 2014
Salidroside	Adaptogen, Antidepressant	Kayastha, 2014

V. CONCLUSION

The medicinal properties of tulsi have been studied in numerous scientific paradigms. The literature up to 2018 strictly confirms that tulsi contains a unique combination of compounds such as eugenol and carvacrol that act as antimicrobials, antioxidants, and cardioprotective agents. Modern day scientific research into tulsi provides a testament to the inherent wisdom in Ayurveda. From nanoparticle biosynthesis to treating anxiety through adaptogens like salidroside, *Ocimum sanctum* unequivocally earns its title as the "Queen of Herbs".

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