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Role of Plant Extract (Tulsi) In Biological Control of Mosquitoes

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Abstract

The utilization of plant extracts, particularly Tulsi (Ocimum tenuiflorum), in the biological control of mosquitoes has garnered increasing attention due to its potential as a natural and sustainable approach to mosquito management. This review paper aims to critically examine the role of Tulsi extract in controlling mosquito populations and mitigating the transmission of mosquito-borne diseases. Through a comprehensive analysis of existing literature and research findings, the paper elucidates the biochemical properties of Tulsi extract relevant to mosquito control, including its chemical composition, mechanisms of action, and efficacy against different mosquito species. Furthermore, the paper explores the potential applications of Tulsi extract in integrated mosquito management strategies, considering factors such as larvicidal, adulticidal, and repellent activities, as well as its environmental impact and safety profile. By synthesizing current knowledge and research gaps, this review provides valuable insights into the utilization of Tulsi extract as a biocontrol agent for mosquitoes, highlighting its potential contributions to public health and sustainable vector control initiatives.

Keywords: Tulsi, Ocimum tenuiflorum, Mosquito, Public health.

Introduction

Mosquitoes pose significant health risks as vectors of various diseases, including malaria, dengue fever, Zika virus, and West Nile virus, affecting millions of people worldwide each year. Traditional methods of mosquito control, such as insecticides and larvicides, have raised concerns about environmental pollution, insect resistance, and adverse effects on non-target organisms. In response to these challenges, biological control strategies have gained attention as sustainable alternatives for managing mosquito populations.

Biological control involves the use of living organisms or natural products to suppress pest populations. In the context of mosquito control, biological agents can include predators, parasites, pathogens, and plant-derived substances with insecticidal properties. These approaches offer several advantages, including specificity to target pests, reduced environmental impact, and compatibility with integrated pest management (IPM) practices. [1]

One promising avenue of biological control is the use of plant extracts, such as those derived from Tulsi (Ocimum tenuiflorum), commonly known as holy basil. Tulsi has a long history of use in traditional medicine and is known for its insecticidal and repellent properties. Research into the efficacy of Tulsi extract against mosquitoes has shown promising results, making it a potential candidate for inclusion in mosquito control programs.

Overview of Mosquitoes and Their Impact

Mosquitoes represent a ubiquitous threat to human health and well-being, serving as vectors for a plethora of infectious diseases globally. With over 3,500 species distributed across diverse habitats, mosquitoes are recognized as one of the most significant disease vectors, transmitting pathogens responsible for illnesses such as malaria, dengue fever, Zika virus, chikungunya, and West Nile virus. These diseases collectively affect millions of people each year, particularly in tropical and subtropical regions where mosquito-borne illnesses are endemic. Beyond the direct health impacts, mosquito-borne diseases impose substantial economic burdens on healthcare systems and hinder socioeconomic development in affected communities. Moreover, climate change and urbanization are contributing to the expansion of mosquito habitats and the proliferation of disease transmission, exacerbating the already formidable challenges posed by these blood-feeding insects. Thus, understanding the biology, ecology, and control of mosquitoes is essential for mitigating their impact on human health and promoting global public health initiatives. [2]

Importance of Tulsi (Ocimum tenuiflorum) in Traditional Medicine

Tulsi (Ocimum tenuiflorum), also known as holy basil, holds significant importance in traditional medicine systems, particularly within the framework of Ayurveda, due to its multifaceted therapeutic properties. Considered a sacred plant in

Hindu culture, Tulsi has been revered for its medicinal virtues for centuries. Its pharmacological profile encompasses antimicrobial, anti-inflammatory, antioxidant, immunomodulatory, and adaptogenic properties, making it a versatile herb for the prevention and treatment of various ailments. In Ayurvedic practice, Tulsi is prescribed for respiratory disorders like asthma, bronchitis, and coughs, as well as for digestive issues, stress management, and promoting overall well-being. Its rich phytochemical composition, including eugenol, rosmarinic acid, and ocimumosides, contributes to its pharmacological activities and underscores its therapeutic potential. While modern scientific research continues to elucidate the mechanisms of action and clinical efficacy of Tulsi, its inclusion in traditional medicine highlights its cultural significance and enduring relevance in promoting health and vitality. [3]

Mosquito Biology and Control Methods

Understanding the biology and behavior of mosquitoes is crucial for the development and implementation of effective control methods aimed at mitigating the transmission of mosquito-borne diseases. Mosquitoes undergo complex life cycles, transitioning through egg, larval, pupal, and adult stages, with each stage presenting unique vulnerabilities and opportunities for intervention. Traditional mosquito control methods have focused on larval source reduction through environmental management and the application of larvicides, targeting breeding sites such as stagnant water bodies. Additionally, adult mosquito populations are often targeted using insecticides applied through space spraying or residual treatments. However, the emergence of insecticide resistance among mosquito populations poses a significant challenge to conventional control efforts. In recent years, alternative control strategies have gained attention, including biological control methods utilizing natural enemies such as predatory fish, bacteria, and parasitic nematodes to suppress mosquito populations. Integrated mosquito management approaches, which combine multiple control tactics tailored to local conditions, show promise in reducing mosquito populations while minimizing environmental impact and mitigating the risk of insecticide resistance. Continued research into mosquito biology, behavior, and control methods is essential for developing sustainable and effective strategies to combat mosquito-borne diseases. [4]

Properties of Tulsi Extract Relevant to Mosquito Control

Tulsi possesses several properties that are relevant to mosquito control efforts. First and foremost, Tulsi exhibits potent insecticidal and repellent properties, making it an effective tool for reducing mosquito populations and deterring their biting behavior. The essential oils present in Tulsi, such as eugenol, thymol, and camphor, have been shown to disrupt the nervous system of mosquitoes, leading to paralysis and death. Additionally, the strong aroma emitted by Tulsi acts as a natural repellent, discouraging mosquitoes from landing on or biting individuals in its vicinity.

Figure: Tusli (Ocimum tenuiflorum)

Furthermore, Tulsi extract exhibits low toxicity to non-target organisms, making it an environmentally friendly alternative to synthetic insecticides. Its biodegradable nature and minimal ecological impact make Tulsi extract a promising candidate for inclusion in integrated mosquito management programs aimed at reducing mosquito-borne disease transmission while minimizing harm to beneficial insects and other organisms in the ecosystem. [5]

Chemical Composition of Tulsi Extract

Tulsi extract is composed of various phytochemical compounds, each contributing to its therapeutic properties and potential for mosquito control. The chemical composition of Tulsi extract is diverse and includes several bioactive constituents, with phenolic compounds being among the most abundant. These phenolic compounds include eugenol, rosmarinic acid, apigenin, luteolin, and quercetin, which possess antioxidant, anti-inflammatory, and antimicrobial properties. Additionally, Tulsi extract contains essential oils

rich in monoterpenes and sesquiterpenes, such as eugenol, methyl eugenol, and β-caryophyllene, which contribute to its characteristic aroma and insecticidal activity against mosquitoes. Other constituents present in Tulsi extract include flavonoids, tannins, alkaloids, and saponins, each with their unique biological activities. The synergistic interactions between these bioactive compounds enhance the overall efficacy of Tulsi extract in mosquito control and make it a valuable natural resource for integrated pest management strategies. Further research into the chemical composition of Tulsi extract and its effects on mosquito biology is essential for optimizing its use as a sustainable and effective mosquito control agent. [6]

Mechanisms of Action Against Mosquitoes

The mechanisms of action of Tulsi (Ocimum tenuiflorum) against mosquitoes involve a multifaceted approach, leveraging its diverse phytochemical composition to disrupt various physiological processes essential for mosquito survival and reproduction. One primary mechanism is the neurotoxic effect exerted by compounds such as eugenol, thymol, and camphor, which target the nervous system of mosquitoes, leading to paralysis and eventual death. These compounds interfere with neurotransmitter function, disrupt ion channels, and inhibit acetylcholinesterase activity, ultimately impairing neuronal transmission and motor function in mosquitoes. Additionally, Tulsi extract exhibits repellent properties attributed to its strong aroma, which acts as a deterrent to mosquitoes, discouraging them from landing on or biting individuals. Furthermore, the antimicrobial and antifungal properties of Tulsi compounds help prevent the proliferation of pathogens transmitted by mosquitoes, reducing the risk of disease transmission. Collectively, these mechanisms contribute to the efficacy of Tulsi extract in controlling mosquito populations and mitigating the spread of mosquito-borne diseases, highlighting its potential as a natural and sustainable tool for integrated mosquito management programs. [7]

Efficacy of Tulsi Extract in Mosquito Control

The efficacy of Tulsi extract in mosquito control has been demonstrated through various studies, showcasing its potential as a natural and sustainable alternative to synthetic insecticides. Research has indicated that Tulsi extract exhibits significant larvicidal, adulticidal, and repellent activities against mosquito species of public health significance, including Aedes aegypti, Anopheles stephensi, and Culex quinquefasciatus. The bioactive compounds present in Tulsi extract, such as eugenol, thymol, and camphor, have been shown to disrupt the nervous system of mosquitoes, leading to paralysis and mortality. Furthermore, the strong aroma emitted by Tulsi acts as a natural repellent, deterring mosquitoes from landing on or biting individuals. Importantly, Tulsi extract demonstrates low toxicity to non-target organisms and minimal environmental impact, making it an environmentally friendly option for mosquito control. Integrated mosquito management approaches incorporating Tulsi extract have shown promising results in reducing mosquito populations and mitigating the transmission of mosquito-borne diseases. [8]

Comparison of Tulsi with Other Mosquito Control Agents

In comparing Tulsi (Ocimum tenuiflorum) with other mosquito control agents, several factors need to be considered, including efficacy, safety, environmental impact, and cost-effectiveness. Synthetic insecticides, such as pyrethroids and organophosphates, are commonly used for mosquito control due to their rapid knockdown and kill effects. However, they pose risks to human health and the environment and can lead to the development of insecticide resistance in mosquito populations over time.

In contrast, Tulsi extract offers a natural and sustainable alternative with demonstrated larvicidal, adulticidal, and repellent activities against mosquitoes. It is biodegradable, environmentally friendly, and generally regarded as safe for humans and non-target organisms. Tulsi extract also exhibits low toxicity and minimal adverse effects, making it suitable for use in integrated mosquito management programs. [9]

Tulsi extract's repellent properties make it an attractive option for personal protection against mosquito bites, particularly in regions where mosquito-borne diseases are endemic. It can be used in various formulations, including sprays, lotions, and candles, to provide long-lasting protection against mosquito vectors.While Tulsi extract shows promise as a mosquito control agent, its efficacy may vary depending on factors such as concentration, formulation, and application method. Furthermore, its availability and affordability may limit widespread adoption, especially in resource-constrained settings.

Tulsi extract represents a promising alternative to synthetic insecticides for mosquito control, offering efficacy, safety, and environmental benefits. Further research and field trials are needed to optimize its use and integration into existing mosquito control strategies, thereby contributing to the sustainable management of mosquito-borne diseases.

Literature Reviews

The study highlights the drawbacks of chemical-based mosquito repellents, emphasizing their toxicity and adverse health effects. It underscores the growing preference for herbal alternatives due to their safety and biodegradability, leading to increased interest in plant-based

repellents. The review emphasizes the efficacy of essential oils from various medicinal plants, such as Cymbopogon Citrullus, Azadirachta indica, and Eucalyptus globulus, in repelling mosquitoes. Furthermore, the formulation of mosquito repellent sticks using a combination of these essential oils demonstrates promising results, with formulations containing Azadirachta indica showing prolonged burning and repellency. The study concludes by highlighting the potential of herbal-based formulations in providing effective and eco-friendly mosquito control solutions. [10]

The study emphasizes the hazardous nature of chemical mosquito repellents containing synthetic pyrethroids and highlights the eco-friendly potential of utilizing cow dung as an insect repellent. Cow dung, traditionally used for various purposes including bio-fertilizer and fuel, is explored as a valuable resource for developing mosquito control products. The study focuses on developing eco-friendly dhoop sticks containing cow urine and dung, along with plant materials such as Neem, Tulsi, Rui, Durva grass, and Ashoka leaves. These natural ingredients are utilized to create dhoop sticks and extract cards, demonstrating anti-mosquito activity while also reducing air microflora in the surrounding area when burned. This research underscores the importance of exploring sustainable and natural alternatives to chemical-based mosquito repellents for public health and environmental well-being. [11]

The study aimed to evaluate the mosquito control activities, including larvicidal, ovicidal, pupicidal, and repellent effects, of various solvent extracts from two Indian medicinal plants, Achras sapota (A. sapota) and Cassia auriculata (C. auriculata), against Anopheles stephensi, a malarial vector. Early third instar larvae of An. stephensi were exposed to different concentrations of plant extracts (30-210 mg/L) and assayed using WHO protocols. LC50 values were determined by probit analysis after 24 hours. Ovicidal activity was assessed with extracts ranging from 50-350 mg/L, while pupicidal activity was recorded after 24 hours of exposure. Repellent efficacy was determined against mosquito species at two different concentrations (1.5 and 3.0 mg/cm2) under laboratory conditions. Methanol extract of A. sapota exhibited superior effectiveness across all parameters compared to C. auriculata, suggesting its potential use in vector control programs. [12]

The study investigated the therapeutic properties of Ocimum sanctum Linn (Tulsi) in modern medicine by examining its pharmacological effects on various systems of the body. Different parts of the Tulsi plant have long been used in traditional medicine for treating a wide range of ailments. Researchers analyzed steam distilled, petroleum ether, and benzene extracts of Tulsi, along with eugenol, to assess their effects on the immune, reproductive, central nervous, cardiovascular, gastric, urinary systems, and blood biochemistry. The results of pharmacological studies provided scientific evidence supporting the traditional uses of Tulsi, highlighting its potential in managing various health conditions. [13]

The study aimed to assess the insecticidal properties of Ocimum sanctum leaves on different stages of mosquito development. Fresh leaves were collected and subjected to various concentrations, with synthetic repellent serving as a control. Results showed significant repellency and mortality rates against larvae, pupae, and adult mosquitoes across different concentrations of O. sanctum leaves. Particularly, a high concentration of 5.0g of dry leaves demonstrated the greatest repellent activity, especially when burnt. These findings suggest the potential of O. sanctum leaves as effective mosquito repellents and highlight their utility in plant-based insecticide products for mosquito control. [14]

The study aimed to analyze the phytochemical components of tulsi leaf extract using different solvents. Soxhlet extraction was performed separately for methanol, ethanol, and distilled water, yielding percentages of 8%w/w, 7%w/w, and 5%w/w, respectively. Various secondary metabolites such as carbohydrates, tannins, flavonoids, saponins, glycosides, terpenoids, fatty acids, and phenols were identified in the tulsi leaf extract. Quantitative analysis revealed high levels of phenols ranging from 1.6% to 7.6%, while alkaloids and flavonoids ranged from 0.91% to 1.28% and 1.56% to 2.24%, respectively. GC-MS analysis of the methanolic extract identified major constituents including eugenol, benzene, 1,2-dimethoxy-4-(2-propenyl), α-farnesene, and cyclohexane, 1,2,4-triethenyl. These phytochemicals possess various beneficial properties, making tulsi an advantageous herbal medicine compared to chemically synthesized drugs. [15]

The researchers conducted a thorough literature review encompassing human studies assessing clinical outcomes following Tulsi ingestion. A comprehensive search was conducted across various sources, including electronic databases and published materials. A total of 24 studies were identified, reporting therapeutic effects on metabolic disorders, cardiovascular disease, immunity, and neurocognition. All studies demonstrated favorable clinical outcomes without significant adverse events. The reviewed literature supports traditional uses and suggests Tulsi as an effective treatment for lifestyle-related chronic diseases such as diabetes, metabolic syndrome, and psychological stress. However, further investigations are warranted to elucidate mechanisms of action, optimize dosage and dosage

forms, and identify populations most likely to benefit from Tulsi's therapeutic effects. [16]

The present study focused on identifying herbs with high efficacy against scale insects, particularly targeting adult females to disrupt egg production in subsequent generations. Phytochemicals were identified as safe, readily available, and cost-effective alternatives, encouraging local initiatives to bolster pest control efforts. The formulation demonstrated effectiveness in large-scale field studies, offering agriculturists a viable solution to combat scale insect infestations during critical growth stages. Importantly, insecticides derived from natural botanical sources, such as Tulsi leaves, were found to be less toxic compared to synthetic alternatives, highlighting the safety and efficacy of natural insecticides with minimal adverse effects on human health. [17]

The study investigated the larvicidal activity of aqueous extracts from various traditional medicinal plants against mosquito larvae, aiming to find safe and cost-effective control methods for mosquito-borne diseases. Extracts from Neem, Tobacco, Turmeric, Tulasi, and Ginger were tested, with combinations like Ginger+Tobacco and Neem+Tobbaco showing the highest efficacy. The results demonstrated significant larvicidal activity without any observed toxic effects, suggesting the potential of these herbal extracts as natural and eco-friendly larvicidal agents for mosquito control. [18]

The study investigated the larvicidal properties of the hexane extract of sweet basil leaves against the wild strain of Asian tiger mosquito, Aedes albopictus. Third instar larvae were exposed to different concentrations of the extract, and mortality rates were recorded. Probit analysis revealed median lethal concentration and 95% lethal concentration values. Fractions from column chromatography displayed high mortality rates, with subsequent analysis identifying active subfractions containing compounds like methyl chavicol and methyl eugenol, known for their larvicidal properties. These findings suggest that sweet basil possesses significant larvicidal activity against Ae. albopictus and could serve as a natural source of larvicidal agents for vector control. [19]

Conclusion

This study underscores the significant potential of this natural plant extract as an effective and sustainable approach to mosquito management. Through an in-depth analysis of its biochemical properties, mechanisms of action, and efficacy against mosquito vectors, the review highlights Tulsi extract's ability to disrupt mosquito life cycles, reduce populations, and mitigate the transmission of mosquito-borne diseases. Moreover, the exploration of its applications in integrated mosquito management strategies emphasizes the versatility and eco-friendly nature of Tulsi extract as a viable alternative to synthetic insecticides. However, further research is warranted to optimize its formulation, dosage, and application methods for practical use in mosquito control programs. Overall, the findings presented in this review paper underscore the importance of harnessing the potential of natural plant extracts like Tulsi in combating mosquito-borne diseases and promoting public health on a global scale.

References

1. P. Arora, “Repellent properties of ‘Tulsi’, Ocimum sanctum L. against mosquitoes,” vol. 9, no. 8, pp. 888–905, 2021, [Online]. Available: www.ijcrt.org.
2. R. K. Upadhyay, “Tulsi: A holy plant with high medicinal and therapeutic value,” *Int. J. Green Pharm.*, vol. 11, no. 1, pp. S1–S12, 2017.
3. P. Pooja and A. Kumar, “A Systemic Review of Tulsi (Ocimum tenuiflorum or Ocimum sanctum): Phytoconstituents, Ethnobotanical and Pharmacological Profile,” *Res. J. Pharmacogn. Phytochem.*, vol. 00028, pp. 179–188, 2023, doi: 10.52711/0975-4385.2023.00028.
4. B. Singh, P. R. Singh, and M. K. Mohanty, “Toxicity of a plant based mosquito repellent/killer,” *Interdiscip. Toxicol.*, vol. 5, no. 4, pp. 184–191, 2012, doi: 10.2478/v10102-012-0031-4.
5. S. Singh, K. Mahour, and S. Prakash, “Evaluation of Mosquito Repellent Efficacy of Ocimum Sanctum Plant Extract,” *J. Herb. Med. Toxicol.*, vol. 3, no. 1, pp. 87–90, 2019.
6. S. K. Mishra, “A Review Paper on Tulsi Plant (Ocimum sanctum L.),” vol. 9, no. July, pp. 515–524, 2020.
7. K. Sneha *et al.*, “Antimicrobial and Larvicidal Activities of Different Ocimum Essential Oils Extracted by Ultrasound-Assisted Hydrodistillation,” *Molecules*, vol. 27, no. 5, pp. 1–9, 2022, doi: 10.3390/molecules27051456.
8. R. Gandhi, “CONTROL OF MOSQUITOES WITH BILE AND HERBAL EXTRACTS AND ASSESSMENT OF RESISTANCE OF POPULATION OF MOSQUITOES IN PUDUCHERRY Department of Veterinary Parasitology Submitted to Acknowledgement,” no. March, 2018.
9. R. MSN, A. L, and S. S, “Development of Herbal Mosquito Repellent Formulations,” *Int. J. Collab. Res. Intern. Med. Public Heal.*, pp. 1–8, 2017.
10. A. Trivedi, P. Rai, and J. Kumar, “Formulation of low smoke herbal mosquito repellent sticks by using different essential oils,” *Pharma Innov. J.*, vol. 7, no. 4, pp. 173–175, 2018, [Online]. Available: www.thepharmajournal.com.
11. K. Sharma, “Assessment of efficiency of

mosquito repellents using different natural plant extracts.," *Int. J. Mosq. Res.*, vol. 8, no. 3, Part A, pp. 6–9, 2021.

12. K. Krishnappa and K. Elumalai, "Mosquitocidal activity of indigenenous plants of Western Ghats, Achras sapota Linn. (Sapotaceae) and Cassia auriculata L. (Fabaceae) against a common malarial vector, Anopheles stephensi Liston (Culicidae: Diptera)," *J. Coast. Life Med.*, vol. 2, no. 5, pp. 402–410, 2014, doi: 10.12980/jclm.2.2014jclm-2014-0034.
13. P. Prakash and N. Gupta, "THERAPEUTIC USES OF OCIMUM SANCTUM LINN (TULSI) WITH A NOTE ON EUGENOL AND ITS PHARMACOLOGICAL ACTIONS: A SHORT REVIEW," *Indian J Physiol Pharmacol*, vol. 49, no. 2, pp. 125–131, 2015.
14. O. K. Obeta, O. M. Uchejeso, O. R. Ejinaka, and M. Akram, "Evaluation of the Insecticidal Effects of Ocimum Sanctum on Mosquito," *Int. J. Pharm. Phytopharm. Res.*, vol. 11, no. 5, pp. 11–17, 2021, doi: 10.51847/orxfannqng.
15. B. R and B. S. P., "Tulsi (Ocimum sanctum), excellent source of phytochemicals," *Int. J. Environ. Agric. Biotechnol.*, vol. 3, no. 5, pp. 1732–1738, 2018, doi: 10.22161/ijeab/3.5.21.
16. N. Jamshidi and M. M. Cohen, "The Clinical Efficacy and Safety of Tulsi in Humans: A Systematic Review of the Literature," *Evidence-based Complement. Altern. Med.*, vol. 2017, 2017, doi: 10.1155/2017/9217567.
17. R. GHASEMI, B. Omidvar, and ..., "STUDY OF THE EFFECTIVENESS OF BIO-PESTICIDE ON MEALYBUG," *... Urban Plan. Res. ...*, vol. 12, no. 10, pp. 3921–3927, 2020, doi: 10.48047/ecb/2023.12.si10.00450.
18. C. P. S, J. Sampada, and W. Sneha, "Herbal control of mosquito larvae," *Int. J. Bioassays*, pp. 794–798, 2018.
19. C. A. Chan, L. Y. Ho, and N. W. Sit, "Larvicidal Activity and Phytochemical Profiling of Sweet Basil (Ocimum basilicum L.) Leaf Extract against Asian Tiger Mosquito (Aedes albopictus)," *Horticulturae*, vol. 8, no. 5, 2022, doi: 10.3390/horticulturae8050443.