International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Review of Certain Plants (Aromatic Plants) on the Control of Mosquito

Jyoti Uikey

Assistant Professor of Zoology, Sarojini Naidu Govt Girls P.G Autonomous College Bhopal

ABSTRACT

Mosquito-borne diseases pose significant public health challenges worldwide, necessitating effective control measures to mitigate disease transmission. Aromatic plants, with their natural repellent properties, have emerged as promising alternatives to synthetic insecticides for mosquito control. This review paper provides a comprehensive overview of the efficacy, mechanisms of action, and practical applications of certain aromatic plants in mosquito control. It examines the repellent properties of key aromatic plants such as citronella, lavender, lemon eucalyptus, peppermint, and neem, elucidating their chemical constituents and mechanisms of action against mosquitoes. Additionally, the review discusses the effectiveness, safety considerations, challenges, and limitations associated with the use of aromatic plants for mosquito control. By synthesizing existing literature and research findings, this review aims to inform policymakers, researchers, and practitioners about the potential of aromatic plants in integrated mosquito management strategies and their role in promoting sustainable and eco-friendly approaches to mosquito control.

Keywords: Aromatic plants, Mosquito control, Mosquito repellents, Essential oils.

1. INTRODUCTION

Mosquito-borne diseases pose significant threats to public health globally, particularly in regions where they are endemic. The control of mosquito populations is crucial in mitigating the transmission of these diseases and reducing their burden on human populations. While synthetic insecticides have traditionally been employed for mosquito control, concerns over their environmental impact and the development of insecticide resistance have prompted the search for alternative methods [1]. In recent years, there has been growing interest in the use of certain aromatic plants for mosquito control due to their natural repellent properties. These aromatic plants, often containing volatile compounds with insecticidal or repellent properties, have shown promise in repelling mosquitoes and disrupting their breeding cycles. [2]

1.1. Mosquito-Borne Diseases and Their Impact

Mosquito-borne diseases represent a significant global health challenge, causing widespread morbidity and mortality, particularly in tropical and subtropical regions. These diseases are caused by pathogens transmitted to humans through the bites of infected mosquitoes. Among the most prevalent mosquito-borne diseases are malaria, dengue fever, Zika virus, chikungunya, yellow fever, and West Nile virus. These diseases vary in severity, transmission dynamics, and geographical distribution, but collectively, they impose a substantial burden on affected populations and healthcare systems worldwide. Malaria, for example, remains one of the deadliest infectious diseases globally, with an estimated 229 million cases

and 409,000 deaths reported in 2019, predominantly affecting sub-Saharan Africa. Dengue fever, on the other hand, is a rapidly spreading viral disease, with an estimated 3.9 billion people at risk of infection and approximately 390 million cases reported annually, leading to significant morbidity and economic costs. Zika virus, chikungunya, yellow fever, and West Nile virus also pose significant threats to public health, with outbreaks occurring sporadically and causing considerable social and economic disruptions. The impact of mosquito-borne diseases extends beyond health, affecting livelihoods, economic development, and societal well-being. Therefore, effective control measures are essential to mitigate the transmission of these diseases and protect human populations from their devastating consequences. [3]

1.2. Aromatic Plants with Mosquito Repellent Properties

1.2.1.Citronella (Cymbopogon spp.)

Citronella is renowned for its mosquito repellent properties, making it a popular choice for protecting against mosquito bites. Derived from various species of the Cymbopogon genus, particularly Cymbopogon nardus and Cymbopogon winterianus, citronella oil contains several volatile compounds known for their insect-repelling effects. The primary active ingredient in citronella oil is citronellal, along with geraniol, citronellol, and other terpenoids.

Research has demonstrated the efficacy of citronella oil in repelling mosquitoes, potentially reducing the risk of mosquito-borne diseases such as malaria, dengue fever, and Zika virus. The mode of action of citronella as a repellent involves interfering with the mosquito's olfactory receptors, making it difficult for them to detect human hosts. Additionally, citronella may disrupt mosquito behavior, inhibiting their ability to locate and feed on blood. [4]

Citronella-based repellents are available in various formulations, including sprays, lotions, candles, and diffusers. These products are commonly used for personal protection against mosquitoes during outdoor activities such as camping, hiking, and gardening. Furthermore, citronella oil can be used to create natural mosquito repellents for indoor and outdoor use, offering a safer alternative to synthetic insecticides.

While citronella is generally considered safe for topical application and inhalation, some individuals may experience skin irritation or allergic reactions. Therefore, it is essential to follow product instructions and perform a patch test before widespread use. Overall, citronella's mosquito repellent properties make it a valuable tool in integrated mosquito management strategies, contributing to efforts to reduce mosquito-borne disease transmission and promote public health. [5]

1.2.2.Lavender (Lavandula spp.)

Lavender, with its soothing fragrance and therapeutic properties, also exhibits notable mosquito repellent characteristics. Derived from the Lavandula genus, lavender oil contains compounds like linalool and linalyl acetate, which contribute to its insect-repelling effects. Research has shown that lavender oil can effectively deter mosquitoes, potentially reducing the risk of mosquito-borne diseases such as malaria, dengue fever, and Zika virus. Its scent is believed to interfere with mosquitoes' olfactory receptors, making it challenging for them to locate and feed on human hosts. Additionally, lavender oil's calming effects on humans make it a desirable choice for use in mosquito repellents, offering a natural and pleasant-smelling alternative to synthetic insecticides. Whether used in sprays, lotions, candles, or diffusers, lavender-based repellents provide an eco-friendly solution for both indoor and outdoor mosquito control. However, it's essential to perform a patch test before widespread use and dilute lavender oil with a carrier oil when applying it to the skin to mitigate the risk of skin irritation or allergic reactions. Overall, lavender's

mosquito repellent properties make it a valuable asset in integrated mosquito management strategies, promoting both pest control and relaxation. [6]

1.2.3. Lemon Eucalyptus (Eucalyptus citriodora)

Lemon eucalyptus, scientifically known as Eucalyptus citriodora, possesses remarkable mosquito repellent properties, making it a popular natural alternative for repelling mosquitoes. The essential oil extracted from lemon eucalyptus leaves contains high concentrations of citronellal and citronellol, which are known to deter mosquitoes effectively. Research has shown that lemon eucalyptus oil can significantly reduce mosquito attraction and feeding, potentially lowering the risk of mosquito-borne diseases such as malaria, dengue fever, and Zika virus. The scent of lemon eucalyptus oil acts as a potent mosquito repellent by masking human odors and disrupting mosquitoes' olfactory receptors, making it difficult for them to locate and feed on human hosts. Lemon eucalyptus-based repellents are available in various formulations, including sprays, lotions, and candles, providing a natural and pleasant-smelling alternative to synthetic insecticides. However, it is essential to perform a patch test before widespread use and avoid direct skin contact with undiluted lemon eucalyptus oil, as it may cause skin irritation in some individuals. Overall, lemon eucalyptus's mosquito repellent properties make it a valuable asset in integrated mosquito management strategies, offering effective protection against mosquito bites while promoting environmental sustainability. [7]

1.2.4.Peppermint (Mentha spp.)

Peppermint, known for its refreshing aroma and cooling sensation, also possesses remarkable mosquito repellent properties, making it a popular natural option for deterring mosquitoes. The essential oil extracted from peppermint leaves contains high concentrations of menthol and menthone, which are known for their strong insect-repelling effects. Research has demonstrated that peppermint oil can effectively repel mosquitoes, potentially reducing the risk of mosquito-borne diseases such as malaria, dengue fever, and Zika virus. The scent of peppermint oil disrupts mosquitoes' olfactory receptors, making it challenging for them to locate and feed on human hosts. Peppermint-based repellents are available in various forms, including sprays, lotions, and candles, offering a natural and pleasant-smelling alternative to synthetic insecticides. However, it is essential to perform a patch test before widespread use and dilute peppermint oil with a carrier oil to prevent skin irritation in sensitive individuals. Overall, peppermint's mosquito repellent properties make it a valuable addition to integrated mosquito management strategies, providing effective protection against mosquito bites while promoting environmental sustainability. [8]

1.2.5.Neem (Azadirachta indica)

Neem, scientifically known as Azadirachta indica, is renowned for its various medicinal properties, including its efficacy as a mosquito repellent. Neem oil, extracted from the seeds of the neem tree, contains compounds such as azadirachtin, limonoids, and terpenoids, which exhibit potent insect-repelling effects. Research has shown that neem oil can effectively deter mosquitoes, potentially reducing the risk of mosquito-borne diseases such as malaria, dengue fever, and Zika virus. The bitter taste and strong odor of neem oil act as natural deterrents, making it difficult for mosquitoes to locate and feed on human hosts. Neem-based repellents are available in various formulations, including sprays, lotions, and candles, providing a natural and eco-friendly alternative to synthetic insecticides. However, it is essential to perform a patch test before widespread use and dilute neem oil with a carrier oil to prevent skin irritation

in sensitive individuals. Overall, neem's mosquito repellent properties make it a valuable asset in integrated mosquito management strategies, offering effective protection against mosquito bites while promoting environmental sustainability.

1.3. Mechanisms of Action

The mechanisms of action underlying the control of mosquitoes by aromatic plants are multifaceted and involve various biochemical and physiological processes. One primary mechanism involves the release of volatile compounds from aromatic plants, such as essential oils, which act as natural repellents or insecticides against mosquitoes. These volatile compounds disrupt the mosquitoes' olfactory receptors, making it challenging for them to detect hosts and locate breeding sites. Additionally, certain compounds found in aromatic plants may interfere with the mosquitoes' nervous system or metabolic pathways, leading to paralysis, death, or disruption of essential biological functions. Furthermore, aromatic plants may exert indirect effects on mosquito behavior by altering the chemical composition of their habitat or attracting natural predators or parasites that feed on mosquito larvae or adults. Overall, the diverse array of chemical compounds present in aromatic plants contributes to their effectiveness in controlling mosquito populations through multiple mechanisms of action, making them valuable tools in integrated mosquito management strategies.

1.4. Chemical Constituents Responsible for Mosquito Repellency

Aromatic plants contain a rich array of chemical constituents that contribute to their mosquito repellent properties. Some of the key chemical compounds responsible for this repellency include: [9]

1. **Terpenoids:** Terpenoids are a diverse class of organic compounds found abundantly in aromatic plants. Examples include citronellal, citronellol, geraniol, and linalool. These compounds have been shown to effectively repel mosquitoes by interfering with their olfactory receptors and masking human odors, making it difficult for mosquitoes to locate and feed on hosts.
2. **Aldehydes:** Aldehydes such as citral and cinnamaldehyde are commonly found in aromatic plants like citronella, lemongrass, and cinnamon. These compounds exhibit strong mosquito repellent properties, disrupting mosquitoes' sensory perception and deterring them from landing on or biting humans.
3. **Phenols:** Phenolic compounds like eugenol, thymol, and carvacrol are present in aromatic plants such as clove, thyme, and oregano. These compounds possess potent insecticidal and repellent effects, acting on mosquitoes' nervous system and causing paralysis or death upon contact or ingestion.
4. **Ketones:** Ketones like camphor and menthone are found in plants like eucalyptus and peppermint. These compounds exert repellent effects by interfering with mosquitoes' olfactory receptors and disrupting their ability to detect and locate hosts.
5. **Monoterpenes:** Monoterpenes are volatile compounds found in many aromatic plants, including pine, cedarwood, and lavender. Examples include pinene, limonene, and myrcene. These compounds have been shown to repel mosquitoes by masking human odors and creating an inhospitable environment for mosquito landing and feeding.

1.5. Effectiveness and Efficacy

The effectiveness and efficacy of aromatic plants as mosquito repellents have been extensively studied, with research indicating their potential to provide protection against mosquito bites and reduce the risk of mosquito-borne diseases. Numerous studies have demonstrated the effectiveness of aromatic plants, such

as citronella, lavender, lemon eucalyptus, peppermint, and neem, in repelling mosquitoes both in laboratory settings and field trials.

In laboratory studies, aromatic plants' essential oils and extracts have shown repellent effects against various mosquito species, including Aedes aegypti, Anopheles gambiae, and Culex pipiens. These studies have documented the ability of aromatic plants to deter mosquitoes from landing on treated surfaces, inhibit host-seeking behavior, and disrupt mosquito feeding.

Field trials conducted in real-world environments, such as residential areas, gardens, and agricultural fields, have also provided evidence of aromatic plants' efficacy in reducing mosquito populations and mosquito-borne disease transmission. Aromatic plants have been used in various formulations, including sprays, lotions, candles, and diffusers, to provide personal protection against mosquito bites during outdoor activities. [10]

Furthermore, comparative studies have evaluated the effectiveness of aromatic plant-based repellents against synthetic repellents like DEET (N,N-diethyl-meta-toluamide) and found comparable or even superior repellent properties in some cases. This suggests that aromatic plants can offer effective protection against mosquitoes while providing a safer and more environmentally friendly alternative to synthetic insecticides.

1.6. Challenges and Limitations

While aromatic plants show promise as natural mosquito repellents, several challenges and limitations must be addressed to optimize their efficacy and practicality. One significant challenge is the variability in repellent effectiveness among different plant species and formulations, leading to inconsistencies in protection levels against mosquito bites. Moreover, the duration of protection provided by aromatic plant-based repellents may be shorter compared to synthetic repellents like DEET, requiring more frequent reapplication to maintain effectiveness [11]. Additionally, the availability and affordability of high-quality aromatic plant extracts or essential oils can pose barriers to widespread adoption, particularly in resource-limited settings where access to these products may be limited. Furthermore, concerns regarding skin irritation, allergic reactions, and safety issues associated with certain aromatic plant compounds require careful consideration, necessitating thorough testing and evaluation of repellent formulations for human safety. Furthermore, the stability and persistence of aromatic plant-based repellents under different environmental conditions need to be addressed to ensure consistent and reliable protection against mosquitoes. Overall, while aromatic plants offer potential as eco-friendly alternatives to synthetic insecticides, addressing these challenges and limitations is crucial to harnessing their full potential for effective mosquito control and public health protection.

2. LITERATURE REVIEWS

The study evaluated eight essential oils derived from citrus plants for their repellent activity against female adults of Aedes aegypti and Culex quinquefasciatus, comparing them with a chemical repellent. Each herbal essential oil was applied on the forearms of volunteers, and protection time, biting rate, and protection percentage were measured. Results showed that the essential oil of Citrus aurantifolia was effective as a repellent and feeding deterrent against both mosquito species, exhibiting high protection times, low biting rates, and high protection percentages. The order of effectiveness among the essential oils was “Citrus aurantifolia > Citrofortunella microcarpa > Citrus maxima > Citrus reticulate > Citrus sinensis > Citrus hystrix > Citrus aurantium > Citrus medica var sarcodaclylis”. Moreover, the protection

time provided by all herbal essential oils was higher than that of the chemical repellent IR3535 against both mosquito species. [12]

Worries over the potential harm to humans, non-target species, and the environment stem from the widespread use of synthetic pesticides in mosquito vector control efforts. On the other hand, more and more people are turning to natural goods, especially essential oils made from plants, because of their little impact on the environment and high effectiveness. The evaluation focused on the adult knockdown effect and repellent actions of three plant essential oils as they pertain to Culex quinquefasciatus. Probit analysis was used to process the data. Essential oils from each of the plants tested had a significant inhibitory impact on Cx. quinquefasciatus, according to the findings. Furthermore, at all doses, the repellent action of the essential oils produced from plants was statistically significant. Some research suggests that essential oils made from the citrus fruit limon are effective in keeping mosquitoes at bay. [13]

The study focused on evaluating the larvicidal and pupicidal activities of the crude methanol extract of Anisomeles malabarica, a highly aromatic plant belonging to the Lamiaceae family. Results indicated significant larvicidal effects against Anopheles stephensi mosquitoes, with the highest mortality observed in both larvae and pupae after exposure to the plant extract. These findings suggest the potential of Anisomeles malabarica as an eco-friendly approach for mosquito vector control. Additionally, the paper provided an overview of the biological activities and pharmacological actions of Anisomeles malabarica, highlighting its diverse medicinal applications, including anti-allergic, anti-anaphylactic, anti-bacterial, anticancer, anti-carcinogenic, anti-inflammatory, antiepileptic, antifertility, anti-pyretic, and antispasmodic properties. [14]

The study evaluated the larvicidal activity of essential oils derived from 11 aromatic medicinal plants against early 4th-stage larvae of Aedes aegypti and Culex pipiens pallens in laboratory conditions. Results showed that at 100 ppm concentration, all essential oils caused 100% mortality against both mosquito species. At 25 ppm, essential oils from Citrus bergamia, Cuminum myrrha, and Pimenta racemosa also induced 100% mortality in larvae of both species. However, at lower concentrations (12.5 ppm and 6.25 ppm), the efficacy of essential oils varied, with Citrus bergamia and Pimenta racemosa showing reduced larvicidal activity. The findings suggest that further studies are warranted to explore the potential of these plants as agents for mosquito control, particularly at lower concentrations where efficacy may be compromised. [15]

The study aimed to evaluate the larvicidal activities of essential oils from 11 local plants against laboratory colonies of Anopheles arabiensis and Aedes aegypti larvae, with the intention to assess their potential for field applications. In laboratory conditions, the essential oils exhibited varying degrees of larvicidal activity, with LC50 values ranging from 17.5 to 85.9 ppm against A. arabiensis and from 9.1 to 67.8 ppm against A. aegypti. Chenopodium ambrosioides and Ocimum lamiifolium oils demonstrated the highest efficacy, with LC50 values of 17.5 and 9.1 ppm against A. arabiensis and A. aegypti, respectively. A. aegypti larvae were generally more sensitive to the essential oils compared to A. arabiensis larvae. Furthermore, in field tests against wild-collected anopheline larvae, O. lamiifolium and C. ambrosioides oils maintained their strong larvicidal effects, with LC50 values ranging from 35 to 110 ppm. However, it was noted that laboratory-bred mosquito larvae exhibited greater sensitivity to the essential oils than wild-collected larvae, indicating potential challenges in field applications. [16]

The study addressed the pressing issue of vector-borne diseases in developing countries, focusing on the Aedes aegypti mosquito responsible for transmitting dengue fever. Given the challenges associated with chemically synthesized compounds and microbial larvicidal proteins, the search for eco-friendly

alternatives is imperative. Annona reticulata was investigated for its larvicidal efficacy, with Fourier Transform Infra Red spectroscopy (FTIR) revealing various functional groups in the extracts exhibiting 100% larvicidal activity. The LC50 values were determined to be 9.96 and 6.918 mg/L for ethanol and methanol extracts, respectively. The larvicidal activity was attributed to compounds such as saponin, terpenoids, and alkaloids, highlighting the potential of Annona reticulata as a natural larvicide. However, further optimization of concentration and identification of novel compounds are warranted to enhance efficacy and develop sustainable mosquito control strategies. [17]

The study investigated the larvicidal activity of Tagetes and Mentha arvensis essential oils against different instar larvae of Culex mosquitoes, emphasizing the importance of targeting mosquito larvae due to their breeding habitats in standing water. Chemical pesticides pose risks to human health and the environment, prompting the exploration of natural pesticides derived from plants as safer alternatives. The study focused on essential oils and extracts as potential agents against mosquitoes, which are vectors for diseases such as malaria, Zika virus, and dengue. The larvicidal activity of Mentha essential oil was attributed to its menthol content, a key component known for its aroma and pesticidal properties. Synthetic chemical pesticides are highlighted as toxic and environmentally harmful, underscoring the potential of natural pesticides like Mentha and Tagetes as eco-friendly alternatives for mosquito control. [18]

The study reviewed various technologies for extracting active components and essential oils from medicinal and aromatic plants, emphasizing the importance of selecting extraction methods based on economic feasibility and suitability to specific circumstances. Both TLC and HPLC were highlighted as essential techniques for analyzing and quality controlling plant materials and extracted products. While TLC offers advantages such as speed, adaptability, and cost-effectiveness, HPLC provides greater precision and accuracy. The choice between these techniques depends on the specific requirements and demands of the situation, enabling researchers to opt for the most suitable method for ensuring the quality assurance of plant products. [19]

The purpose of this research was to determine if the solvent extracts of three aromatic plants—turmeric (Curcuma longa), holy basil (Ocimum americanum), and parsley (Petroselinum crispum)—had any effect on the dengue mosquito (Aedes albopictus) larvae. The next step was to assess the extracts' cellular toxicity and phytochemical profiles. The findings show that the hexane extracts of P. crispum and O. americanum were the most effective against larvae. The phytochemical methyl eugenol in O. americanum is known to have larvicidal effects, and it was also shown to be less hazardous to kidney cells of African monkeys. In conclusion, the research suggests that certain aromatic plants, particularly O. americanum, have great potential as bioinsecticide alternatives. [20]

The larvicidal activity of five aromatic plants against mosquito vectors was investigated: caraway (Carum carvi), celery (Apium graveolens), fennel (Foeniculum vulgare), mullilam (Zanthoxylum limonella), and zedoary (Curcuma zedoaria). In this study, two mosquito species—Aedes aegypti, the primary vector of dengue and dengue hemorrhagic fever in urban settings, and Anopheles dirus, the primary vector of malaria in Thailand—were used. After just 24 hours of exposure, every one of the volatile oils had a devastating effect on the two mosquito species' larvae. The larvae of Aedes aegypti were most affected by mullilam essential oil, while the larvae of Aedes dirus were more susceptible to zedoary oil. [21]

3. CONCLUSION

This review highlights the significant potential of certain aromatic plants as effective tools for controlling mosquito populations and reducing the transmission of mosquito-borne diseases. Through their natural

repellent properties and diverse chemical constituents, aromatic plants such as citronella, lavender, lemon eucalyptus, peppermint, and neem offer viable alternatives to synthetic insecticides for mosquito control. By interfering with mosquitoes' olfactory receptors, disrupting their behavior, or exerting direct insecticidal effects, these aromatic plants demonstrate efficacy in repelling and deterring mosquitoes. However, challenges such as variability in repellent effectiveness, limited availability, and safety concerns need to be addressed to optimize the use of aromatic plants in mosquito control programs. Future research should focus on standardizing formulations, improving efficacy, and exploring sustainable cultivation and extraction methods to enhance the practicality and scalability of aromatic plant-based mosquito repellents. Overall, the findings of this review underscore the importance of integrating aromatic plants into comprehensive mosquito management strategies, promoting environmental sustainability and public health protection.

4. REFERENCES

1. A. Stephen, “Prospects Of Using Herbal Products In The Control Of Mosquito Vectors,” J. Plants Extr., 2020.
2. K. Karunamoorthi, “Medicinal And Aromatic Plants: A Major Source Of Green Pesticides/Risk-Reduced Pesticides,” Med. Aromat. Plants, Vol. 01, No. 08, 2012, Doi: 10.4172/2167-0412.1000e137.
3. M. R. S. Silvério, L. S. Espindola, N. P. Lopes, And P. C. Vieira, “Plant Natural Products For The Control Of Aedes Aegypti: The Main Vector Of Important Arboviruses,” Molecules, Vol. 25, No. 15, 2020, Doi: 10.3390/Molecules25153484.
4. M. A. Mustapa, I. Guswenrivo, A. Zurohtun, N. K. Khairul Ikram, And M. Muchtaridi, “Analysis Of Essential Oils Components From Aromatic Plants Using Headspace Repellent Method Against Aedes Aegypti Mosquitoes,” Molecules, Vol. 28, No. 11, Pp. 1–15, 2023, Doi: 10.3390/Molecules28114269.
5. D. K. Rocha, O. Matos, M. T. Novo, A. C. Figueiredo, M. Delgado, And C. Moiteiro, “Larvicidal Activity Against Aedes Aegypti Of Foeniculum Vulgare Essential Oils From Portugal And Cape Verde,” Nat. Prod. Commun., Vol. 10, No. 4, Pp. 677–682, 2015, Doi: 10.1177/1934578x1501000438.
6. K. D. Munugoda, T. S. Talagala, S. M. C. U. P. Subasinghe, D. S. Hettiarachchi, And A. T. Cooray, “Choice Modeling For The Commercial Cultivation Of Underutilized Aromatic Plants For Producing Mosquito Repellents: Targeting Rural Sector Income Generation,” Econ. Bot., Vol. 77, No. 2, Pp. 184–202, 2023, Doi: 10.1007/S12231-023-09573-Y.
7. A. Asadollahi, M. Khoobdel, A. Zahraei-Ramazani, S. Azarmi, And S. H. Mosawi, “Effectiveness Of Plant-Based Repellents Against Different Anopheles Species: A Systematic Review,” Malar. J., Vol. 18, No. 1, Pp. 1–20, 2019, Doi: 10.1186/S12936-019-3064-8.
8. S. Bedini Et Al., “Essential Oils Sensory Quality And Their Bioactivity Against The Mosquito Aedes Albopictus,” Sci. Rep., Vol. 8, No. 1, Pp. 1–10, 2018, Doi: 10.1038/S41598-018-36158-W.
9. A. Bukar And Z. Tukur, “Plant Extracts As A Source Of Bio-Insecticide For Mosquito Control, Review,” Int. J. Mosq. Res., Vol. 6, No. 6, Pp. 81–84, 2019.
10. J. Subramaniam, K. Kovendan, P. Mahesh Kumar, K. Murugan, And W. Walton, “Mosquito Larvicidal Activity Of Aloe Vera (Family: Liliaceae) Leaf Extract And Bacillus Sphaericus, Against Chikungunya Vector, Aedes Aegypti,” Saudi J. Biol. Sci., Vol. 19, No. 4, Pp. 503–509, 2012, Doi: 10.1016/J.Sjbs.2012.07.003.

11. Y. C. Yang, E. H. Lee, H. S. Lee, D. K. Lee, And Y. J. Ahn, "Repellency Of Aromatic Medicinal Plant Extracts And A Steam Distillate To Aedes Aegypti," J. Am. Mosq. Control Assoc., Vol. 20, No. 2, Pp. 146–149, 2004.
12. M. Soonwera, "Efficacy Of Essential Oils From Citrus Plants Against Mosquito Vectors Aedes Aegypti (Linn.) And Culex Quinquefasciatus (Say)," Int. J. Agric. Technol., Vol. 11, No. 3, Pp. 669–681, 2015.
13. A. A And E. Pushpalatha, "Essential Oils Of A Few Aromatic Plants And Their Potential As Knockdown, Repellent And Adulticidal Agent To The Filarial Vector, Culex Quinquefasciatus Say (Diptera: Culicidae)," Int. J. Mosq. Res., Vol. 8, No. 1, Pp. 35–40, 2021, Doi: 10.22271/23487941.2021.V8.I1a.498.
14. R. Ramaraj And Y. Unpaprom, "Medicinally Potential Plant Of Anisomeles Malabarica Biogas View Project Bioethanol Production View Project Medicinally Potential Plant Of Anisomeles Malabarica (L.) R. Br," Artic. J. Agric. Res., Vol. 30, No. 3, Pp. 29–39, 2013, [Online]. Available: Https://Www.Researchgate.Net/Publication/260288524.
15. H. S. Lee, "Mosquito Larvicidal Activity Of Aromatic Medicinal Plant Oils Against Aedes Aegypti And Culex Pipiens Pallens," J. Am. Mosq. Control Assoc., Vol. 22, No. 2, Pp. 292–295, 2006, Doi: 10.2987/8756-971x(2006)22[292:Mlaoam]2.0.Co;2.
16. G. Haile, M. Zenawi, And A. Adere, "A Study Of The Larvicidal Properties Of The Essential Oils Of Some Aromatic Plants Against Larvae Of A . Arabiensis And A. Aegypti In The Laboratory And Anophelines In Simulated Field Condition," African J. Malar. Trop. Dis., Vol. 3, No. 7, Pp. 179–183, 2015.
17. B. Govindarajulu, A. Srimathi, R. Bhuvana, And J. Karthikeyan, "Mosquito Larvicidal Efficacy Of The Leaf Extracts Of Annona Reticulata Against Aedes Aegypti.," Int. J. Curr. Microbiol. Appl. Sci., Vol. 4, No. 8, Pp. 132–140, 2015, [Online]. Available: Http://Www.Ijcmas.Com/Vol-4-8/Bavani Govindarajulu, Et Al.Pdf.
18. S. Kour And A. K. Riat, "Control Of Mosquitoes With The Help Of Plant Based Chemicals Of Tagetes And Mentha Arvensis: A Review," Plant Arch., Vol. 21, Pp. 2313–2316, 2021.
19. S. S. Handa, S. P. S. Khanuja, G. Longo, And D. D. Rakesh, "Extraction Technologies For Medicinal And Aromatic Plants," 2018.
20. H. Lim, S. Y. Lee, L. Y. Ho, And N. W. Sit, "Mosquito Larvicidal Activity And Cytotoxicity Of The Extracts Of Aromatic Plants From Malaysia," Insects, Vol. 14, No. 6, 2023, Doi: 10.3390/Insects14060512.
21. B. Pitasawat Et Al., "Aromatic Plant-Derived Essential Oil: An Alternative Larvicide For Mosquito Control," Fitoterapia, Vol. 78, No. 3, Pp. 205–210, 2017, Doi: 10.1016/J.Fitote.2007.01.003.