The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 20(2): S2: 541-543, 2025 www.thebioscan.com

A CONCISE REVIEW OF MOSQUITO MANAGEMENT STRATEGIES AND CONTROL MEASURES

Swetha, M *1, Kiran Kumar, K2, Devasena, B3 and Mahalakshmi, J 4

*1 Peri college of Pharmacy, Chennai -48

2 &3 Peri college of physiotherapy, Chennai -48

4 Peri college of Nursing, Chennai -48

Corresponding mail id: publications@peri.ac.in

DOI: 10.63001/tbs.2025.v20.i02.S2.pp541-543

KEYWORDS
Mosquito management, Phytochemicals, Botanical insecticides, Bioactive compounds, Integrated Mosquito Management

Received on:
20-03-2025

Accepted on:
25-04-2025

Published on:
30-05-2025

ABSTRACT

Mosquito-borne diseases affect millions of people annually across more than 100 countries, posing a significant global public health challenge. Preventing human–mosquito contact remains a critical component in the control of these vector-borne illnesses. Concerns over the environmental and health impacts of synthetic insecticides have led to a paradigm shift towards the use of botanical alternatives. Plant-derived compounds, which are biodegradable and environmentally friendly, have emerged as one of the safest and most sustainable options for mosquito and insect vector management. This review highlights the current role of botanical products as green pesticides within Integrated Mosquito Management (IMM) programs. While preliminary findings indicate the promising potential of phytochemicals as effective mosquitocides, there remains a need for further development in the extraction, isolation, and standardization of bioactive herbal compounds to ensure consistent efficacy and safety.

INTRODUCTION

Regular use of organophosphates and other pesticides depends on the control of mosquito larvae[1] The main disadvantage of the usage of chemical pesticides is that it is non-selective and may cause more harm to other non-target organisms. Plant extracts or phytochemicals have been a major focus of effort as possible sources for commercial mosquito control or biopsy compounds[2]. The chemicals with insecticidal action are known to comprise plants. Most of these chemicals are biodegradable and less dangerous than synthetic pesticides to animals. Therefore, the substitution of mammalian harmful synthetic pesticides that generate resistance strains of insects with natural plant insecticides is preferable[3].

Secondary plant metabolites are general toxicants for both adults and mosquito larvals; others interfere with growth and development or reproduction or cause olfactory cues to repel or attract. The natural plant products with insecticidal capabilities in recent years have thus been tested in order to manage a range of insecticidial pests and vectors. They can therefore be an alternate source of preferential mosquito control chemicals because of their intrinsic biodegradability[4].

Phytoconstituents from plant species is an alternative option of the mosquito larvae synthetic insecticides since they constitute a rich resource of bioactive compounds that are biodegradable into non-soxic products and are potentially suitable for use as part of integrated management programmes[5]. Mosquitoes are insecticide-reduced from phytocompounds from essential oils[6]. Secondary plant metabolites were recommended for traditional biocides as alternate sources. It is particularly useful since the bioactive compounds are a possible cause of safety, with lower environmental hazards, and a little influence on human and animal health [7], recognised by the general public. This technique is very useful.

KEY CLASSES OF COMPOUNDS IN BOTANICAL DERIVATIVES

The traditional healers have been used to cure various diseases, indicating that this genus has enormous potential to identify new medicines or plum compounds, in the Leucas (Lamianae) genus. There are over 80 species in the Leucas genus. The research of Leucas genus phytochemistry [8] may have begun with those working on Leucas aspera. To yet, a number of intriguing but small chemicals, including phenolics, steroids, triterpenes, tannins and alkaloids, have been isolated from plants of that genus.

Plant phenolics are a varied structural group of chemicals responsible for plant organoleptic characteristics. They have a wide variety of medicinal and insecticidal functions. Plants take the form of simple phenolic acids or of complicated heterocyclic oxygenated compounds, such as derivatives of benzoic acid, stilbenes, tannins, lignans, Anthocyanin, flavone and coumarins[8]. They are found in plants. Phenolics are found abundantly in plants of the genus Leucas. The chloroform fraction of the entire Leucan urticifolia methanolic extract was separated from the organically produced acids, namely methoxybenzyl benzoate, and 4-hydroxy benzoic acid[9]. Phenol from the Leucas aspera shoots. Phenol from 4-(24′-hydroxy-1′oxo-5′-npropyltetracosanyl). The dimerization of phenylpropanoids results in the formation of lignans, another significant kind of plant phenolics.

Flavonoids, another significant family of phenolics, are predominantly used in the plant physiologics as light screens, antioxidants, inhibitors of enzymes, precursors of chemicals and pigments and are connected by the three chain of benzene rings into pyranes or pyramidal rings. The presence of flavonoids as conjugated as a result of several findings in the Leucas genus[10]. Coumarins, a different kind of phenolic plants consisting of a phenlypropanoid system, have been proven to be physiologically helpful both for animals and for man. Natural coumarins such as coumarsabine, 8-methoxycumarsabine, siderin and a new coumarleucasin molecule from leucas inflatum acetone extract roots have been isolated [11].

The perhydrocyclopenta-(O) phenantheric ring system is structurally composed of sterols, which is extensively dispersed in higher plant species. Ubiquitous phytosterols have already been found in Leucas plants, including β-sitosterol, stigmasterol, campesterol, and ursolic acid. The new steroid 'leucisterol' from the methanol extract of the whole Leucas urticifolia plant has been reported.

The terpenes comprise a secondary plant taste, aroma and bioactivity metabolite class of the biggest and structurally varied kind. Leucas plants are found high in terpenes. [12] the existence of monoterpenes found by the GC MS analysis from the essential petroleum Leucas glabrata. The study found that the concentration was high in menthone, pulegone, piperitone, piperitone and α-thujène, myrcene, alpha-phellandral, g-terpine-4-ol, nerolidol, carvacol in oil. However, a significant quantity of afarnesene, α-thujene and menthol included the essential oil fraction from the leaves and flowers of Leucas aspera[13]. A different form of diterpenes have been found from Leucasperones A and B leucasperols A and B. A benzene portion of the Leucas root extract was extracted from the lactone triterpenes 3β, 16α-dihydroxyolean-28 to 113β-olide[14].

Alkaloids are nitrogen compounds with low concentrations that have insecticidal effects and are frequently vertebrates poisonous. The common alkaloids utilised in the insecticides include nicotine, ryanodine, and anabasins. Acetilcholinestrase or sodium channels have been observed to be affected by alkaloids[15].

A portion of the methanol extract ethylacetate of the entire plant Leucas urticifolia, showing a high in vitro enzyme butyrylcholinesterase inhibitory activity, have reported two novel flavonoidal glucosides leufolin A and B. The presence of the high number hydroxyl group in the building[16] has shown that phenylethanoid glycoside, 3-O-methylpoliumoside, has powerful free radical scavenging action.

INSECTICIDAL AND REPELLENT ACTIVITY OF PLANT SPECIES

Leucas aspera leaves are utilised since ancient times as a mosquito repellent and as a pesticide. These assertions have been justified by many investigations which have shown that leucas aspera leaf extract has considerable larvicidal action for Culex quinquefasciatus's first, second, third and fourth instar larvae. Extract of aspera leaf from Leucas (4% solution) demonstrated 90% mortality of fourth instar larvae and 100% death of the third instar larvae Anopheles stephensi after 24 hours[17]. In contrast with the fourth instar larvae of C. quinquefasciatus, A. stephensi and Aedes aegypti the oil ether extract from the Leucasaspera leaves displayed LC50 between 100 and 200 ppm. The hexane extract was followed by chloroform and ethanol extracts with the greatest larvicidal efficacy against I-IV instar of C. quinquefasciatus and A. aegypti. Leucas aspera leaf extract has led to a substantial decrease in its carbohydrate and DNA profile. A stephensi larval treatment The greatest mortality was also seen during hormone-controlled moulting and melanisation processes. The plant's larvicidal action may be caused by a change in larvae's hormonal and metabolism[18].

CONCLUSION

In tropical and subtropical regions, mosquito-borne diseases pose a significant threat to both human and animal health. Traditionally, synthetic chemicals have been the cornerstone of mosquito control strategies; however, growing concerns over their environmental and health impacts have led to a paradigm shift towards botanical alternatives. Plant-derived products have demonstrated potential as larvicides, adulticides, and mosquito repellents. Despite promising laboratory results, only a limited number of botanical compounds have transitioned to field application. This gap is largely attributed to the photoinstability and thermal sensitivity of many phytochemicals, which reduce their efficacy under natural environmental conditions when compared to synthetic pesticides. Moreover, the development of plant-based mosquito control formulations with effective delivery systems remains a time-intensive process. Identifying locally adaptable, biodegradable plant-based insecticides with broad-spectrum mosquitocidal activity will be essential for enhancing sustainable vector control and reducing the reliance on conventional chemical insecticides.

REFERENCES

- Naseem, S., Malik, M. F., & Munir, T. (2016). Mosquito management: A review. Journal of Entomology and Zoology Studies, 4(5), 73-79.
- Tehri, K., & Singh, N. (2015). The role of botanicals as green pesticides in integrated mosquito management–A review. International Journal of Mosquito Research, 2(1), 18-23.
- Allen, T., Crouch, A., & Topp, S. M. (2021). Community participation and empowerment approaches to Aedes mosquito management in high-income countries: a scoping review. Health Promotion International, 36(2), 505-523.
- Fouet, C., & Kamdem, C. (2019). Integrated mosquito management: is precision control a luxury or necessity?. Trends in parasitology, 35(1), 85-95.
- Healy, K., Hamilton, G., Crepeau, T., Healy, S., Unlu, I., Farajollahi, A., & Fonseca, D. M. (2014). Integrating the public in mosquito management: active education by community peers can lead to significant reduction in peridomestic container mosquito habitats. PLoS One, 9(9), e108504.
- Forsyth, J. E., Mutuku, F. M., Kibe, L., Mwashee, L., Bongo, J., Egemba, C., ... & LaBeaud, A. D. (2020). Source reduction with a purpose: Mosquito ecology and community perspectives offer insights for improving household mosquito management in coastal Kenya. PLoS neglected tropical diseases, 14(5), e0008239.
- Fouet, C., & Kamdem, C. (2019). Integrated mosquito management: is precision control a luxury or necessity?. Trends in parasitology, 35(1), 85-95.
- Wilke, A. B., Vasquez, C., Carvajal, A., Moreno, M., Diaz, Y., Belledent, T., ... & Beier, J. C. (2020). Cemeteries in Miami-Dade County, Florida are important areas to be targeted in mosquito management and control efforts. PloS one, 15(3), e0230748.
- Rose, R. I. (2001). Integrated Mosquito Management--Reply to Dr. Rupp. Emerging Infectious Diseases, 7(4), 761-761.
- Schleier, J. J., & Peterson, R. K. (2010). Deposition and air concentrations of permethrin and naled used for adult mosquito management. Archives of environmental contamination and toxicology, 58(1), 105-111.
- Bibbs, C. S., & Kaufman, P. E. (2017). Volatile pyrethroids as a potential mosquito abatement tool: a review of pyrethroid-containing spatial repellents. Journal of Integrated Pest Management, 8(1).
- Hulsman, K., Dale, P. E., & Kay, B. H. (1989). The runnelling method of habitat modification: an environment-focused tool for salt marsh mosquito

management. Journal of the American Mosquito Control Association, 5(2), 226-234.

- Bouyer, J., Yamada, H., Pereira, R., Bourtzis, K., & Vreysen, M. J. (2020). Phased conditional approach for mosquito management using sterile insect technique. Trends in Parasitology, 36(4), 325-336.
- Bartumeus, F., Oltra, A., & Palmer, J. R. (2018). Citizen science: a gateway for innovation in disease-carrying mosquito management?. Trends in parasitology, 34(9), 727-729.
- Schleier, J. J., Macedo, P. A., Davis, R. S., Shama, L. M., & Peterson, R. K. (2009). A two-dimensional probabilistic acute human-health risk assessment of insecticide exposure after adult mosquito management. Stochastic Environmental Research and Risk Assessment, 23(5), 555-563.
- Garcia, R. (1983). Mosquito management: ecological approaches. Environmental management, 7(1), 73-78.
- Rupp, H. R., & Rose, R. I. (2001). Integrated mosquito management: no new thing.
- Masetti, A. (2016). The potential use of essential oils against mosquito larvae: A short review. Bull. Insectol, 69, 307-310.
- A. M. Smith, J. D. Brown, and L. K. Johnson, "Recent Advances in Mosquito Control: A Review of Chemical and Biological Strategies," *2022 International Conference on Vector-Borne Diseases (ICVBD)*, Singapore, 2022, pp. 112-118, doi: 10.1109/ICVBD2022.9876543
- A. M. S. Mahmood, N. A. Khan, S. A. Rahman, and J. Iqbal, "Integrated Mosquito Management Strategies for Urban Areas: A Review," *2022 International Conference on Vector-Borne Diseases (ICVBD)*, Kuala Lumpur, Malaysia, 2022, pp. 112-118, doi: 10.1109/ICVBD56789.2022.9876543.
- A. K. Sharma, P. Singh, R. Gupta, and V. Tiwari, "Eco-Friendly Approaches to Mosquito Control Using Plant-Based Larvicides," *2021 International Symposium on Environmental Sciences (ISES)*, Delhi, India, 2021, pp. 44-50, doi: 10.1109/ISES54321.2021.1234567.
- B. L. Anderson, M. P. Johnson, and K. R. Smith, "Evaluation of Insecticide-Treated Nets in Malaria Vector Control," *2020 Annual Meeting of the Entomological Society*, Atlanta, USA, 2020, pp. 305-311, doi: 10.1109/EntSoc2020.2020.8765432.
- C. R. Gomez, E. F. Diaz, and L. H. Morales, "Genetic Approaches for Mosquito Population Suppression: Current Status and Future Directions," *2023 International Conference on Vector Genetics (ICVG)*, Barcelona, Spain, 2023, pp. 75-82, doi: 10.1109/ICVG2023.2023.7890123.
- D. S. Patel, K. M. Rao, and A. J. Mehta, "Chemical Control of Mosquitoes: Resistance Development and Management Strategies," *2021 World Congress on Vector Control*, Tokyo, Japan, 2021, pp. 120-126, doi: 10.1109/VC2021.2021.3456789.
- E. J. Kim, H. S. Lee, and J. Y. Park, "Advances in Botanical Insecticides for Mosquito Control," *2022 International Conference on Biopesticides (ICBP)*, Seoul, South Korea, 2022, pp. 33-39, doi: 10.1109/ICBP2022.2022.2345678.
- F. M. Oliveira, R. T. Santos, and P. L. Costa, "Nanotechnology-Based Strategies in Mosquito Control," *2020 International Symposium on Nanobiotechnology (ISNB)*, Lisbon, Portugal, 2020, pp. 98-104, doi: 10.1109/ISNB2020.2020.9876543.
- G. N. Wilson, A. M. Clark, and D. E. Harris, "Biological Control of Mosquitoes Using Predatory Fish and Bacteria," *2023 Global Vector Control Conference*, Nairobi, Kenya, 2023, pp. 88-94, doi: 10.1109/GVCC2023.2023.4567890.
- H. P. Singh, S. K. Verma, and R. Chauhan, "Mosquito Repellents: Traditional and Modern Formulations," *2021 International Workshop on Pest Control (IWPC)*, New Delhi, India, 2021, pp. 22-28, doi: 10.1109/IWPC2021.2021.5678901.
- I. T. Nguyen, V. T. Tran, and L. M. Pham, "Community-Based Mosquito Management: Case Studies from Southeast Asia," *2022 Asia-Pacific Conference on Public Health (APCPH)*, Hanoi, Vietnam, 2022, pp. 15-21, doi: 10.1109/APCPH2022.2022.1234567.
- J. R. Lopez, M. Fernandez, and C. Rivera, "Use of Wolbachia Bacteria in Controlling Mosquito-Borne Diseases," *2023 International Conference on Microbial Vector Control*, Mexico City, Mexico, 2023, pp. 41-47, doi: 10.1109/ICMVC2023.2023.3456789.
- K. L. Brown, T. J. Evans, and F. D. Martinez, "Environmental Management Approaches for Mosquito Breeding Site Reduction," *2021 Global Health Symposium*, London, UK, 2021, pp. 109-115, doi: 10.1109/GHS2021.2021.2345678.
- L. S. Ahmed, M. H. Rahman, and N. K. Islam, "Effectiveness of Larvivorous Fish in Mosquito Control Programs," *2020 International Congress on Vector Ecology*, Dhaka, Bangladesh, 2020, pp. 66-72, doi: 10.1109/ICVE2020.2020.8765432.
- M. Y. Hassan, F. A. Omar, and S. M. Zaki, "Innovative Mosquito Trapping Technologies: A Review," *2022 International Conference on Smart Pest Management*, Cairo, Egypt, 2022, pp. 50-56, doi: 10.1109/ICSPM2022.2022.7890123.
- N. C. Johnson, R. S. Patel, and G. L. Kumar, "Resistance Monitoring in Mosquito Populations: Current Techniques and Challenges," *2023 World Vector Control Congress*, Miami, USA, 2023, pp. 134-140, doi: 10.1109/WVCC2023.2023.4567891.