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Plant extracts in controlling disease vector mosquitoes

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Abstract

Millions of people are afflicted by mosquito-borne illnesses every year, which represent a serious danger to world health. Plant extracts have drawn attention for their ability to control mosquitoes as an environmentally acceptable option. This review discusses the effectiveness, modes of action, and future possibilities of plants that have mosquitocidal qualities, as well as the present level of research in this area. Although the molecular mechanisms underlying pyrethrum's insecticidal action are recognised, its repelling qualities are still unclear. Derived from chrysanthemum flowers, pyrethrum is a popular natural insecticide. Chinaberry extracts include active compounds that interfere with mosquito development stages. This results in a sustainable method of controlling mosquito populations, less reliance on synthetic pesticides, and the promotion of sustainable public health initiatives.

Keywords: Mosquito, plant extracts, neem, lemon, cinnamon, synthetic pesticides, mosquitocidal qualities

Introduction

Mosquitoes are notorious vectors of several deadly diseases, including malaria, dengue fever, Zika virus, and chikungunya. The prevalence of these diseases poses a significant global health challenge, prompting researchers to explore alternative and sustainable methods for mosquito control. One promising avenue is the use of plant extracts, which have demonstrated efficacy in repelling and killing disease vector mosquitoes. This article explores the potential of plant extracts in controlling disease vector mosquitoes, citing relevant studies and scientific evidence.

Natural Repellents from Plants

Numerous plant species have been identified for their ability to repel mosquitoes naturally. Citronella, derived from lemongrass (*Cymbopogon citratus*), is a well-known example. A study by Trongtokit *et al.* (2005) ^[1] found that citronella oil exhibited strong repellent activity against *Aedes aegypti*, the mosquito responsible for transmitting dengue fever. Other plant extracts with proven mosquito repellent properties include neem (*Azadirachta indica*), eucalyptus, and lavender.

Insecticidal Properties of Plant Extracts

Beyond their repellent properties, certain plant extracts exhibit insecticidal effects, causing mortality in mosquitoes. Pyrethrum, derived from chrysanthemum flowers, is a well-known natural insecticide. Pyrethrum contains pyrethrins, which target the nervous system of mosquitoes and lead to paralysis and death. A study by Govindarajan *et al.* (2016) ^[2] demonstrated the effectiveness of pyrethrum against *Aedes* mosquitoes, showcasing its potential as an eco-friendly alternative to synthetic insecticides.

Another promising plant extract is derived from the chinaberry tree (*Melia azedarach*). Research by Govindarajan *et al.* (2016) ^[2] revealed that extracts from chinaberry seeds exhibited larvicidal and pupicidal activities against *Aedes aegypti* and *Anopheles stephensi*. The active compounds in chinaberry extracts disrupt the developmental stages of mosquitoes,

providing a sustainable approach to mosquito control. Mosquito-borne diseases pose a significant global health threat, with millions of people affected annually. Conventional mosquito control methods often involve the use of synthetic insecticides, raising concerns about environmental impact and resistance development. As an eco-friendly alternative, plant extracts have gained attention for their potential in mosquito control. This review explores the current state of research on plant extracts with mosquitocidal properties, discussing their efficacy, mechanisms of action, and future prospects (Tolle, 2009) [3].

Neem (*Azadirachta indica*)

Neem extracts have demonstrated remarkable efficacy in mosquito control. The active compound, azadirachtin, disrupts the physiological processes of mosquitoes, affecting their feeding and reproductive abilities. Studies (Govindarajan *et al.*, 2016) [2] have highlighted neem's larvicidal and pupicidal activities against various mosquito species, including the vectors of malaria and dengue. In a study by Maia and Moore (2011) [4], the essential oil from neem demonstrated effective repellency against *Anopheles* mosquitoes, which are responsible for transmitting malaria. Neem extracts contain compounds such as azadirachtin, which disrupt the mosquito's ability to feed and reproduce. Additionally, neem extracts have minimal environmental impact compared to synthetic chemicals (Pramanik *et al.*, 2023) [11].

Pyrethrum (*Chrysanthemum cinerariifolium*)

Pyrethrum, derived from chrysanthemum flowers, contains pyrethrins that target the nervous system of mosquitoes, leading to paralysis and death. Research (Govindarajan *et al.*, 2016) [2] supports pyrethrum's effectiveness against *Aedes* mosquitoes, making it a potential natural insecticide for mosquito control (Liu *et al.*, 2021) [5]. Worldwide, pyrethrum extracts from *Chrysanthemum* spp. flower heads are utilised in repellents and pesticides. The molecular underpinnings of pyrethrum's insecticidal effect are understood, but its repellent properties are yet unknown. In this investigation, we discover that in *Aedes aegypti* mosquitoes, the main constituents of pyrethrum, pyrethrins, and a minor component, (E)- β -farnesene (EBF), each activate a particular kind of olfactory receptor neurones [5].

Chinaberry (*Melia azedarach*)

Chinaberry extracts, particularly from the seeds, have exhibited larvicidal and pupicidal activities against *Aedes* and *Anopheles* mosquitoes (Govindarajan *et al.*, 2016) [2]. The active components in chinaberry disrupt the developmental stages of mosquitoes, providing a sustainable approach to mosquito control. Abiy *et al.* (2015) reported that to evaluate the repellent properties of four repellents: two were manufactured in a laboratory and generated as 20% neem oil and 20% chinaberry oil, while the other two were commercially available repellents, DEET (N, N-diethyl-1,3-methylbenzamide) and MyggA (p-methane diol). Six volunteers were used in a 6 by 6 Latin square pattern, and they were given alternating treatments of repellents and noog abyssinia (*Guizotia abyssinica*), also known locally as noog oil (diluent to the two plant oils), an Ethiopian Niger seed [6].

Lemon Eucalyptus (*Corymbia citriodora*)

The essential oil derived from lemon eucalyptus has gained

recognition for its effectiveness in repelling and killing mosquitoes. The active compound, PMD (Para-menthane-3, 8-diol), has been found to rival the efficacy of synthetic repellents like DEET. This plant extract is particularly useful for personal protection against mosquito bites (Lee *et al.*, 2018) [7]. MyggA Natural is a repellent that is sold commercially that works against arthropods that feed on blood (Bioglan, Lund, Sweden). Thirty percent of *Corymbia citriodora* (Hook.) K. D. Hill & L. A. S. Johnson (*Myrtaceae*), the lemon-scented eucalyptus oil, has a minimum of fifty percent p-menthane-3, 8-diol. Small concentrations of the essential oils of geranium, Pelargonium graveolens L'Her. (*Geraniaceae*), and lavender, *Lavandula angustifolia* Mill. (*Lamiaceae*), are also included in MyggA Natural. *Ixodes ricinus* (L.) host-seeking nymphs were completely repelled by Mygg A Natural and *C. citriodora* oil in lab bioassays (Acari: Ixodidae). When diluted to 1% in 1,2-propanediol, lavender and geranium oils showed only moderate repellent effects on *I. ricinus* nymphs; however, at 30% in 1,2-propanediol, they demonstrated 100% repellency. 1, 2-Propanediol (100%) did not exhibit any discernible repellent activity as compared to the control: Jaenson *et al.* (2006) [8].

Cinnamon (*Cinnamomum* spp.)

Cinnamon extracts have shown promise as mosquitocidal agents. Studies (Dharmagadda *et al.*, 2005) [9] have reported the lethal effects of cinnamon oil on mosquito larvae, suggesting its potential application in larval control strategies. Mahran *et al.* (2023) reported that when applied as a nanoemulsion, cinnamon's effectiveness and long-term effects on *Culex pipiens* larvae were greatly enhanced. Sesame oil and cinnamon together also produced a synergistic effect. This could support efforts to combat *Culex pipiens*, the house mosquito [10]. It is said that using natural goods, such as essential oils, is a safe substitute. Research on Malaysian plants' ability to repel mosquitoes is still uncommon. The present study reports on the repellent efficacy of essential oils derived from *Cinnamomum iners* leaves and barks. The local communities employ the entire plant to ward off mosquitoes and other bloodsucking insects (Wahab *et al.*, 2020) [12].



Fig 1: Mosquitocidal qualities of different plants against mosquito

Conclusion

One viable and long-term solution to the problem of

mosquito-borne diseases affecting the world's population is the use of plant extracts to suppress disease-carrying mosquito populations. Numerous plant extracts have been shown in scientific tests to be effective at both killing and repelling mosquitoes, making them a more environmentally friendly option than synthetic chemicals. The effective incorporation of plant-based mosquito control techniques into public health programmes requires ongoing research, formulation standardisation, and community involvement. Using plant extracts to harness the power of nature may prove to be a crucial part of our attempts to create a healthier and more sustainable world as we traverse the complexity of diseases carried by mosquitoes. The global problem of diseases carried by mosquitoes has the potential for an environmentally friendly remedy in the form of plant extracts. These extracts contain an extensive number of chemicals that can be used to target different phases of mosquito development, from larvae to adults. The use of plant extracts into all-encompassing mosquito control strategies may, as research advances, lessen dependency on artificial pesticides and promote sustainable public health measures.

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