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A Review On API Neem (Azadirachta Indica) As A Herbal Mosquito Repellent

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Abstract: *Mosquito-Delivered condition remain a major public health concern, with malaria, dengue, chikungunya, and Zika virus causing significant global challenges. Chemical repellents such as DEET, although effective, raise safety and environmental concerns. Neem (Azadirachta indica), a traditional medicinal plant widely used in Ayurveda, has gained increasing attention as a natural alternative. This review explores neem's mosquito-repellent properties, mechanisms of action, formulations, and comparative effectiveness with synthetic repellents. Current evidence suggests neem-based products demonstrate considerable repellent activity against multiple mosquito species, are environmentally safer, and can contribute to integrated vector management. However, more standardized formulations and clinical validations are needed before large-scale adoption.*

Keywords: Neem, Azadirachta indica, mosquito repellent, herbal insecticide, vector control

I. INTRODUCTION

Mosquitoes are responsible for transmitting a wide range of vector-borne diseases that account for millions of cases worldwide every year. Synthetic repellents like N,N-diethyl-meta-toluamide (DEET) are commonly used but are associated with skin irritation, neurotoxicity, and ecological hazards. As a result, there is a growing demand for safe, plant-based alternatives.

Neem (Azadirachta indica), often referred to as the "Rural pharmacy," is well known for its germicidal, mycocidal, and insecticidal properties. Traditional practices in India, Africa, and Southeast Asia have used neem oil and leaves to repel insects for centuries. This review highlights the role of neem as a potential herbal mosquito repellent.

2.Literature Search Method :-

Relevant studies were collected from PubMed, Scopus, and Google Scholar using the keywords Neem, Azadirachta indica, mosquito repellent, vector control, and herbal insecticide. Publications between 1990 and 2025 were considered. Both laboratory and field-based studies were included to assess the efficacy of neem formulations.

3.Mosquito-Repellent Properties of Neem :-

(Tree)

(Seed)

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Biological Sources:- Azadirachta indica A. Juss. (INDIA).
Common names :- Neem, Margosa tree, Indian lilac.
Family :- Meliaceae (Mahogany family).

3.1 Chemical constituent :-

-Neem contains several bioactive compounds, including azadirachtin, salannin, nimbin, and gedunin, which exhibit insect-repellent and insect-growth regulatory effects.
-Azadirachtin disrupts mosquito feeding and reproduction.
-Salannin acts as a strong mosquito deterrent, comparable to DEET in some studies.

3.2 Neem Oil as a Repellent :-

-Multiple studies demonstrate that neem oil applied topically (diluted in coconut oil or other carriers) provides protection against mosquito bites.
-A study in India reported 96–100% protection for 8 hours against Anopheles species when neem oil was used in combination with mustard oil.
-In African field trials, neem oil offered significant reduction in malaria vector bites, although effectiveness varied with formulation.

3.3 Neem Extracts in Sprays and Coils :-

-Neem leaf extracts are incorporated into mosquito coils, sprays, and vaporizing agents. These products release bioactive compounds that repel or kill mosquitoes indoors. Studies show neembased coils produce fewer toxic fumes than conventional chemical coils, making them safer for households.

3.4 Comparative Efficacy with Synthetic Repellents :-

-While neem does not always outperform DEET in terms of duration, it provides comparable shortterm protection and is considered much safer for children, pregnant women, and the environment. Unlike synthetic repellents, neem biodegrades naturally and does not accumulate in ecosystems.

4. Advantages of Neem-Based Repellents :-

-Natural & Biodegradable: Environmentally friendly with minimal toxic residue.
-Safe for Humans: Fewer side effects compared to DEET and pyrethroids.
-Multi-functional: Offers antimicrobial and skin-healing properties alongside repellency.
-Cultural Acceptance: Widely used in traditional medicine, increasing acceptance in rural areas.

5. Phytochemistry — the active ingredients :-

-Neem seeds and oil contain complex triterpenoids (limonoids) — foremost among them azadirachtin — plus nimbin, salannin, and various volatile constituents. These compounds differ considerably by extraction method, tree provenance, and processing ,which strongly influences biological activity and formulation design.

6. Modes of action relevant to mosquito control :-

-Repellency / anti-host seeking: volatile fractions and oil formulations can reduce mosquito landings/biting for a limited time, likely by masking host cues or acting as behavioral deterrents.
-Larvicidal and growth regulation: azadirachtin and related limonoids disrupt molting and development, reduce feeding, fecundity and egg viability, producing mortality or delayed development in larvae and immature stages.
-Ovicidal / anti-oviposition: neem derivatives can reduce egg laying or egg hatch in some species. These multimodal effects make neem attractive for integrated control

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7. Evidence of efficacy

7.1 Laboratory studies :-

-Laboratory assays often show strong larvicidal activity with relatively low LC_{50} values for neem seed oil or concentrated azadirachtin extracts; mortality and developmental disruption increase with dose and exposure time. Adult repellency results in controlled cage tests are mixed — some demonstrate significant reductions in biting for a few hours, while others report modest or inconsistent protection depending on mosquito species and formulation.

7.2 Field and semi-field trials:-

-Field trials report variable repellency durations; for example, 20% neem oil solutions have produced 71% average repellency and protection for up to 3 hours against some Anopheles species in selected trials, but effectiveness depends heavily on formulation, concentration, and environmental factors

e.g. temperature, wind, host cues. Larvicidal field applications in breeding sites have reduced larval densities in multiple reports but require repeated applications due to biodegradation and dilution.

7.3 Comparative performance:-

-Compared with synthetic repellents (e.g., DEET, picaridin), neem formulations often show shorter protection times and greater variability. However, neem can add value where synthetic options are unavailable, culturally unacceptable, or undesirable due to environmental concerns; it also offers population-level benefits via larvicidal and reproductive suppression that personal repellents do not.

8. Formulation considerations and delivery systems:-

-Neem's volatile oils evaporate relatively quickly and azadirachtin is photosensitive; thus, a major technical challenge is achieving mixing release and stability. Common approaches include: Incorporating neem oil into creams/lotions with fixatives or emulsifiers to extend protection time. Combining neem with other botanicals (e.g., citrus peel oils) or carrier oils to produce synergistic or organoleptic improvements.

Microencapsulation, soap/lotion matrices, slow-release dispensers, and larvicide formulations for water bodies. Several studies show improved efficacy when neem is combined with complementary oils or when formulated to slow volatilization.

9. Safety, toxicity and environmental profile:-

-Toxicology studies indicate low acute toxicity for topical use of diluted neem oil, but pure neem extracts or improperly formulated concentrates can cause irritation, and oral ingestion of concentrated neem oil has documented toxicity in children and animals. Environmental effects are relatively beneficial (rapid biodegradation), but non-target insect impacts (e.g., beneficial insects) must be considered for broad environmental spraying. Regulatory status varies by country and by product type (cosmetic repellent vs pesticide).

10.Limitations :-

-Variable efficacy between preparations and mosquito species.

Shorter duration of repellency than gold-standard synthetics (DEET/picaridin) without advanced formulation.

Stability, standardization, and regulatory hurdles for commercial products.

Potential for irritation or toxicity with concentrated or improperly used products.

11.Research priorities:-

- Standardized testing protocols:- heterogeneity in assay conditions complicates comparisons; adoption of WHO-aligned testing for botanical repellents would help.
- Optimized slow-release formulations :- microencapsulation, polymer matrices, or synergist blends to extend protection time.
- Large-scale field trials :- well-powered randomized trials comparing neem formulations with standard repellents and measuring epidemiological endpoints where feasible.

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- Toxicology and exposure studies:- long-term safety and effects in vulnerable populations (infants, pregnant women).
- Environmental impact assessments :- effect on non-target aquatic and beneficial insect species for larvicidal uses.

II. CONCLUSION

Neem provides a promising, multifaceted botanical option for mosquito control: strong larvicidal and growth-regulating properties, moderate repellency, and an overall attractive safety/environmental profile when properly formulated. The main barriers to replacing or matching synthetic repellents are formulation stability and short protection duration; however, neem's additional population-level effects (reduced fecundity, oviposition) make it valuable in integrated vector management. Focused formulation research, standardized testing, and rigorous field trials are the next steps to unlock neem's full potential in public-health mosquito control.

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