IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Botanical Neem-Based Products As Sustainable Alternatives To Conventional Eco-Toxic Chemical Mosquito Control Agents

Author: A. J. Rama Rao[1] & Dr. Koppula Sampath[2]

[1]Assistant Professor of Botany, Government Degree College for Women, Khammam
[2]Assistant professor of Botany, Government Degree College Pargi, Vikarabad Dist. Telangana

Corresponding Author: Dr Koppula Sampath, Assistant professor of Botany, Government Degree College Pargi, Vikarabad Dist. Telangana

Abstract

Mosquito-borne diseases pose serious health risks to millions of people worldwide, as mosquitoes act as vectors for several deadly communicable diseases such as malaria, filariasis, dengue, and yellow fever. The widespread use of conventional chemical insecticides to control mosquito populations has led to the emergence of biological resistance in these vectors, along with significant adverse environmental impacts.

In response, recent years have witnessed increasing research efforts focused on developing eco-friendly, plant-based alternatives particularly neem-based products for mosquito control. Neem oil, extracted from the seeds *of Azadirachta indica A*. (commonly known as neem), has emerged as a promising botanical insecticide effective against a wide range of medically and veterinary important mosquito species. It is environmentally friendly, biodegradable, and exhibits target-specific action. Neem oil contains several biologically active compounds, primarily limonoids such as azadirachtin A, nimbin, salannin, and many others yet to be fully characterized. Among these, azadirachtin is the most potent and is chiefly responsible for the insecticidal activity. The efficacy of neem oil is largely dependent on its azadirachtin content, which in turn is influenced by the method of extraction and formulation.Neem oil can be applied directly or used in advanced formulations such as nanoemulsions, nanoparticles, or effervescent tablets. When introduced into natural mosquito breeding habitats, it acts through multiple mechanisms as an ovicide, larvicide, pupicide, and oviposition repellent. These effects are achieved by disrupting key physiological pathways in mosquito larvae or inducing physical deformities that hinder development. However, direct use of neem oil may have limitations, particularly its degradation under atmospheric conditions, which can reduce its effectiveness. Despite this, several formulations have demonstrated environmental stability and prolonged

efficacy. Additionally, neem seed cake a byproduct of neem oil extraction has also shown mosquitocidal activity. One of the greatest advantages of neem-based products is their low potential for resistance development in target species, primarily due to the complex mixture of active compounds and their synergistic actions. This makes neem and its derivatives promising yet underexplored candidates for sustainable mosquito control.

Objective: This study aims to formulate and evaluate herbal mosquito repellent sticks using powders of *Azadirachta indica (*Neem), *Ocimum sanctum* (Tulasi),and Cinnamomum verum (Cinnamon) and to assess their physical, combustion, and repellent properties.

MethodsTen herbal formulations were developed using different combinations of plant-based powders and natural excipients. Each formulation was evaluated based on its physical appearance, moisture content, potential for irritation, suffocating effect, ash value, burning time, smoke visibility, and mosquito repellency across various indoor environments.

Results: Plants as sources of mosquito control agents Throughout history, plants have been recognized as significant sources of chemicals that may be used to control insects. They are the sources of the naturally occurring insecticidal and larvicidal substances such as nicotine and its

derivatives present in pyrethrum extract (*Azadirachta indica A. Ocimum sanctum* (Tulasi),and *Cinnamomum verum* (Cinnamon). The invention of the structurally similar synthetic pyrethroid, nicotinoid, and rotenoid families of insecticides, as well as the piperonyl butoxide synergist, was based on these and other naturally occurring insect repellents.

Conclusion: The developed herbal sticks showed promising potential as natural, non-toxic mosquito repellents. Their effectiveness, safety, and eco-friendly nature position them as viable alternatives to chemical repellents. Further field trials and phytochemical standardization are recommended.

This artical aims to elucidate the potential of neem oil and its various botanical formulations in controlling mosquito vectors of public health importance.

Keywords: *Azadirachta indica. A*; Eco-friendly mosquito control; Larvicide; Mosquito repellent; Neem oil formulations.

Introduction

Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700 000 deaths annually. They can be caused by either parasites, bacteria or viruses (WHO), It is estimated by the World Health Organization (WHO, 2024). Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are bloodsucking insects which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated. Often, once a vector becomes infectious, they are capable of transmitting the pathogen for the rest of their life during each subsequent

bite/blood meal. Diseases of mosquitoes are transmitted to human beings through bites only. Over the years, there has been no effective vaccine available for the control of these diseases, thus prevention of mosquito bites is one of the main strategies to control or minimize incidence of these diseases.

Fradin (1998) noted that protection against mosquito bites can be best achieved by avoiding infested habitats, wearing protective clothing and applying insect repellent. The use of repellent has been advocated. Insect repellents date back to ancient times, with the use of tars, smokes, plant oils and other modalities (Peterson and Coats, 2001). Insect repellents work by masking human scent, making it impossible for the mosquito to sense the carbon dioxide and lactic acid present in sweat in humans and act as attractive substances for mosquitoes. The use of insect repellants can provide practical and economical means of preventing mosquito-borne diseases. It is important not only for local people in disease risk areas especially in tropical countries, but also for travelers who are vulnerable to diseases spread by mosquito vectors when they visit and seek (Mendhekar SY et al (2017))

Therefore, there is a growing demand for eco-friendly and herbal mosquito repellents that are biodegradable, non-toxic, and safe for human use (Gupta A (2013) et al, Archana B (2022) etal and Selvadurai S (2023) et al). Plant-based mosquito repellents, particularly those made using *Azadirachta indica* (Neem), *Ocimum sanctum* (Tulasi), *Acorus calamus* (Sweet Flag), *Syzygium aromaticum* (Clove), and *Cinnamomum verum* (Cinnamon) have gained prominence due to their naturalorigin and therapeutic properties (Borah R (2018) et al)

Neem: (Azadirachta indica, family: Meliaceae) is a fast-growing tree native to South Asia. Various parts of the plant, especially leaves and seeds, possess bioactive compounds with proven insecticidal, antimicrobial, and therapeutic effects. Neem has been widely used to protect crops and homes from mosquitoes and other pests (Ibrahim SI (2019) et al)

Tulasi: (*Ocimum sanctum* or O. *tenuiflorum,* family: *Lamiaceae)*, commonly known as Holy Basil, is an aromatic herb native to India and revered in traditional medicine. It contains essential oils such as camphene and eugenol, which exhibit insect-repelling and antifungal properties, making it suitable for herbal mosquito repellents.

Cinnamon: (*Cinnamomum verum*, family: *Lauraceae*) is derived from the inner bark of tropical evergreen trees, primarily cultivated in Sri Lanka and India. Known for its warm aroma and antimicrobial effects, cinnamon also contributes natural insect-repellent properties due to the presence of cinnamaldehyde.

Materials and Methods

Study Design: This is a field trial experimental study that seeks to examine locally acclaimed plant that grows in Telangna State, India, for mosquito repellence and mosquitocidal activities. Volatile oil were extracted from the leaves of the test plants formulated into two different concentrations (two formulations) and tested on volunteered human subjects. The study was conducted between September through October,

2024, using the extracted essential oils as test material and olive oil as negative control. (Trivedi A, et al (2018))

Description of Study Area: This study was conducted in Telangana. All these places lie within the rainforest zone of the southeastern Telangana with typical tropical climate. The temperature range during the study period was 30-35°C. The study was carried out in two different location, Parigi, Vikarabad District and Khammam District.

Study Population: The study population for this study comprise individuals living in the two locations, which are Vikarabad and Khammam Municipal. Selection of houses to be included in the investigation was done by the researcher. Selection criteria included the presence of stagnant water collections in gutters and potholes as well as refuse dumps littering the vicinity of the houses. Such practices promote proliferation of mosquitoes. Houses where mosquitoes were found inside bathroom floors and around water closets and septic tanks were enlisted. Sample Size: In each of the three locations, four (4) human baits who voluntarily.

Sample Preparation: Fresh leaves of *A. indica* were collected along the back saide of Parigi Government Degree College, Telangana. The leaves were air dried until the moisture content was reduced to barest minimum. The collected leaves of each of the plant materials were pulverized into powder using a Binatone Mx10 blender and sieved to obtain a fine powder of the plant part. 150g of each pulverised plant part was placed in a plain sheet of white paper, then placed in the timbel of the soxhlet apparatus compartment using petroleum ether extraction solvent (Okigbo et al, (2010)). The oils extracted were stored in an appropriate sample bottles at a temperature of 40 C till the period of formulation and repellency testing.

Methods

Standardized Method for the Preparation of Herbal Powders All powdered ingredients used in the mosquito repellent stick formulation namely Neem (*Azadirachta indica*), *Tulasi* (*Ocimum tenuiflorum), Cinnamon (Cinnamomum verum), Camphor (Cinnamomum camphora*), Starch, Sawdust, and Charcoal were prepared using standard methods to ensure quality and uniformity. Plant-based materials such as neem, tulasi, sweet flag, clove, and cinnamon were selected fresh, washed thoroughly with clean water to remove dirt and impurities, and dried in a shaded, well-ventilated area for several days until completely moisture-free (Hashim N, *et al.,* 2021).

Results and Discussions

Mosquito Repellent Test Procedure: The method adopted for mosquito repellency test is that developed by Oparaocha et al, (2010) but was adapted using WHO (2009) procedures for field trial. The volunteers worked in pairs and or each of the six in each location, a volunteer used the negative Control. All the six pairs worked for three sessions (morning, evening and night). The pairs for the three sessions worked for three consecutive days, twice a month and rotated lotion type and session every day. All the formulations were tested the same day so as to allow equal exposure to the same environmental conditions (Kalyanasundaram M *et al*., 206). For the testing, 2ml of the test lotion was given to the volunteers to rub

on the exposed parts of the body (the arms, legs and on the face). The pairs that worked in the morning and evening sessions stayed outside the house at about 20 m distance from each other from 5:30am to 7:30am and from 6:00pm to 8:00pm, while the pair for the night stayed in different rooms in the same house. Repellents are substances that act locally or at a distance, deterring an arthropod (insect/mosquito) from flying to, landing on or biting human or animal skin (Sah et al., 2010). Volatile oils of *Azadirechta indica* have shown from this study, to possess mosquito repelling abilities. The result showed that all the two types of repellent formulations offered a considerable amount of protection from mosquito species.

Figure-1: Materials used for Formulations of Mosquito Repellent Sticks

Neem sticks Neem Powder Cinnamon Powder

Table 1: **Monthly and average mosquito biting rate (24hrs/month) on treated and control volunteers**

Formulation/Month	Vikarabad		Khammam	
	Treated	Control	Treated	Control
30% (v/v) of *A. indica* in olive oil (A1)				
September	18	211	23	237
October	29	146	26	145
Total	47	357	49	382
60% (v /v) of A. indica in olive oil (A2)				
September	21	176	27	213
October	17	165	20	206
Total	38	341	48	421

Table 2: **Monthly percentage repellents of the formulations in the two locations**

Formulation/Month	Vikarabad	Khammam
30% (v/v) of *A. indica* in olive oil (A1)		
September	90.3	85.74
October	80.13	74.77
Total	85.84	80. 03
60% (v /v) of A. indica in olive oil (A2)		
September	88.06	86.02
October	88.70	81.70
Total	87.85	85.27

CONCLUSSION

This study can conclude that volatile oils of *Azadirachta indica* possess mosquito (*Anopheles culicifacies and Anopheles stephensi* and *Aedes aegypti*) repellent effects, especially at higher concentrations. It has also been established from this study that effective protection offered by the repellent is dependent on concentration of the repellent formulation. This study also concludes that volatile oils of *Azadirachta indica* possess mosquitocidal effects, in which mosquitoes are immobilized and paralyzed on contact with a skin treated with the formulation. Malaria-transmitting mosquitoes primarily bite during the night, as well as at dusk and dawn. As such, oil extracted from Azadirachta indica (neem) presents a relatively safe, natural alternative for repelling mosquitoes during these high-risk periods. It can be particularly useful for protecting individuals while they are in bed at night and when they are outdoors at dawn and dusk times when many people remain outside due to inadequate housing, harsh climatic conditions, or social and religious activities.

Given the simplicity of the extraction process, and the fact that the lotion's color, fragrance, and consistency remained stable throughout a two-month study period, neem oil-based formulations can be easily prepared at the community level. The use of olive oil as a base which is locally available and holds religious significance in many regions further supports the acceptability and practicality of these preparations.

Such formulations could serve as effective, low-cost supplements to traditional mosquito control measures, especially for individuals who are unable or unwilling to use insecticide-treated bed nets due to their cost or the odor of chemicals like permethrin.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study

REFERENCES:

1. **Archana** B, Chavhan AA, Jain SG. Formulation of economically affordable herbal mosquito repellent sticks. International Research Journal of Pharmacy and Medical Sciences,2022:5(6):5–7.
2. **Borah R**, Biswas M. Tulsi (Ocimum sanctum), excellentsource of phytochemicals. International Journal of Environment Agriculture andBiotechnology,2018:3(5):1732–1738.
3. **Fradin, M. S.** (1998). Mosquitoes and mosquito repellents: a clinician's guide. Annals of International Medicine, 128:931-940.
4. **Gupta A,** Oswal RJ, Patel EK. A review on: mosquito repellent methods. International Journal of Pharmaceutical, Chemical and Biological Sciences,2012:2:310–317.
5. **Hashim N,** Abdullah S, Hassan LS, Ghazali SR, Jalil R. A study of neem leaves: identification of method and solvent in extraction. Materials Today: Proceedings,2021:42:217–221
6. **Kalyanasundaram M,** Mathew N. N,N-diethyl phenylacetamide (DEPA): A safe and effective repellent for personal protection against hematophagous arthropods. J Med Entomol. 2006;43(3):518-525

7. **Mendhekar SY,** Bodke NN, Thorat PB, Jadhav SL, Gaikwad DD. Formulation and evaluation of polyherbal mosquito repellent creams (ointment type) with extra skin nourishing impact. World Journal of Pharmacy and Pharmaceutical Sciences,2017:6:1731–1742.
8. **Nwakocha, A. R**. (2007). Malaria - current trends. Proceedings of the Directorate of Research and Publications, Journal of College Medicine, 1:4-6.
9. **Peterson, C**. and Coats, J., (2001). Insect repellents- past, present and future, Pesticide Outlook, 12: 154-158
10. **Selvadurai S**, Swetha V, Anbazhagan S, Shanmugapandiyan P. Formulation and development of herbal based mosquitoes repellent Dhoop by using Azadirachta indica and Vitex negundo. International Journal of Herbal Medicine,2023:11(4):15–17.
11. **Sah, M**. L., Mishra, D., Sah, S. P. and Rana, M.(2010). Formulation and Evaluation of Herbal Mosquito Repellent Preparations. Indian Drugs, 47(4):45-50.
12. **Trivedi A,** Rai P, Kumar J. Formulation of low smoke herbal mosquito repellent sticks by using different essential oils. The Pharma Innovation Journal,2018:7(4):173–175.
13. **Ibrahim SI**, Fakhraddeen YM, Hauwa U. Mosquito repellent activity of leaf and seed extract of Azadirachta indica (neem). Journal of Malaria Research and Phytomedicine,2019:(1):19–23.
14. **Okigbo, R.N**., Okeke, J.J. and Madu, N.C. (2010). Larvicidal effects of Azadirachtaindica, Ocimum gratissimum and Hyptis,suaveolensagainst mosquito larvae. Journal of Agricultural Tech. 6 (4): 703-719.
15. **Oparaocha, E**. T.,Iwu, I. and Ahanaku, J. E. (2010). Preliminary study on mosquito repellent and mosquitocidal activities of Ocimum gratissimum (L.) grown in eastern Nigeria. Journal of Vector Borne Diseases; 47:45–50.

World Health Organization (2009). 10 Facts on Malaria. Geneva: World Health Organization, http://www.who.int/features/factfiles/malaria/en/index.html