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Elucidation of Herbal Mosquito Repellent

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Abstract: Mosquitoes are vectors that can transmit so many diseases like Dengue, Malaria, Zika virus, Arbovirus and others. According to World Health Organization (WHO), about half of the world's population is at risk of Malaria, Dengue and Chikungunya. In India about 40 million people suffer from mosquito borne diseases every year. Overall eradication of mosquito population is impossible; only remedy is to avoid mosquito bites; but the widespread use of mosquito repellents and insecticides in public health programs has caused severe environmental pollution and probable health hazards. The introduction of new and more toxic and rapidly spreading mosquito repellents and pesticides into the environment has demanded accurate identification of their potential hazards to human health. Many of them are extremely toxic to mammals and also other non-target organisms. Thus one can realize the need for a safe and eco-friendly mosquito repellent based on herbal origin. Currently various mosquito control methods are applied throughout the world. Chemical mosquito repellents have a wonderful safety profile, but it contains Transfluthrin chemical which is proved to be poisonous to human causing rashes on skin, brain swelling in children, anaphylactic shock, low BP and eye irritation. Another investigation pointed out by the scientists that overuse of chemical mosquito repellents develops resistance in mosquito. Herbal origin mosquito repellents are safer, eco-friendly and non-toxic to human and others. Present paper focus on new way for formulation of herbal mosquito repellent improving with silver nanoparticles and eco-friendly control of mosquito population. *Aloe vera* plant extract is natural product that have long been used for their health benefits. It has been shown to be effective for repelling mosquitoes. *Aloe vera* gel contains a compound called acemannan, which has been shown to be toxic to mosquitoes.

Keywords: Herbal mosquito repellent, Formulation, Insecticidal properties, Nanotechnology. *Aloe vera*,

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Introduction

Aloe vera is a juicy plant which belongs to Order Asparagales, and family Sphodelaceae. It is found in dry region and conserve water. *Aloe vera* leaves are chubby having gel-like substance (Surjushe *et al.*, 2008). Geographically *Aloe vera* plant is distributed worldwide. Studies suggested that its gel is being used in cosmetics. *Aloe vera* is now being used as herbal insecticide. It has been shown to be effective for repelling mosquitoes. *Aloe vera* plant juicy gel contains acemannan which has been shown to be toxic to mosquitoes. Mosquitoes are identified to spread many diseases such as malaria, dengue, filariasis, yellow fever and Japanese encephalitis. According to World Health Organization (WHO) about half of the world's population is at risk of Malaria, Dengue and Chikungunya. In India about 40 million people suffer from mosquito borne diseases every year. *Anopheles* species and *Aedes aegypti* are the most important species as they are capable vector for malaria parasites, dengue and Zika (Shaw and Catteruccia, 2019; Gonzales-Wartz *et al.*, 2024) Global occurrence of dengue has severely increased in the last few years. The World Health Organization (WHO) has declared the Zika virus a global public health emergency. The outbreak of Zika began at Brazil during 2015, and then spread in South and North America. The virus can be spread from an infected pregnant woman to her fetus, and then can causes microcephaly and other harsh brain disorders in the infant (Marbán-Castro *et al.*, 2021). It was predicated that, use of mosquito repellent creates health hazard problems such as these are toxic to the skin causing rashes, brain swelling in children, eye irritation, anaphylactic shock, and low blood pressure (Patil *et al.*, 2012). Many people dislike the odor of mosquito repellent which causes vomiting in women and children. Toxic element Palletehrin and Allethrin used in chemical mosquito repellent can cause cancer and defect in child birth and giddiness. Hence, herbal mosquito repellents are ideal than chemical mosquito repellents (Nandini *et al.*, 2013). The oil

extracted by *Vitex neugundo* leaves by stream distillate and fractionated by column chromatography shows mosquito repellent activity against *Aedes aegypti* (Hebbalkar *et al.*, 1992). Present paper focus on formulation of herbal mosquito repellent with nanotechnology and ecofriendly eradication of mosquito population. There are many mosquito management strategies. Various communities around the world are using chemical pesticide for mosquito control strategies owing to a lack of adequate information. Public awareness and campaigning are necessary in this regard. Communities must boost up the awareness for obstacle of ecofriendly mosquito control methods in mosquito-borne illnesses. Herbal mosquito repellents are mostly preferred than chemical mosquito repellents because they are safer and ecofriendly (Pandharbale, 2020). Silver nanoparticles are synthesized by using herbal plant leaves having insecticidal properties. The mosquito repellency was tested against mosquitoes in laboratory.

Materials and Methods

Traditional methods of repelling mosquitoes in India are by using herbal plants as neem (*Azadirachta indica* A. Jess) and Tulsi (*Ocimum sanctum*) leaves. *Aloe vera* leaf extract is a medicinal agent with multiple properties including an antibacterial effect (Maharjan and Nampoothiri, 2015). *Aloe vera* leaves contain lignin, hemicellulose, and pectins which can be used in the reduction of silver ions (Tippayawat *et al.*, 2016). *Aloe vera* gel has cooling properties and also mosquito repellent properties. Using traditional knowledge, eco-friendly mosquito repellent was formulated with nanotechnology.

Plant Collection and Gel extraction

Fresh *Aloe vera* plant was collected from its natural habitat. Leaves were properly cut and peeled off by sharp knife, then the inner gel was spoon out. Gel was kept in a glass jar for further experimental analysis. The volume of the filtrate was adjusted to 100 ml by distilled water.

Table 1: Testing of herbal Liquid mosquito repellent for mosquito repellent (*in vitro*)

Repellent Sample	Number of Mosquito Tested		No any action		Mosquito migrate away		Mosquito paralyzed		Remark
	Total	%	No.	%	No.	%	No.	%	Repellency
Sample 1 Herbal (<i>Aloe vera</i>) silver nanoparticles	15	100	10	66.0	04	26.0	01	6.0	Good repellency
Sample 2 (water+ silver nitrate)	15	100	15	100	00	00	00	00	No repellency

Nanoparticle synthesis was carried out by adding 10 ml of *Aloe vera* gel extract in 90 ml of 1 ml AgNO₃ solution. Then it was kept at constant room temperature for 4 h. The reaction medium acquired a yellowish brown colour, indicated the formation of silver nanoparticles (Gastón *et al.*, 2023). The extract containing herbal nanoparticles was centrifuged (Remi) at 10000 rpm for 20 min. The pellet was separated and mixed with sterile distilled water so as to re-dispersion of nanoparticles. Finally, repellent (Plant gel extract) is ready for testing of mosquito repellency *in vitro*.

Results and Discussion

Prepared *Aloe vera* herbal mosquito repellent based on nanotechnology was tested to study mosquito repellency. The herbal mosquito repellent sample 1 (*Aloe vera* silver nanoparticles) and control (sample 2- water+ silver nitrate) were tested by putting them in the evaporator under the mosquito cage containing mosquitoes (15) for 2 h.

It was observed that 6.0% mosquitoes get paralyzed with sample 1, 26.0% Mosquitoes were migrated while sample 2 control (water) does not show any action on mosquito activity (Table 1). It was determined that sample 1 contains *Aloe vera* plant extract with herbal nanoparticles which increase the efficiency of mosquito repellent; while Sample 2 does not show any action on

mosquito activity as it was control containing water. The formulated herbal mosquito repellent is eco-friendly. It is innovative way for formulation of herbal mosquito repellent. It can be prepared at home as it does not require any heavy infrastructure and investment as compared to coils and mats.

Ethical Statement

This study was in accordance with the Academic Research Committee (ARC) of the Annasaheb Awate College, Manchar, Tal. Ambegaon, Dist. Pune, Maharashtra.

Author Contributions

Pokale Sanjaykumar and *Pandharbale Ashok* have theoretical, practical and methodological contributions. They have done analysis of relevant literature. *Sayyed Shabnam*, *Patil Swapna*, *Gavit Hemangi*, *Kale Snehal*, *Admuthe Namdeo*, *Bhor Abhishek* were involved in material collection. All the authors were involved in manuscript preparation. *Gavit Hemangi* and *Theurkar Sagar* were involved in manuscript revision. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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