Scientific Inquiry and Review (SIR)
Volume 3, Issue 1, January 2019
ISSN (P): 2521-2427, ISSN (E): 2521-2435
Journal DOI: https://doi.org/10.32350/sir
Issue DOI: https://doi.org/10.32350/sir.31
Homepage: https://ssc.umt.edu.pk/sir/Home.aspx

Journal QR Code:

Article	**Biological Control of Mosquito Vectors: A Review**
Author(s)	**Hareem Sajjad** **Neelam Arif**
Online Published	January 2019
Article DOI	https://doi.org/10.32350/sir.31.03
Article QR Code	Hareem Sajjad
To cite this article	Sajjad H, Arif N. Biological control of mosquito vectors: A review. *Sci Inquiry Rev*. 2019;3(1):25–32. Crossref
Copyright Information	This article is open access and is distributed under the terms of Creative Commons Attribution – Share Alike 4.0 International License.

Indexing Agency

Crossref
ULRICH'S PERIODICALS DIRECTORY
OCLC WorldCat
Scientific Indexing Services
GENERAL IMPACT FACTOR
INDEX COPERNICUS INTERNATIONAL JOURNAL MASTER LIST
GENAMICS ...research from your desktop Genamics JournalSeek
DRJI Directory of Research Journals Indexing
ROAD DIRECTORY OF OPEN ACCESS SCHOLARLY RESOURCES
Academic Resource Index ResearchBib

A publication of the
School of Science, University of Management and Technology
Lahore, Pakistan.

Biological Control of Mosquito Vectors: A Review

Hareem Sajjad* and Neelam Arif

Department of Zoology, University of Gujrat, Punjab, Pakistan

*hareemajjad123@gmail.com

Abstract

The main purpose of this review paper is to study different biological control methods for controlling mosquito vectors. Mosquitoes act as vector for many harmful diseases including malaria, dengue fever, yellow fever, filarial, encephalitis, chikungunya, dengue and poly arthritis. The use of chemical insecticides for controlling mosquitoes is limited because they develop resistance against these insecticides. So, efforts have been made to control the mosquito vectors by eco-friendly techniques. At present, biocontrol agents are used to control the mosquito species with the aim to reduce the impact and cost of insecticide based strategies. These biocontrol agents involve the use of natural enemies including bacteria, fungi, larvivorous fish, protozoans and nematodes. These agents target mosquitoes at different stages of their life cycle. In this paper, we focus on several bio-controlling methods used to reduce the population of mosquito vectors.

Keywords: biological control, larvivorous fish, copepods, mosquito borne-diseases

1. Introduction

Mosquitoes act as important vectors for most of the bacterial and viral diseases [1]. They are considered as an important group of insects where the spread of disease and public health is concerned. In recent years, the population of mosquitoes has increased rapidly which is a very serious problem because they spread different types of diseases including malaria, filarial, yellow fever, encephalitis, chikungunya, dengue and epidemic polyarthritis [21]. These mosquito borne diseases are a major problem for many tropical and subtropical countries of Asia, Africa and America [2].

Mosquitoes are responsible for transmitting diseases in more than 100 countries of the world. There are approximately 3500 species of mosquitoes in tropical and subtropical regions [3]. Real genera of mosquitoes that go about as vector for different diseases are Culex (Japanese Encephalitis, West Nile, Chikungunya,) Anopheles (Filariasis, Malaria) and Aedes (Chikungunya, Dengue, Yellow fever) [4].

Aedes Eegyptii is a noteworthy vector which transmits dengue and chikungunya, affecting more than 2.5 million individuals each year [5]. Anopheles mosquito is the major cause of malaria and it spreads vivax, grassi, protozoan parasites, and plasmodium falciparum in the host organism [6]. The most effective explanations for the expansion of dengue fever are increased breeding places for mosquitoes, less viable control of existing mosquito populations, increasing urbanization and growth and development of human population [7]. Every year, 200-450 million diseases are caused by Anopheles mosquito worldwide that lead to 2.7 million deaths. It's an endemic problem in many countries. According to a BBC report, mosquito is considered as the world's most dangerous animal [8].

Mosquitoes cause serious diseases which can lead to death, so prevention is important to stop the disease in its tracks as quickly as possible [9]. Unfortunately, there is no treatment for these diseases in the form of vaccines or drugs [10]. Previously, chemical insecticides were used to control the pests. But these pesticides are not eco-friendly. On the other hand, mosquitoes also gain resistance against these insecticides [11].

Biocontrol strategies involve the use of natural enemies of mosquitoes including the predators and parasitoids [12]. These strategies are more effective and have no harmful impact on environment [13]. Using these strategies, mosquitoes are targeted at different stages of their life cycle, keeping in view the suitability of these strategies for the environment [14]. Different biological agents are involved in controlling mosquito species. The characteristics of a biological agent is that it has a high reproduction rate, little effect on the populations of non-target species and it is feasible in the introduced environment [15].

2. Means of Biological Control

2.1. Bacterial Agents

The utilization of bacterial specialists in controlling vector borne diseases has several advantages such as these microorganisms are exceedingly successful, naturally sheltered, harmless and exert selective impact. Among the many tried bacterial organisms, Bacillus Thuringenesis (BT) and Bacillus Sphaericus (BS) are the most encouraging bacterial larvicidal strains in malarial vector control [16, 17]. They are available in a broad range of environments, from ocean water to soil and are even found in exotic environments such as hot springs [17]. BT is considered as viable and targets particular insects. BS has great larvicidal activity against many mosquito larva, but its operational utility has not been clearly demonstrated [18]. BS and BT cause the creation of endotoxin proteins that harm the stomach of larva and consequently kill it [19]. Both species of bacteria produce two type of endotoxin proteins which are *cry* and *cyt1A* and these toxins work in tandem. *Cyt1A* proteins have a more long lasting effect as compared to *cry* proteins [2]. These bacteria strains have a toxic effect on different mosquito species including Aedes, Culex Quinquesfasciatus etc. [15].

Another important genus of bacteria is Asaia. It is associated with the larva and adults of Anopheles Stephensi, which is responsible for causing malaria in Asia. These bacteria are present in large numbers in female gut and salivary glands, which are considered as important sites for plasmodium development. Asaia damages these plasmodium development sites in their offspring [20]. For battling malaria, microbial operators are considered very important since they can forsake the development of plasmodium in mosquito or straightforwardly mark the Anopheles vector [21].

2.2. Entomopathogenic Fungi

Fungal diseases in insects are normal and their population can be annihilated in fabulous epizootics. Essentially, all insects are vulnerable to contagious fungal diseases including dipterans. Fungal pathogens, for example, lagenidium, coelomomyces and culicinomyces are known to decrease mosquito populations and have been considered broadly [22]. The spores of these fungi, once germinated, directly enter the mosquito exoskeleton and change the behavior of the vector. They produce a lot of toxic compounds and form hyphal bodies called blastopores in the body of the insect, which cause depletion of nutrients and eventually result in the death of the host mosquito [23].

Fungi are also powerful against existing insecticide resistant mosquito populations and are relied upon to impose reduce choice for new resistance traits relative to conventional chemicals [24]. Unlike chemical insecticides, fungi may take up possibly more than seven days to kill the host mosquito following exposure. This moderate kill speed can also decrease malarial transmission because malarial parasite itself takes no less than eight days to finish its development inside the mosquito. However, both fungal virulence and parasite advancement rate are dependent upon temperature; it is conceivable that the efficiency of bio-pesticide could change cross wise over different transmission situations [25].

2.3. Larvivorous Fish

Since 1937, larvivorous fish has been used for controlling the mosquito larvae [26]. One of the most important and widely used larvivorous fish against mosquito vectors is mosquito fish (Gambusia affinis). This fish can consume almost 100 to 300 larva of mosquito per day. Another important fish for mosquito control is Guppy (Poecilia reticulate) and this can eat 80 to 100 mosquito larva per day. Both of these fishes are very small in size and prefer those areas of water where mosquito larva are in a large amount [27]. Guppies are involved in Aedes infestations in the water bodies up to 98 percent [28].

Larvivorous fish are preferable as compared to chemical control because they face less danger of mosquito resistance, are less costly and remain safe for both natural life and humans and are also utilized at low measurements.

The use of larvivorous fish as a biocontrol agent also has some drawbacks. For example, Gambusia Affinis has some negative impact on its surroundings because it is an opportunistic predator and feeds on a variety of food including zooplankton, algae, young ones and eggs of amphibians [21]. So, for better movement of fish the expulsion of vegetation is essential [26].

2.4. Other Biocontrol Agents

2.4.1 Copepods. Copepods are a group of small crustaceans that prey on mosquito larvae. They are abundant in both oceans and fresh water habitats. Copepods are the natural predators of the larvae Aedes Ageyptii. Two species of copepods are recorded as the predator of Aedes which are Macrocyclops Albidus and Mesocyclops Leuckarti. Studies revealed that if they are used along with Bacillus Thuringenesis, they show long term effects against mosquito larvae.

2.4.2 Mermithid Nematodes. Mermithid nematodes are also used as biocontrol agents for many species of mosquito vectors. A study was conducted in 1973 to check the efficacy of nematode parasite as a biocontrol agent for the mosquito larva. Romanomermis Culicivorax is a mermithid nematode that is an endoparasite of mosquito family Culicidae and feeds on the larva of these mosquitoes. When they exit the host, they make a large hole in the cuticle of the insect which becomes the primary cause of death of the mosquito [21].

2.4.3. Protozoans. Protozoans are also used as biocontrol agents for mosquitoes but they are of very little importance. This is due to the reason that they have a very narrow host range. Some species of protozoa including Haemogregarina, Nosema, Babesia and Theileria are pathogenic for some parasites, such as ticks [21]. In Aug 2001, in Delhi, high death rates were observed in an experiment on different species of mosquito larva due to a ciliated protozoan named Chilodonella Uncinata.

3. Conclusion

Based on this study it is concluded that biocontrol systems for mosquito borne illnesses are expected to help lessen the use of insecticides that are currently utilized as the essential techniques for mosquito control. Eco-accommodating, safe, and feasible techniques ought to be produced that can be used against a variety of mosquito species. The pathogenic bacteria BT and BS have been broadly utilized because of their capacity to specifically execute mosquito larva and additional pathogens, for example, Entomopathogenic Fungi, might be powerful in future control programs. Mosquito behaviour plays a key role in mosquito vector control and further knowledge about the chemical ecology of mate searching, swarming landmarks, and mate choice in swarming sites is required to improve biocontrol strategies.

References

[1] Atieli FK, Munga SO, Ofulla AV, Vulule JM. The effect of repeated washing of long-lasting insecticide-treated nets (LLINs) on the feeding success and survival rates of Anopheles gambiae. *Malar J*. 2010 Dec;9(1): 304.

[2] Baldacchino F, Bruno MC, Visentin P, et al. Predation efficiency of copepods against the new invasive mosquito species Aedes koreicus (Diptera: Culicidae) in Italy. *Eur Zool J*. 2017 Jan 1;84(1): 43–8.

[3] Benelli G, Jeffries CL, Walker T. Biological control of mosquito vectors: Past, present, and future. *Insects*. 2016 Oct 3;7(4): 52.

[4] Chandra G, Bhattacharjee I, Chatterjee SN, Ghosh A. Mosquito control by larvivorous fish. *Indian J Med Res*. 2008 Jan 1;127(1): 13.

[5] Gaddaguti V, Rao TV, Rao AP. Potential mosquito repellent compounds of Ocimum species against 3N7H and 3Q8I of Anopheles gambiae. *3 Biotech*. 2016 Jun 1;6(1): 26.

[6] Ghosh A, Chowdhury N, Chandra G. Plant extracts as potential mosquito larvicides. *Indian J Med Res*. 2012 May;135(5): 581.

[7] Heinig RL, Paaijmans KP, Hancock PA, Thomas MB. The potential for fungal biopesticides to reduce malaria transmission under diverse environmental conditions. *J Appl Ecol*. 2015 Dec;52(6): 1558–66.

[8] Heinig RL, Thomas MB. Interactions between a fungal entomopathogen and malaria parasites within a mosquito vector. *Malar J*. 2015 Dec;14(1): 22.

[9] Kalita B, Bora S, Sharma AK. Plant essential oils as mosquito repellent-a review. *Int J Res Dev Pharm Life Sci*. 2013 Oct 27;3(1): 741–7.

[10] Kamareddine L. The biological control of the malaria vector. *Toxins (Basel)*. 2012 Sep 19;4(9): 748–67.

[11] Kiplang'at K, Mwangi RW. Synergistic repellent activity of plant essential oils against Aedes aegypti on rabbit skin. *Int J Mosq Res*. 2014 Jan 1;1(4): 55–9.

[12] Kiplang'at KP, Mwangi RW. Repellent activities of Ocimum basilicum, Azadirachta indica and Eucalyptus citriodora extracts on rabbit skin against Aedes aegypti. *J Entomol Zool Stud*. 2013;1(5): 84–91.

[13] Kumar R, Hwang JS. Larvicidal efficiency of aquatic predators: a perspective for mosquito biocontrol. *Zool Stud*. 2006 Oct 1;45(4): 447.

[14] Land M, Miljand M. *Biological control of mosquitoes using Bacillus thuringiensis israelensis: a pilot study of effects on target organisms, non-target organisms and humans*. Stockholm, Sweden: Mistra EviEM; 2014.

[15] Maia MF, Moore SJ. Plant-based insect repellents: a review of their efficacy, development and testing. *Malar J*. 2011 Dec;10(1): S11.

[16] Marten GG, Che WE, Bordes ES, Che WY. Compatibility of cyclopoid copepods with mosquito insecticides. *J Am Mosq Control Assoc*. 1993 Jun 1;9: 150.

[17] Meisch M. Physical, chemical, and biological controls: modern and future approaches to mosquito control. *Med Hyg*. 1984;21(6): 985–88.

[18] Mendki MJ, Singh AP, Tikar SN, et al. Repellent activity of N, N-diethylphenylacetamide (DEPA) with essential oils against Aedes

aegypti, vector of dengue and chikungunya. *Int J Mosq Res*. 2015;2(1): 17–20.

[19] Naseem S, Malik MF, Munir T. Mosquito management: a review. *J Entomol Zool Stud*. 2016;4(5): 73–9.

[20] Peterson C, Coats J. Insect repellents-past, present and future. *Pestic Outlook*. 2001 Jan 1;12(4): 154–8.

[21] Sarwar M. Control of dengue carrier Aedes mosquitoes (Diptera: Culicidae) larvae by larvivorous fishes and putting it into practice within water bodies. *Int J Prev Med Res*. 2015;1(4): 232–7.

[22] Scholte EJ, Knols BG, Samson RA, Takken W. Entomopathogenic fungi for mosquito control: a review. *J Insect Sci*. 2004 Jan 1;4(19): 7.

[23] Seng CM, Setha T, Nealon J, Socheat D, Chantha N, Nathan MB. Community-based use of the larvivorous fish Poecilia reticulata to control the dengue vector Aedes aegypti in domestic water storage containers in rural Cambodia. *J Vector Ecol*. 2008 Jun;33(1): 139–44.

[24] Soonwera M. Efficacy of essential oils from Citrus plants against mosquito vectors Aedes aegypti (Linn.) and Culex quinquefasciatus (Say). *J Agric Technol*. 2015;11: 669–81.

[25] Sritabutra D, Soonwera M. Repellent activity of herbal essential oils against Aedes aegypti (Linn.) and Culex quinquefasciatus (Say.). *Asian Pac J Trop Dis*. 2013 Aug;3(4): 271.

[26] Sukumar K, Perich MJ, Boobar LR. Botanical derivatives in mosquito control: A review. *J Am Mosq Control Assoc*. 1991 Jun;7(2): 210–37

[27] Tawatsin A, Asavadachanukorn P, Thavara U, et al. Repellency of essential oils extracted from plants in Thailand against four mosquito vectors (Diptera: Culicidae) and oviposition deterrent effects against Aedes aegypti (Diptera: Culicidae). *Southeast Asian J Trop Med Public Health*. 2006 Sep 1;37(5): 915.

[28] Yoon JK, Kim KC, Cho Y, et al. Comparison of repellency effect of mosquito repellents for DEET, citronella, and fennel oil. *J Parasitol Res*. 2015;2015: 1–6