International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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The effect of some insecticides on the larvae of *Aedes aegypti* in Jeddah Governorate, Makah Province, Kingdom Saudi Arabia

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International Journal of Science and Research Archive, 2021, 03(02), 043–048

Publication history: Received on 07 August 2021; revised on 16 September 2021; accepted on 18 September 2021

Article DOI: https://doi.org/10.30574/ijsra.2021.3.2.0128

Abstract

Mosquitoes can act as vectors for many disease-causing viruses and parasites through carrying these organisms from person to person. The objective of this study was to evaluate the susceptibility of *Aedes aegypti* larvae to some insecticides in Jeddah Governorate. Mosquito larvae were collected from all the available breeding sites in Jeddah municipalities using standard larval collection kits. The diagnostic doses (LC50 and LC90) were calculated from the mortality and concentration data. The larvicides Pirimiphos methyl, Fenitrothion, Bifenthrin and Cypermethrin were tested against the larvae of *Ae. aegypti* mosquito. The results showed positive correlation between the concentrations under investigation and mortality% of the treated larvae. Cypermethrin gave strong effect against *Ae. aegypti* larvae (LD_{50} 0.0015 ml/L) followed by Pirimiphos methyl (LD_{50} 0.0020 ml/L), Bifenthrin (LD_{50} 0.039 ml/L), and at last rank Fenitrothion (0.041 ml/L). The same trend was obtained in LD_{90s}. *Ae. aegypti* in Jeddah was susceptible to Bifenthrin, Cypermethrin, Pirimiphos methyl and Fenitrothion. Further studies should be run to conduct an intensive and appropriate vector control program in Jeddah Governorate.

Keywords: Clove pods; Phytochemistry; GC-MS; Mosquitoes; Natural products

1. Introduction

Mosquitoes (Diptera: Culicidae) are members of a group of about 3,500 species [1]. Mosquitoes are found everywhere, except Antarctica and from below sea level to elevation of 3,000 m or more. The majority of mosquito species fall into three groups: anophelines, culicines and aedines [2]. Mosquitoes can be an annoying, serious problem in man's domain. Mosquito-borne diseases are responsible for a significant fraction of the global disease burden and also on socioeconomic development of affected nations [3]. Larviciding largely depends on the use of synthetic chemical insecticides but it disrupted natural biological control agents and resulting in the development of resistance [4].

One of the most successful methods for mosquito control is the use of insecticides. However, long-term use of insecticides has resulted in the development of resistance in mosquito populations [5]. Protection from mosquito bites could be achieved by avoiding physical contact with mosquitoes. In order to solve the problem caused by insecticides to mammals and to find environmentally friendly control method, some natural products has been used to reduce the reliance on pesticide. This compound has generally been regarded as safe, but adverse effects when misapplied can be severe [6]. To avoid these harmful effects, several researchers are now focusing on the repellent qualities of products

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derived from natural plant extracts. This work has recently led to a number of essential oils being recommended as mosquito repellents due to their eco-friendly and biodegradable nature [7].

In Jeddah Governorate, community participation is an important component of *Ae. aegypti* control strategies, through the elimination of water container breeding-sites in the domestic and pre-domestic area and environmental sanitation programs. However, community action alone may not be sufficient for the control of these vector populations since some breeding-sites could be neglected by the actions of environmental sanitation programs, making other intervention forms necessary, such as chemical control.

The objective of this work was to explore for the optimum and valuable control agent from different and modern formulations of larvicides, in order to conduct an intensive and appropriate vector control program in Jeddah Governorate.

2. Material and methods

2.1. Study Area

The study was conducted in Jeddah City (21°32N and 39°10E), Makah province, Saudi Arabia. It is situated on the coast of the Red Sea and, as home to about 3.5 million people, is considered to be the major urban area of western Saudi Arabia. According to Jeddah Health Affairs, Ministry of Health, this area reports the highest incidence of mortality and morbidity in Jeddah.

2.2. Mosquito Collection, Identification and Rearing

Mosquito larvae were collected from all the available breeding sites in the study area (Jeddah municipalities) using standard larval collection kits. The collected larvae were identified and separated from predators. The collected larvae were transferred in the same day of collection to the Insectary (Public Health Pests Laboratory, Jeddah Municipality). During the rearing period, the larvae were fed on fish food. A few numbers of emerged adults were selected randomly for morphological identification using morphological features according to the identification key for common mosquito adults.

2.3. Larval bioassays

The diagnostic doses (LC50 and LC90) were calculated from the mortality and concentration data. The 3rd instar larvae of *Ae. aegypti* was used to evaluate the susceptibility of the laboratory strains following WHO [8] instructions**.**

2.4. Insecticides used

- Synthetic ops larvicides: Pirimiphos methyl 50% EC and Fenitrothion 50% EC.
- Synthetic Pyrethroids larvicides: Bifenthrin 10% EC and Cypermethrin 10% EC.

2.5. Statistical analysis

Mortality percentages were corrected and calculated for natural mortalities by Abbott's [9]. The dosage mortality data were subjected to Probit analysis according to Finney [10]. The tested compounds were compared for their efficiency on insecticides according to their LC_{50}, LC_{90} and slopes of the toxicity lines and statistical parameters.

3. Results and discussion

3.1. Primiphos methyl and Fenitrothion

Primiphos methyl (at 0.00125-0.005 ml/L) and Fenitrothion (at 0.0156-0.25 ml/L) were tested under laboratory conditions against *Ae. aegypti* larvae. The larval mortality% of Primiphos methyl ranged between 20 – 97.5% in laboratory strain, while larval mortality% of Fenitrothion ranged between 25-96.5% in laboratory strain (Table 1 and Figure 1). The results showed positive correlation between the concentrations under investigation and mortality% of the treated larvae.

The results showed that Pirimiphos methyl gave high effect against *Ae. aegypti* larvae (LD_{50} 0.002 ml/L). The same trend was obtained in LD_{90s}, which was 0.0038 (ml/L) for Primiphos methyl, whereas Fenitrothion gave low effect against *Ae.*

aegypti larvae (LD_{50} 0.041 ml/L, LD_{90} 0.113 ml/L). The results indicated that, *Ae. aegypti* in Jeddah was susceptible to Pirimiphos methyl and Fenitrothion.

Table 1 Susceptibility of *Ae. aegypti* mosquito larvae to Primiphos methyl and Fenitrothion after 24 hours under laboratory conditions in Jeddah Governorate

Insecticide	Effective conc. (ml/L)	Larval Mortality (%)[a]	Statistical parameters			
			LC_{50} (ml/L)	LC_{90} (ml/L)	Slope	R^2
Primiphos methyl	0.0012	20.0	0.0020	0.0038	5.1	0.77
	0.0015	25.0				
	0.0023	40.0				
	0.0038	65.0				
	0.0050	97.5				
Fenitrothion	0.0156	25.0	0.041	0.113	2.19	0.85
	0.048	42.5				
	0.068	57.5				
	0.083	70				
	0.250	97.5				

The obtained results did not agree with those obtained by Ponlawatm *et al.* [11], whom found that *Ae. aegypti* from all study sites were resistant to permethrin, but were susceptible to malathion. Resistance to temephos was detected in all strains of *Ae. aegypti*, except those from Nakhon Ratchasima. *Ae. Albopictus* larvae had low levels of resistance to all three insecticides, except Mae Sot and Phatthalung strains, which were resistant to permethrin.

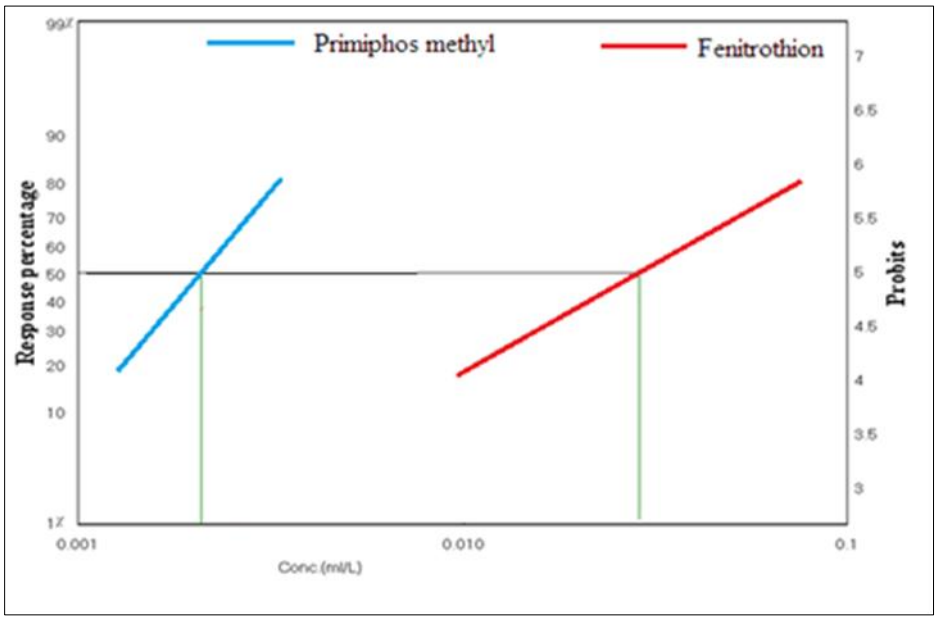

Figure 1LC-P lines of Primiphos methyl and Fenitrothion against larvae of *Ae. aegypti* under laboratory conditions in Jeddah Governorate

The obtained results are agreed with those obtained by Rodríguez *et al.* [12] evaluated organophosphate insecticide resistance, including temephos, malathion, fenthion, methyl pirimiphos, fenitrothion and chlorpyriphos against *Ae. aegypti* larvae from Cuba and other Latin-American countries. They found all of the *Ae. aegypti* strains temephos resistance (RR_{50}> 10x), except for the Nicaragua strain which exhibited moderate resistance to this OP (RR between 5 and 10x), with a value of 9.1x. The highest RR value to temephos was (89.9x) in the Havana city strain followed by Costa Rica (68.3x), Jamaica (42.5x), Panama (23.3x), Peru (22.5x) and Venezuela (13.1x). Also found *Ae. aegypti* larvae were susceptible to malathion in all of the strains, and similar results were obtained for fenthion and fenitrothion.

3.2. Bifenthrin and Cypermethrin

Bifenthrin (at 0.015-0.24 ml/L) and Cypermethrin (at 0.0005-0.0312 ml/L) were tested under laboratory conditions against *Ae. aegypti* larvae. The larval mortality% of Bifenthrin ranged between 20-97.5%, while larval mortality% of Cypermethrin ranged between 22.5 -97.5% (Table 2). The results showed positive correlation between the concentrations under investigation and mortality% of the treated larvae (Table 2 and Figure 2). The results showed that Bifenthrin gave high effect against *Ae. aegypti* larvae (LD_{50} 0.039 ml/L), whereas Cypermethrin gave strong effect against *Ae. aegypti* larvae (LD_{50} 0.0015 ml/L). The same trend was obtained in LD_{90s}. The result indicated that, *Ae. aegypti* in Jeddah was susceptible to Bifenthrin and Cypermethrin.

The obtained results did not agree with those obtained by Sirisopa and Thanispong [13] they found *Ae. aegypti* from different localities in Thailand were strongly resistant to bifenthrin, permethrin and deltamethrin. High resistance to lambda-cyhalothrin was detected from all localities with the exception of *Ae. aegypti* from Bangkok and Uttaradit which demonstrated incipient resistance.

Table 2 Susceptibility of *Ae. aegypti* mosquito larvae to Bifenthrin and Cypermethrin after 24 hours under laboratory conditions in Jeddah Governorate

Insecticide	**Effective conc. (ml/L)**	**Larval Mortality (%)**	**Statistical parameters[b]**			
			LC_{50} (ml/L)	**LC_{90} (ml/L)**	**Slope**	**R^2**
Bifenthrin	0.015	20.0	0.0389	0.1015	3.07	0.92
	0.033	35.0				
	0.051	55.0				
	0.095	77.5				
	0.240	97.5				
Cypermethrin	0.0005	22.5	0.0015	0.0086	1.68	0.89
	0.0011	37.5				
	0.0023	55				
	0.0221	80				
	0.0312	97.5				

Generally, the larger theR^2 indicates the greater the homogeneity of results [14]. Results in Table (2) indicated that the calculated R^2 reached 0.92 and0.89, respectively, for Bifenthrin and Cypermethrin, while it were 0.77 and0.85forPrimiphos methyl and Fenitrothion, respectively.

The obtained results not agree completely with those obtained by Sirisopa and Thanispong [13] they found strong resistance to bifenthrin, permethrin and delta methrin was observed in all field test populationswhereasalpha-cypermethrinandcypermethrindemonstratedincipientornoresistance.

On the other hand, in Thailand studies have reported that there has been an increased deltamethrin resistance in several field populations of *Ae. aegypti* [15, 16]. The increased incidence of resistance is raising awareness of the need for alternative insecticides or newer, more innovative methods of controlling mosquito vectors. Alpha-cypermethrin,

another synthetic pyrethroid, is being used in Thai homes for protection against indoor biting mosquitoes and other arthropod pests.

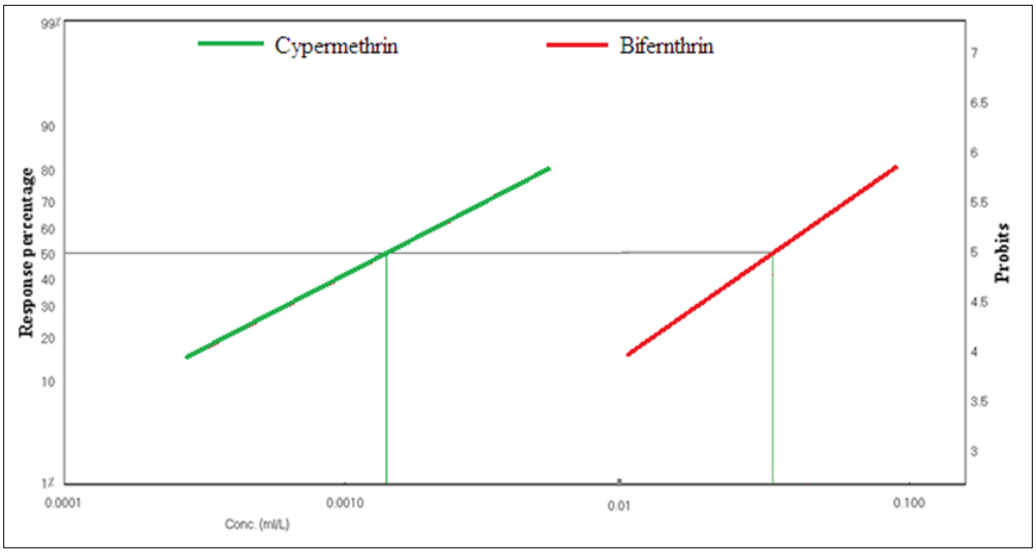

Figure 2LC-P lines of Bifenthrin and Cypermethrin against larvae of *Ae. aegypti* under laboratory conditions in Jeddah Governorate

4. Conclusion

All results showed positive correlation between the concentrations under investigation and mortality% of the treated larvae. Cypermethrin gave strong effect against *Ae. aegypti* larvae (LD_{50} 0.0015 ml/L) followed by Pirimiphos methyl (LD_{50} 0.0020 ml/L), Bifenthrin (LD_{50} 0.039 ml/L), and at last rank Fenitrothion (0.041 ml/L). The same trend was obtained in LD_{90s}. *Ae. aegypti* in Jeddah was susceptible to Bifenthrin, Cypermethrin, Pirimiphos methyl and Fenitrothion.

Compliance with ethical standards

Acknowledgments

Thanks, are for the staff of the Insectary of the Public Health Pests Laboratory, Jeddah Municipality; and Blue Nile National Institute for Communicable Disease, University of Gezira for their academic advice and technical support.

Disclosure of conflict of interest

The authors (MohiEldin; Omar; Ashraf and Mutaman) declare no conflicts of interest regarding the publication of this paper.

Statement of ethical approval

The present research work does not contain any studies performed on animals/ humans subjects by any of the authors.

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