

Evaluation of pyrethroids efficacy in *Aedes aegypti* (Diptera- Culicidae) from semi-arid zone, Jaipur

* Shashi Meena, Neetu Kachhwaha

Centre for Advanced Studies in Zoology, University of Rajasthan, Jaipur, Rajasthan, India

Abstract

The pyrethroids efficacy in larvae and adults of *Aedes aegypti* from semi-arid zone, Jaipur was investigated using World Health Organization standard procedures. Studies were carried out on 4th instar larvae and female adults of *Aedes aegypti* and percent mortality determined by log probit analysis. Data of LC₅₀ and LC₉₀ values were observed to be 0.0003 and 0.0794 ppm and 0.0063 and 0.0158 ppm for cypermethrin and permethrin against larvae of *Aedes* mosquitoes vector respectively. The results showed that both larvae and adults of *A. aegypti* were more susceptible to cypermethrin than permethrin as tested. Mortality rates after exposing adults to discriminating concentrations showed LC₅₀ and LC₉₀ to be 0.0019 and 1.0501 ppm and 0.1000 and 0.3981 ppm for cypermethrin and permethrin respectively, when subjected for 60 min. time exposure. As the study area is endemic outbreak prone, the present study of pyrethroids susceptibility assay could yield a powerful approach in mosquito's population control strategy.

Keywords: Pyrethroids efficacy, *Aedes aegypti*, percent mortality, cypermethrin, permethrin

1. Introduction

Mosquitoes causing diseases are magnificently spread throughout the world. *Aedes* mosquitoes represent a major cause of mosquito borne diseases which include dengue fever, chikungunya and yellow fever and collectively infect 50–100 million people every year. *Aedes aegypti* is a principal vector of Dengue hemorrhagic fever in semi-arid zone of Rajasthan where it has a unique characteristic of breeding proficiently in underground water tanks prevalent in villages and urban areas [1]. In the year 2013, the number of dengue cases had reached around 2,500 in Rajasthan which the whopping figure was, however, the highest in past seven years in the state. Recently, in the year 2016, 178 cases of dengue were reported from different parts of Rajasthan, out of these, nearly 100 cases were reported in the first week of September alone [2,3]. (Dna, Public Health Dept., 2013, 2016). An effective vaccine against dengue is not available yet and control of vector is mainly depend on chemical control. Insecticide application is considered the most important component in the global mosquito vector control effort [4, 5, 6]. In India, the main insecticides used for indoor residual spraying include DDT, Malathion and synthetic pyrethroids in rural areas and source reduction and anti-larval measure in urban areas. Currently pyrethroids are the best option for the control of mosquito population due to their relative safety for humans at low dosage, excito-repellent properties, biodegradable in nature, rapid rate of knock-down and killing effects [7]. Therefore, the objective of this study was to determine the current susceptibility of the larvae and adults of *Aedes* mosquito's vector against permethrin and deltamethrin. The information on the insecticide susceptibility rate of the mosquito will be useful for selecting the appropriate insecticide and their concentrations that provide the most effective control measures for *A. aegypti* controlling in these areas.

2. Materials and Methods

2.1 Insecticide: Permethrin (Technical grade 96.2 % purity) and Cypermethrin 25% EC formulation purchased from

Chemet Chemicals Pvt, Ltd. Bharuch, Gujrat, India

2.2 Mosquitoes sampling: Mosquitoes larvae of *Aedes aegypti* were collected from different areas belonging to a semi-arid regions around Jaipur city and colonized in the laboratory in Department of Zoology, University of Rajasthan, Jaipur. Larvae were collected from human dwellings, water stored pits, plastic & earthen containers etc. and species identified with the help of standard identification keys. The collected larvae were transferred in caged cloth and culture maintained at room temperature of 27 ± 2°C and relative humidity of 75–85% and daily fed with the crushed dog biscuits. Emerged adult mosquitoes were allowed to feed on 10% glucose solution soaked in cotton pads.

2.3 Bioassay: Bioassay method was carried out according to the recommended protocol of World Health Organization to evaluate susceptibility in IVth instar larvae and adult of *A. aegypti* exposed to several concentrations of synthetic pyrethroids viz., Cypermethrin and permethrin. The different concentrations of insecticide solution were prepared in acetone ranging from 0.00001, 0.0001, 0.001, 0.01, 0.1 ppm. Acetone was used as a control reagent. Five replicates were kept for each concentration and in each replicate 20 early 4th instar larvae were released into disposable 250 ml beakers containing 99 ml of dechlorinated tap water. With the help of micropipette one milliliter of insecticide solution of diagnostic dose was dispensed in the beaker. Larval mortality was recorded after 24 hours observation and mortality was calculated using Abbott's formula [8]. Unmoved and moribund larvae were recorded as dead. The mortality data were further subjected to probit analysis for estimating LC₅₀ and LC₉₀ values using Finney method [9]. Using CDC bottle bioassay female adults, exposed against the diagnostic dosages of insecticides for one hour. Four replicates of each vector species usually containing 20 female mosquitoes were taken simultaneously for each insecticide. Control replicates were also held parallel to each test.

Table 1: Log probit analysis of the percent mortality data of IVth instar larvae of *Aedes aegypti* to cypermethrin and permethrin.

Insecticides	Concentration (ppm)	No. of insects exposed	Percent mortality	LC ₅₀ (ppm)	LC ₉₀ (ppm)
Cypermethrin	0.01	100	98	0.0003	0.0794
	0.001	100	72		
	0.0001	100	50		
	0.00001	100	36		
Permethrin	0.1	100	90	0.0063	0.0158
	0.01	100	60		
	0.001	100	34		
	0.0001	100	18		

Table 2: Log probit analysis of the percent mortality data of female's adults of *Aedes aegypti* to cypermethrin and permethrin.

Insecticides	Concentration (ppm)	No. of insects exposed	Percent mortality	LC ₅₀ (ppm)	LC ₉₀ (ppm)
Cypermethrin	0.1	100	90	0.0019	1.0501
	0.01	100	80		
	0.001	100	68		
	0.0001	100	42		
Permethrin	1	100	84	0.1000	0.3981
	0.1	100	64		
	0.01	100	40		
	0.001	100	22		

3. Results and Discussion

Comparative efficacy of two synthetic pyrethroids was evaluated against larvae and adults of *Aedes aegypti*. It's obvious by present study that pyrethroids at very low concentrations are very effective for control of *Aedes* mosquito population and cypermethrin as found to be more toxic than permethrin. Estimated LC₅₀ and LC₉₀ values were observed to be 0.0003 and 0.0794 ppm for cypermethrin and 0.0063 and 0.0158 ppm for permethrin respectively (Table-1). Experiments have also been carried out with female adults of *Aedes* mosquito vector with the diagnostic doses and found that adults were fully susceptible to the pyrethroids as tested. Mortality rates female adult mosquitoes showed LC₅₀ and LC₉₀ concentration to be 0.0019 and 1.0501 ppm and 0.1000 and 0.3981 ppm for cypermethrin and permethrin respectively, after exposing one hour (Table-2). Complete susceptibility of many mosquito species towards several synthetic pyrethroids have been observed by many authors [11, 12, 13]. As compared LC₅₀ values, showed cypermethrin to be most toxic with a value of 0.16 ppb at 20°C against *A. aegypti*. Permethrin, fenvalerate, d-phenothrin, flucythrinate and bioallethrin less toxic, in descending order [10]. In other study, 100% mortality occurred with deltamethrin at concentration of 1.25 µg/ml against *A. aegypti* adult females post 30 minutes exposure [14]. Similarly, the sensitivity of four strains of *Aedes* to permethrin, after two hours contact with insecticide-soaked paper using the WHO standard method determined [15]. In response to present study, diagnostic dose 5 µg/ml for cypermethrin 10% EC, was observed for susceptible population of *A. aegypti* and for deltamethrin (1.5% EC) in the adult females (susceptible population) was 2.5 µg/ml post 30 minutes exposure against *A. albopictus* [16]. Also, toxicity of λ-cyhalothrin, a synthetic pyrethroid presented a LC₅₀ of 1.140 ppm against *Aedes* mosquitoes in Tamilnadu [17]. The single diagnostic dose of 0.147% permethrin, 0.094% bifenthrin, 0.005% deltamethrin, 0.221% cypermethrin, 0.086% alpha-cypermethrin and 0.012% lambda-cyhalothrin for different populations of *Ae. aegypti* were found completely susceptible with 100% after 60 min. [18]. However, LD₅₀ and LD₉₀ of permethrin were observed

to be 41.8 mg/m² and 66.4 mg/m² respectively, against *A. albopictus* [19]. Thus, It is suggests that pyrethroids can be effectively employed in *Aedes* mosquito control during period of epidemic and endemic outbreaks, provide alternative tool in the integrated vector management programme during emergencies. Further studies are needed to unravel the resistance mechanism exhibited by dengue mosquito species.

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