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Susceptibility status of dengue fever vector *Aedes aegypti*, (L.) in Republic of Yemen

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ABSTRACT

The aim of the present research work was to determine the current susceptibility level of larvae and adults of a field strain dengue fever vector *Aedes aegypti* (L.) to some conventional insecticides. Taking the values of LC50 (concentration required to kill 50 % of mosquito larvae), the results showed that the mosquito larvae of *A. aegypti* were more susceptible to the OP insecticides sumithion (0.007 ppm) than acifon (0.019 ppm), actillic (0.049 ppm) and of onac (1.87 ppm) respectively, while the pyrethroids fendona (0.09 ppm) was more effective against larvae than aralin (1.24 ppm) by about 13.8 times. On the other hand, the findings revealed that the exposure of mosquito adult females to the diagnostic dosages of deltamethrin(0.05%), lambdacyhalothrin(0.5%), permethrin(0.75%), cyfluthrin(0.15%), malathion(5%) and fenitrothion (1%) caused 81, 75, 90, 84, 64 and 29% mortality, respectively. According to WHO criteria, the data indicated that adult mosquitoes of the field strain *A. aegypti* were resistant to the insecticides lambdacyhalothrin, malathion and fenitrothion but were tolerant to deltamethrin, permethrin and cyfluthrin.

KEY WORDS: DENGUE FEVER, CONVENTIONAL MOSQUITOCIDES, AEDES AEGYPTI, INSECTICIDES RESISTANCE

INTRODUCTION

Dengue fever is an acute virus disease of the tropic and subtropic regions around the world, especially in urban and semi-urban areas (Halsted *et al.*, 2001). It is a mosquito-borne viral illness that is caused by one of the four serotypes of dengue virus, belonging to the family Flaviviridae and predominantly transmitted by *Aedes aegypti* and few other *Aedes* species. It has emerged as a major international health problem with an expanded geographic distribution and potential to cause major epidemics (Gubler, 2002; Fakeeh and Zaki, 2003; Rodriguez *et al.*, 2002, Fansiri *et al.*, 2006; WHO, 2010). The present study was conducted to determine the current susceptibility status of mosquito larvae and adults of *A. aegypti* the primary vector of dengue fever to some conventional insecticides commonly used in mosquito control.

MATERIALS AND METHODS

MOSQUITO STRAIN

Tests were performed on a field strain of *A. aegypti* (L.) raised from wild larvae, collected from different localities of Ibb governorate,Yemen. The larvae were reared until pupation and adult emergence took place for maintaining the stock colony.

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This strain was maintained at a room temperature of 27 ± 1Co and 70 ± 5% R. H. With a 14 : 10 L : D photoperiod throughout this study.

MOSQUITO LARVICIDES TESTED

The following insecticides were used:

- The synthetic pyrethroid Fendona (Alphacypermethrin 6%).
- The synthetic pyrethroid Aralin (Tetramethrin 2% + cypermethrin 11%).
- The organophosphates Ofonac (Pyridafenthion 40%).
- The organophosphates Acifon (Trichlorfon 50%).
- The organophosphates Actillic (Pirimiphos methyl 50%).
- The organophosphates Sumithion (Tetramethrin 2.5% + Phtrothion 25%).

LARVAL BIOASSAY

Susceptibility tests of *A. aegypti* larvae were conducted according to the procedure recommended by WHO (1981). Early fourth instar larvae were exposed to serial concentrations of the tested insecticides for 24 hours, in groups of glass beakers containing 100 ml of tap water. Five replicates of 20 larvae each per concentration, and so for control trials were set up. Larval mortalities were scored at 24 hr post-treatment (WHO, 2005).

Data were subjected to probit analysis, for calculating LC50 and LC95 values using the Finney (1972) method and GW BASIC probit1 Statistical software.

MOSQUITO ADULTICIDES TESTED

The insecticides used in the present study were diagnostic doses of WHO impregnated papers kindly supplied by Center of WHO, School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang. The tested adulticide were the pyrethyroids i.e., Deltamethrin (0.05%), Lambdacyhalothrin (0.5%), Permethrin (0.75%), Cyfluthrin (0.15%) and organophsp-horous i.e., Malathion (5.0%) and Fenitrothion (1.0%).

ADULT BIOASSAY

The adult bioassay was conducted using WHO test kits (WHO, 1981). Non blood Fed mosquito females aged 3-5 days old were exposed for 1hr to the tested insecticides. For each insecticide, four replicates were used, each containing 25 mosquito females.

Mosquitoes used as controls were exposed to papers without insecticides. After the exposure period, the mosquitoes were transferred to clean holding tubes and provided with cotton pads soaked with 10% sugar solution. Mortality counts were recorded 24 hr after the exposure period and compared with control trials. The resistance status was determined according to WHO criteria: population is considered to be susceptible to the test adulticide if the percent mortality is equal or greater than 98%, a resistant population is the one which shows less than 80% mortality (WHO, 1981).

RESULTS AND DISCUSSION

Susceptibility levels of *A. aegypti* mosquito larvae following treatment with different concentrations of the pyrethroid insecticides fendona and aralin as well as the organophosphates insecticide ofonac, acifon, actikil and sumithion are shown in Table 1. The effective concentrations of the above compounds against 4th larval instars ranged from 0.06 - 0.20 ppm; 0.50-4.00 ppm; 1.5-4.0 ppm; 0.01-0.1 ppm; 0.02-0.2 ppm and 0.005 0.05 ppm, respectively. The corresponding larval mortalities for these compounds were 17-93%; 23-87%; 21-93%; 27-97%; 18 96% and 22-93% respec-tively. LC50 values at 24 hours showed that the sumithion (0.007 ppm) proved to be the most effective compound, followed by the acifon (0.019 ppm), actillic (0.049ppm), fendona (0.09), aralin (1.24ppm) while the ofonac (1.87ppm) was the least effective.

In other words, the results indicate that mosquito larvae of *A. aegypti* were more susceptible to the organophosp-hates sumithion than ofonac, actillic and acifon by about 267.14; 7 and 2.71 folds, respectively, while the pyreth-roid fendona was more efficient than aralin against *A. aegypti* by about 13.8 times. However, it can be concluded that the change in the susceptibility levels of the present mosquito larvae is possibly due to the differential mode of action of the test compounds and its effective concentrations. The fluctuations in the percentage mortalities obtained for the different concentrations of different compounds tested against the present mosquito larvae support this conclusion (Saleh and Aly, 1987; Canyon and Hii, 1999; Nazniet *et al.*, 2005; Coleman *et al.*, 2006; Vittum *et al.*, 2008).

Data of table 2 show results of susceptibility status of mosqui-to adults of a field strain of *A. aegypti* against four pyre-throids (deltamethrin, Lambdacyhalothrin, permethrin and cyfluthrin) and two organophosphate adulticides (malathion and fenitrothion), at diagnostic dosages using WHO filter impregnated paper assays. The records showed that the exposure of mosquito females of *A. aegypti* to the diagnostic dosages of deltamethrin, lambdacyhalothrin, permethrin, cyfluthrin malathion and fenitrothion caused 81, 75, 90, 84, 64 and 29% mortality, respectively. Taking WHO criteria into consideration, the results indicate that *A. aegypti* mosquito females were resistant to lamblacyhalothrin, malathion and fenitrothion but were tolerant to deltam-ethrin, permethrin and cyfluthrin.

In Jeddah, the susceptibility status of mosquito adults of field strain Culex pipiens against some insecticides have been were determined. The records showed that exposure of adult females to the diagnostic dosages of lambdacyha-lothrin, permethrin, malathionand fenitrot-hion caused 54, 57, 56 and 23% mortality respectively, indicating resistance of the present mosquito species to the above insecticides (Mahyoub, 2011).

In different parts of the world, laboratory and field trials in this respect have been carried out by several workers (Huong and Nguyen, 2000; Hemingway and Ranson, 2000; Rodriguez *et al.*, 2002; Huber *et al.*, 2003; Nazni *et al.*, 2005). In Port Sudan City - Red Sea State, Aedesa egypti were found to be susceptible to Deltamethrin 0.05%, Bendiocarb 0.1%, tolerant to Lambdacyhalo-thrin 0.05% and resistant to DDT 4% and Malathion 5% respectively (Husham *et al.*, 2010).

In India, Katyal *et al*., (2001) used the diagnostic dosage of different insecticides against mosquito adults of *A. aegypti*. They found that the test mosquitoes were resistant to DDT (74% mortality) and dieldrin (46% mortality) but were tolerant to fenitrothion (91% mortality) and were susceptible to lambdacyhalothrin (100% mortality). Liu *et al*., (2004) detected high resistance values to some pyrethroid insecticides against Culex of unique fasciatus in Alabama and Florida. In Thailand, the field strain of *A. aegypti* was found to be susceptible to fenitrothion, resistant to permethrin and highly resistant to DDT (Paeporn *et al*., 2005).

In general, it can be concluded that resistance status to insecticides within mosquito populations is a dynamic process depending on the type of insecticide used, the frequency of use and the possible effect of environmental pollution following pest control measures (Orshan *et al*., 2005).

On the other hand, variations in susceptibility are so great that susceptibility investigations should assess mosquito samples collected from many sites with an area, rather than relying on the results obtained from one area (Conyon and Hii, 1999). However, considera-tion must be taken regularly to monitor the susceptibility status of local mosquitoes to insecticides used in control programmes. Such records on insecticide susceptibility are essential in defining future control strategies against mosquito vectors.

TABLE 1: Susceptibility levels of a field strain of *A. aegypti* larvae to the insecticides fendona, aralin, ofonac, acifon, actillic and sumithion.

Larvicides	Effective Concentration (Ppm)	Larval Mortality (%)	Lc_{50} (LC_{95})	Slope
Fendona	0.06-0.20	17-93	0.09 (0.17)	3.1
Aralin	0.50-4.00	23-87	1.24 (11.6)	1.76
Ofonac	1.50-4.00	21-93	1.87 (1.87)	3.9
Acifon	0.01-0.10	27-97	0.019 (0.095)	2.5
Actillic	0.02-2.20	18-96	0.049 (0.19)	2.8
Sumithion	0.005-0.05	22-93	0.007 (0.073)	1.8

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