RESPONSE OF *CULEX QUINQUEFASCIATUS* SAY (DIPTERA: CULICIDAE) FROM DIFFERENT LARVAL HABITATS TO DELTAMETHRIN AND BENDIOCARB INSECTICIDES

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ABSTRACT

Laboratory evaluation of Bendiocarb and Deltamethrin insecticides for the management of Culex quinquefasciatus mosquitoes were conducted in June, 2016 at Arbovirus and Vectors Research Centre, Enugu, Nigeria. Cx. quinquefasciatus larvae were obtained from breeding sites (ground pools, dirty water, containers) at Michael Okpara University of Agriculture, Umudike, Southeast Nigeria. They were reared and fed with ground biscuit to adulthood. Two- to three-day old, non-blood engorged female mosquitoes were exposed separately to discriminating dosages of 0.1 % bendiocarb and 0.05 % deltamethrin-impregnated papers embedded in World Health Organisation (WHO) diagnostic test kit following their standard protocol of susceptibilities. Knockdown effect was recorded at 5 and 10 minutes intervals, and their mortality scored 24 hours after exposure. Fifty and ninety percent knockdown times (KDT_{50} and KDT_{90}) were determined using probit analysis. The result showed that the Cx. quinquefasciatus collected from the breeding habitats were resistant to bendiocarb with a mortality of 38.50 % after 24 hours exposure. A similar result was also obtained from deltamethrin treatment with percentage mortality of 10.80. The KDT_{50} and KDT_{90} were 30 and 60 minutes, respectively in deltamethrin treated mosquito, whereas 40 and 60 minutes in bendiocarb treated. This result revealed that bendiocarb and deltamethrin insecticides may not be suitable alternatives to control Culex spp. at this location.

Keywords: *Culex quinquefasciatus,* Larval habitats, Bendiocarb, Deltamethrin, Knockdown time

INTRODUCTION

Culex quinquefasciatus Say 1823 is the vector of lymphatic filariasis caused by nematode (*Wuchereria bancrofti*) in the tropics and subtropics. It is also a vector of avian malaria, and Dengue fever. Reports from the neighbouring country, republic of Benin has identified carbamates (bendiocarb) as a potential alternative to combat pyrethroid-DDT resistance in *An. gambiae* populations (Corbel *et al*., 2007; Akogbeto *et al*., 2010), mainly because of its separate mode of action (Oduola *et al*., 2012). However, there is need for more information on the insecticide resistance status of the field strain of *An. gambiae* in Nigeria to carbamate insecticide (Olayemi *et al.,* 2011; Oduola *et al*., 2012).

Targeting the larval stage in the mosquito is preferable since the larvae are stationed in their breeding site rather than adult mosquito which is cumbersome to control. Mosquito larvicides like *Bacillus sphaericus* and *B. thuringiensis* have been widely and effectively used in mosquito control programs, but the industrial production of these bacilli is

expensive. Due to the widespread of this disease and the vector, there is the need for the evaluation of bendiocarb which is a relatively effective, environment-friendly, and affordable insecticide for the management of this important malaria vector.

To avoid indiscriminate use of insecticides and its residual effects on human health, it is necessary to determine the effectiveness of these insecticides periodically at various locations. The data on the susceptibility of *Cx. quinquefasciatus* to bendiocarb and deltamethrin (a pyrethroid) at Michael Okpara University of Agriculture Umudike is scarce in spite of the public health importance of this insect vector. This investigation was undertaken to generate a baseline data on susceptibility of adult *Cx. quinquefasciatus* to these insecticides at Umudike South East, Nigeria. This study investigated the efficacy of deltamethrin and bendiocarb insecticides for the control of *Cx. quinquefasciatus* mosquito in a humid environment.

MATERIALS AND METHODS

Susceptibility Test

Bendiocarb: This was performed using standard WHO diagnostic test kit (WHO, 1981) on the newly emerged 2 – 3 day old adults on 0.1 % bendiocarb impregnated paper. Mosquitoes were first kept in holding tube for one hour, during which all unfit mosquitoes were removed. The mosquitoes were then exposed to the test paper in batches of 18 to 26 per exposure tube for one hour in a normal vertical position at room temperature and the knockdown rate recorded at 5 and 10 minutes interval during the period of exposure. Thereafter, they were gently transferred to holding tubes with cotton wool moistened with 10 % sucrose solution and final mortality was recorded 24 hours post exposure. Samples were identified using morphological keys (Huang and Ward, 1981; Gillies and Coetzee, 1987). Number of dead and alive mosquitoes were counted and recorded, and then percentage mortality calculated.

The KDT_{50} and KDT_{90} were evaluated using probit analysis (Finney, 1952).

Deltamethrin: The susceptibility test was done after one hour of pre-test using WHO standard test kit and procedure (WHO, 1998). Accordingly, 0.05 % deltamethrin impregnated paper strips were introduced into 4 exposure tubes and rolled to line with the wall of the tube and fastened into position by a wire clip. The control was lined with plain sheet of paper. After which the mosquitoes were transferred into the exposure tubes through a hole on the lid that separated the holding tube and the exposure. The exposure tubes were then set upright with the screen-end up and allowed to stand for one hour. Records of mortalities were taken at 5 minutes, and then at 10 minutes interval. The mosquitoes were carefully transferred back to the holding tubes and kept for 24 hours during which they were fed with 7 % sucrose solution. Records of final mortality were taken after 24 hours. All the dead mosquitoes were removed from the holding tubes and identified using morphological keys of (Gillet, 1972; Service, 1980; Gillies and Coetzee; 1987).

Statistical Analysis: The 24 hours percentage mortality of each insecticide was calculated as the proportion of mosquitoes that died after 24 hours and the total number of mosquitoes exposed using 95 % confidence intervals. Mortality rate in the control tube was not above 5 %, and hence were not corrected using Abbott formula (Abbott, 1987). The resistance of the mosquito samples was determined according to WHO criteria (WHO, 1998). Mortality rates of less than 80 % indicated full resistance whereas those greater than 98 % indicated full susceptibility. Mortality rates between 80 – 98 % suggested the possibility of resistance that needed to be clarified. The Knock down data was subjected to Probit analysis using statistical software (Statsdirect, 2013) to compute the KDT_{50} and KDT_{90} (time taken to knock down 50 and 90 % of the exposed mosquitoes) and their 95 % confidence intervals.

RESULTS AND DISCUSSION

Bendiocarb: The knockdown of *Cx. quinquefasciatus* within 60 minutes of exposure to 0.05 % bendiocarb and percentage mortality within 24 hours after exposure is presented in Table 1.

Table 1: Knockdown time and percentage mortality of *Culex quinquefasciatus* within 60 minutes of exposure to bendiocarb

Description	Mortality (%)	
	Control	Treatments
Number of mosquitoes tested	25.00	21.50 ± 0.50
Number KDA 10 minutes	0.00	1.50 ± 0.65
Number KDA 15 minutes	0.00	0.75 ± 0.48
Number KDA 20 minutes	0.00	1.00 ± 0.58
Number KDA 30 minutes	0.00	4.50 ± 1.85
Number KDA 40 minutes	0.00	5.00 ± 1.29
Number KDA 50 minutes	0.00	11.75 ± 2.17
Number KDA 60 minutes	0.00	14.75 ± 2.29
Mortality after recovery period (24hrs)	0.00	8.75 ± 3.32
Observed mortality (%)	0.00	48.00 ± 13.13

KDA = knockdown after, Mean percentage mortality at 24 hours after exposure was 38.50%; (KDT_{50} = 30 minutes; KDT_{90} = 60 minutes)

The mean mortality of *Cx. Quinquefasciatus* due to bendiocarb exposure at 24 hour was 8.75 ± 3.32 (38.50 %). This low mortality rate might be attributable to the agrarian activities around their habitats surrounded by agricultural research institute and communities where pesticides and fertilizers are frequently used. The information of the effect of breeding habitats on resistance of mosquitoes is critical for managing immature stages of mosquitoes in their aquatic habitats. Djouaka *et al.* (20011) worked in Benin and showed that resistance was affected by breeding habitats of mosquitoes because insecticides are used.

Furthermore, the study was conducted in the rainy season, when the application of the chemical against crop pest is common which could exert pressure on the mosquito population and result in an increase in resistance. The results obtained in this study will guide in the choice of insecticides for use in vector control programmes in the area. In addition, the data obtained provide baseline information needed in the monitoring of the development of resistance to the insecticide arising either due to selective pressure from the use of insecticides and pesticides or through migration to the area of mosquitoes with insecticide resistant genes.

Deltamethrin: The knockdown of *Cx. quinquefasciatus* within 60 minutes of exposure to 0.01 % deltamethrin and percentage mortality within 24 hours post exposure is presented in Table 2.

Table 2: Knockdown time and percentage mortality of *Culex quinquefasciatus* within 60 minutes of exposure to deltamethrin

Description	Mortality (%)	
	Control	Treatments
Number of mosquitoes tested	26.00	20.75 ± 0.50
Number KDA 10 minutes	0.00	2.50 ± 0.86
Number KDA 15 minutes	0.00	4.75 ± 0.75
Number KDA 20 minutes	0.00	6.00 ± 0.41
Number KDA 30 minutes	0.00	8.25 ± 0.48
Number KDA 40 minutes	0.00	10.50± 1.04
Number KDA 50 minutes	0.00	11.25 ± 1.49
Number KDA 60 minutes	0.00	12.25 ± 0.85
Mortality after recovery period (24hrs)	0.00	2.25 ± 1.11
Observed mortality (%)	0.00	

KDA = knockdown after, Mean percentage mortality at 24 hours after exposure was 10.8 %; (KDT_{50} = 40 minutes; KDT_{90} = 60 minutes)

The mean mortality of *Cx. quinquefasciatus* due to deltamethrin treatment at 24 hour was 2.25 ± 1.11 (10.80 %). The results indicated that *Cx. quinquefasciatus* collected for the study might have developed high levels of resistance to the diagnostic concentration of deltamethrin. A similar results were obtained from previous studies in Kuala Lumpur (Nazni *et al*., 2005), Benin (Corbel *et al*., 2007) and Nagpur District, India (Karlekar *et al.,* 2013). This could be attributed to the indiscriminate use of pyrethroid insecticides and other pesticides at the school farm and the neighbouring institute of root crop. Furthermore, Djouaka *et al*. (2011) in Benin and Akogbeto *et al*. (2005) in Nigeria made similar observations. *Culex* mosquitoes are mostly outdoor feeders and breeders (Ndams *et al.,* 2006). They also breed in very dirty aquatic environments (gutters, very dirty water pools) where they stand the risk of being exposed to insecticidal runoffs. All these in addition to agricultural insecticides would have exerted enough pressure for the development of resistance in *Culex*.

The results of the knockdown assessment showed that the tested insecticidal papers induced knockdown of the adult *Culex* mosquitoes, suggesting that knockdown mechanisms could be operating in the *Cx. quinquefasciatus* population of Umudike. This confirmed several reports on the knockdown effects of insecticide impregnated papers against mosquitoes in Nigeria (Awolola *et al*., 2005; 2007: Oduola *et al*., 2010; Olayemi *et al*., 2011; Ibrahim *et al*., 2014; Umar *et al*., 2014). The knockdown of the mosquitoes exposed to insecticidal papers indicates the presence of knock down resistance (kdr) mechanism (Kristan *et al.,* 2003; Awolola *et al*., 2007; Ibrahim *et al.,* 2014; Umar *et al*., 2014) observed with populations of *Culex* mosquitoes at Umudike. In Nigeria the use of pyrethroid and cabamate for malaria vector control has been an old-time tradition which might have contributed to the development of organophosphate resistance in *Cx. quinquefasciatus.* Wild strain *Culex* spp. from Umudike might have shown potential for resistance to these insecticides.

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