Susceptibility of Anopheles Mosquitoes to Deltamethrin and Bendiocarb Insecticides in Nasarawa Local Government Area, Nasarawa State Nigeria

P.S. Lama, J. D. C. Tongjura, R. J. Ombugadu, and A. B. Yako

ABSTRACT

Anopheles mosquito's resistance to insecticides has been one of the major challenges in eradicating malaria. This study was carried out to determine the susceptibility status of *Anopheles* mosquitoes to Deltamethrin and Bendiocarb in some communities of Nasarawa Local Government Area of Nasarawa State for four months. The research was carried out at the insectary laboratory of Nasarawa State University Keffi. Center for Disease Control (CDC) bioassay bottle and WHO impregnated papers were used to test the susceptibility of *Anopheles* mosquitoes. The result shows that *Anopheles* mosquitoes exposed to Bendiocarb and Deltamethrin using CDC bioassay bottles were susceptible at 15mins, there was no mortality recorded from the control at 30 minutes of exposure. *Anopheles* mosquitoes exposed to WHO impregnated paper of Bendiocarb and Deltamethrin were susceptible at 60 minutes, mortality was recorded at 24h post exposure time from the control. χ^2 analysis of Bendiocarb and Deltamethrin insecticides exposed to CDC bioassay bottles was statistically insignificant $p>0.05$, while χ^2 analysis of Bendiocarb and Deltamethrin exposed to WHO impregnated papers was also insignificant $p>0.05$. These results indicated susceptibility of *Anopheles* mosquitoes to Bendiocarb and Deltamethrin for the two methods of susceptibility test. The use of these synthetic insecticides in the control of malaria should be encouraged and made available.

Keywords: Anopheles mosquitoes, Bendiocarb, Bioassay, Deltamethrin.

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I. INTRODUCTION

The general use of insecticides for agricultural pests, human vector and livestock diseases has made insecticide resistance difficult in the control of malaria [19]. These mosquitoes transmit human diseases such as malaria, yellow fever, dengue fever, hemorrhagic fever, filariasis and encephalitis [17], [12]. These have accounted for high incidence of maternal and mortality rate, financial losses in the treatment and prevention of malaria to about 132 billion naira in Nigeria [7]. Nigeria and public health agencies responsible for public health in Nigeria have set up a control program to eradicate the disease. The malaria vector intervention control program in Nigeria focuses more on Long Lasting Insecticide Nets (LLIN), Indoor Residual Spray (IRS), intermittent preventive treatment (IPT) and environmental management [14]. Despite all these intervention control, malaria has remained one of the major challenges in the world despite intense national and international efforts [23]. However, attention should be given to malaria control in both rural and

urban communities to aimed at determining the susceptibility of *Anopheles* mosquitoes to Deltamethrin and Bendiocarb insecticide.

Resistance of *Anopheles* mosquitoes to insecticides in Nigeria is on the increase and these has shown that *Anopheles gambiae* s. s is resistance to DDT and less to Permethrin in all the geographical zones of Nigeria, but highest levels of resistance were found in the forest savannah, Mosaic and Guinea savanna. For instance, *Anopheles* mosquitoes were resistance to all the classes of insecticides except organophosphate in Ghana while DDT and Permethrin showed high levels of resistance in Cameroun and Ogun state, Nigeria [4], [5], [22], [2]. In Auyoof Jigawa state, susceptibility status of *Anopheles* species siblings to three classes of insecticides such as DDT, Permethrin and Bendiocarb using WHO adult insecticide susceptibility bioassay was observed. The *Anopheles gambiae* were highly resistant to DDT and Permethrin but less resistant to Bendiocarb [8].

In Awka Anambra state, *Anopheles* mosquitoes were exposed to the three classes of insecticide i.e.,

Organochlorine, Pyrethroid and Carbamate. It was observed that Anopheles mosquitoes were susceptible to Carbamate (Bendiocarb) and resistant to the other classes of insecticide (Pyrethroid and Organochlorine) [15], [9] in Rwanda. It was also observed by [18] that Anopheles mosquitoes were susceptible to the four insecticides in Akwa Ibom state such as Deltamethrin, Lambdacyhalothrin, Permethrin and Malathion. Three species of Anopheles mosquitoes, *An. gambiae*, *An. arabiensis* and *An. Melas* were exposed to Deltamethrin, DDT and Propoxur in Gambia, by [11] observed that the mosquitoes were susceptible except for *An. gambiae* which was resistant to DDT.

II. MATERIALS AND METHODS

A. Study Area

The study was carried out in Nasarawa Local Government Area of Nasarawa state which is located in the western senatorial zone with latitude 08°41'20" to 08°32'10" N and longitude 07°48'43" to 07°50'00" E. It has two seasons rainy seasons starts from April to October while dry season start from October to March.

B. Sample Collection and Procedures

Anopheles mosquitoes larval were collected from their natural water habitat in some communities of Nasarawa Local Government Area using Entomological ladles (i.e., plastic scoop to scooped) into a well labeled container, they were transported to the Insectary laboratory, Department of Zoology Nasarawa State University Keffi. The Anopheles larval were reared to adult stage in the laboratory and fed with biscuit and yeast while the adult fed on sugar solution according to the procedures of [24].

C. Procedure for WHO Method of Susceptibility

The susceptibility test was carried out using four bottles for each of the insecticides used (Bendiocarb and Deltamethrin) and two control bottles each. An aspirator was used to introduce 25 Anopheles mosquitoes into the coated bottles. A timer was used to record both the number of dead and live mosquitoes after 15 minutes to 30 minutes until all were dead. The mortality in the control bottle was recorded as well [24].

D. Data Analysis

The data was analyzed using Chi Square analysis to test the level of significance between the insecticides used in the study.

III. RESULTS

Result showed that a total number of 100 female Anopheles mosquitoes exposed to CDC bioassay bottle for 30 minutes and at 15 minutes 99% were knockdown and 1 alive and at 30 minutes observation, there was 100% knockdown/mortality of the adult Anopheles mosquitoes. At 30 mins there was no mortality recorded from the control (Table I). The result of the chi square analysis was statistically insignificant ($p=0.199$) since $p > 0.05$.

One hundred (100) adult Anopheles mosquitoes were exposed to Deltamethrin using CDC bioassay bottle for 30 minutes. Anopheles mosquitoes were observed for 15

minutes and 30 minutes, at 15 minutes 98% Anopheles mosquitoes were knockdown while 2 were alive. At 30 minutes there was 100% knockdown/mortality of Anopheles mosquitoes after post exposure and no record of mortality from the control (Table II). The chi square analysis was statistically insignificant ($p=0.199$) since $p > 0.05$.

Total number of 100 adult Anopheles mosquitoes were exposed to Bendiocarb using WHO impregnated paper and mortality was recorded every 10 minutes for 60 minutes and 24 hour post exposure. At 60 minutes there was 100% knockdown of Anopheles mosquitoes, and the control was 0%, but at 24h post exposure, 2 (1%) mortality was recorded from the control (Table III). The mortality of Anopheles mosquitoes to Bendiocarb was highly insignificant ($p=0.243$).

A total number of 100 female Anopheles mosquitoes were exposed to Deltamethrin using WHO impregnated paper for 60 minutes and 24 hour post exposure. In Table IV, susceptibility was recorded at 60 minutes with 98% mortality of Anopheles mosquitoes. After 24h post exposure, 100% mortality was recorded, while 2 (1%) mortality was observed from the control. Statistically there is no significant difference $p = 0.224$.

TABLE I: SUSCEPTIBILITY OF ANOPHELES MOSQUITOES EXPOSED TO BENDIOCARB USING CDC

Exposure time (mins)	Number of An. Mosquitoes exposed	Number alive	Number of An. Mosquitoes knockdown	% knockdown	Control R1 R2
0	100	100	0	0	0 0
15	100	2	98	98	0 0
30	100	0	100	100	0 0

TABLE II: SUSCEPTIBILITY STATUS OF ANOPHELES MOSQUITOES TO DELTAMETHRIN USING CDC BIOASSAY BOTTLE

Exposure time (mins)	Number of An. Mosquitoes exposed	Number alive	Number of An. Mosquitoes knockdown	% knockdown	Control R1 R2
0	100	100	0	0	0 0
15	100	2	98	98	0 0
30	100	0	100	100	0 0

TABLE III: SUSCEPTIBILITY STATUS OF ANOPHELES MOSQUITOES TO BENDIOCARB USING WHO IMPREGNATED PAPERS

Exposure time (mins)	Number of An. Mosquitoes exposed	Number of An. Mosquitoes knockdown	Number alive	% knockdown	Control R1 R2
10	100	0	100	0	0 0
20	100	40	60	40	0 0
30	100	74	26	74	0 0
40	100	96	4	96	0 0
50	100	99	1	99	0 0
60	100	100	0	100	0 0
24h	100	100	0	100	1 1

TABLE IV: SUSCEPTIBILITY STATUS OF ANOPHELES MOSQUITOES EXPOSED TO DELTAMETHRIN USING WHO IMPREGNATED PAPERS

Exposure time (mins)	Number of An. Mosquitoes exposed	Number of An. Mosquitoes knockdown	Number alive	% knockdown	Control R1 R2
10	100	0	100	0	0 0
20	100	21	79	21	0 0
30	100	41	59	41	0 0
40	100	68	32	68	0 0
50	100	85	15	85	0 0
60	100	98	2	98	0 0
24h	100	100	0	100	1 1

IV. DISCUSSION

Adult female *Anopheles* mosquitoes exposed to bendiocarb 12.5mg using CDC bioassay bottle for 30mins were 100% susceptible to the insecticide and 15mins with 99% knockdown/mortality. [21] Observed that *Anopheles stephensi* were susceptible to CDC bioassay bottles of Bendiocarb at 97.5%, [13] also observed that *Anopheles gambiae*, *Anopheles funestus* were 100% susceptible to Bendiocarb at 15mins of exposure in Uganda. This is because Bendiocarb work by inhibiting acetylcholinesterase, enzymes required for nerve impulses leading to death of the mosquitoes.

Anopheles mosquitoes exposed to Deltamethrin were susceptible at 15 minutes of exposure with 98% knockdown/mortality while 100% knockdown/mortality was observed at 30 minutes. This is because Pyrethroid insecticides works by disrupting the nervous system of *Anopheles* mosquitoes by weakening the insect leading to death. These findings support [1] who observed *Anopheles* mosquitoes' susceptibility to Deltamethrin (100%) mortality. [21] Also reported susceptibility of *Anopheles* mosquitoes to Deltamethrin using CDC bioassay bottle with 100% mortality in Iran. Though, this study is in contrast with the study of [13] who observed that *Anopheles gambiae* were resistance to Deltamethrin with only 87% mortality.

Anopheles mosquitoes exposed to WHO impregnated papers of Bendiocarb for 60mins indicated 100% mortality. [15] Also reported high susceptibility of *Anopheles* mosquitoes (100%) in Anambra state. This study is also similar to the work done by [6] in Rivers state with (100%) knockdown/mortality to Bendiocarb. Similarly, [3] reported susceptibility of *Anopheles* mosquitoes to Bendiocarb in Akwa Ibom state with 99%-100% mortality. Though, [10] reported resistance of *Anopheles* mosquitoes to Bendiocarb in Ibadan with only 87.7% knockdown/mortality. While [20] observed high resistance of *Anopheles* spp to Bendiocarb in Bauchi (17.29%) mortality. [16] observed total resistance of *Anopheles* mosquitoes to Bendiocarb (80%) in Lagos. This may probably be due to climate change which can influence the shift of variance where there is susceptibility and in another it shows resistance to Bendiocarb.

The female *Anopheles* mosquitoes exposed to Deltamethrin using WHO impregnated papers were susceptible at 60 minutes with 98% mortality which is in agreement with WHO standard of susceptibility. This study confirmed the findings in Ibadan by [10] where *Anopheles* mosquitoes were susceptible to Deltamethrin (98.8%) mortality. Though [6] observed resistance of *Anopheles* mosquitoes to Deltamethrin (25-65%) mortality. [20] Also recorded resistance of *Anopheles* mosquitoes to Deltamethrin in Bauchi state (13.20%) mortality [3]. Also observed resistance of *Anopheles* mosquitoes to Deltamethrin in Akwa Ibom state (63-66%) mortality. These variations may be due to differences in environmental conditions affecting the *Anopheles* mosquitoes.

V. CONCLUSION

From this present study, *Anopheles* mosquitoes were susceptible to Deltamethrin and Bendiocarb. From the result, CDC bioassay bottle and WHO impregnated papers method of susceptibility adherence to protocol and procedure of WHO standard were followed and a knockdown/mortality was observed at a standard approved state of mortality of *Anopheles* mosquitoes in the areas of samples collected. Therefore, Deltamethrin and Bendiocarb are active insecticides which should be recommended for control of mosquitoes and could be used as one of the intervention national malaria vector control programme.

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