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ASSESSMENT OF *ANOPHELES* MOSQUITO RESISTANCE TO PYRETHROID INSECTICIDE IN VEGETABLE GROWING AREA IN KEFFI LOCAL GOVERNMENT AREA, NASARAWA STATE, NIGERIA

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ABSTRACT
Malaria remains a major public health threat in Nigeria and its prevention is facing challenges due to the rapid expansion of insecticide resistance in vector population. This study was conducted to determine the resistance status of female *Anopheles* mosquitoes to Pyrethroid (Deltamethrin) in vegetable growing areas in Keffi. Larvae were collected from three vegetable growing areas in Keffi namely: DadinKowa, AngwanTofa and Sabon Pegi and were transported to Entomology laboratory, Department of Zoology, Nasarawa State University, Keffi. Larvae were reared to adult stage. CDC bottle bioassay intensity was performed using adult *Anopheles* mosquitoes. The result indicated deltamethrin resistance at Dadinkowa.No resistance was recorded in SabonPegi in the month of May and June. In UngwanTofa no resistance was observed in month of May and June. Resistance intensity assays at x5 and x10 did not indicate any signs of resistance at all the sites. Using Anova statistical analysis; there was no significant difference based on the concentration of the insecticide and the time of exposure ($P<0.05$). Though resistance was observed in DadinKowa, it is focal and low in intensity. This implies that the use of pesticides in vegetable areas in Keffi does not contribute to the resistance in female *Anopheles* mosquitoes in Keffi.
Keywords: *Anopheles mosquitoes, Deltamethrin, Bioassay, Resistant and Keff*

INTRODUCTION
Insecticide resistance is widespread across the world, especially in Africa (Annan *et al.,* 2014). Increased insecticide resistance is continuously reported and threatens the control of the vectors of vector-borne diseases in general and malaria vectors in particular. In 1989, among the 504 arthropod species that had become resistant to one or several insecticides families, 114 were mosquitoes, the most important vectors of human diseases (Brogdon, W.G and McAllister, J.C., 2014). Until recently, the evolution of resistance could only be studied by bioassays, which measure the overall result of the resistance genes present in a population (French-Constant *et al.,* 2001). The single most effective tool to combat malaria is vector control, which addresses the source of transmission at a low cost. The fight against malaria is increasingly threatened by failures in vector control due to growing insecticide resistance. A major source of insecticide exposure for malaria vectors is public health insecticide use, which is the main focus of the recent Global plan for insecticide resistance management in malaria (GPIRM) (WHO, 2012). However, some of the earliest reports of insecticide resistance in Africa observed that agricultural pesticides use might have contributed to the selective pressure on *Anopheline* mosquitoes (Chouibou *et al.,* 2016). This study aimed at determining the intensity of insecticide resistance of *Anopheles* mosquitoes found in a vegetable growing area in Keffi, where insecticides, herbicides and fertilizers are massively used for plant protection.

MATERIALS AND METHODS
Study area
This study was conducted from the month of May to July, 2018 in Keffi Local Government Area, Nasarawa State, Nigeria. The town is 68km from Abuja, the Federal Capital Territory and 128km from Lafia, the Nasarawa State Capital. Keffi has the population of 92,664 at the 2006 census in which more than 60% reside in the rural area (Akwa *et al*., 2007). The residents of Keffi are mainly farmers, traders and civil servants.

Study population
The population for this study were 50 adult mosquitoes on each month between May and June of the three sites namely Dadin Kowa, Sabon Pegi and Ungwan Tofa vegetable areas of the study at Keffi L.G.A of Nasarawa State

Larvae sampling
Larvae sampling was carried out for the period of two months. Larvae of *Anopheles* were collected from three vegetable growing areas located in Keffi Local Government Area, these included Dadin Kowa, Sabon Pegi and Ungwan Tofa. At each location, *Anopheles* larvae were collected from various breeding habitats which included permanent water bodies, small water pools and foot prints using dipping and scoping methods described by WHO 2013. At the vegetable farms, the following were grown: spinach, onion, pepper, water melon and sweet melon and because of the temporal nature of the majority of these breeding sites, several dips from each site were collected. The farmers all agreed to the use of agro- chemicals in the control of insects on their vegetables.

Insecticides susceptibility test
Insecticide susceptibility test was carried out using CDC bottle bioassay method to determine the susceptibility status of the mosquitoes to the different concentration (1 to 100%) of the insecticides used (WHO, 2013).

Bioassay procedure
The bottles were lined up with lids opened. A group of 25 female (unfed) (2-4 days old) *Anopheles* mosquitoes were collected using aspirator from the rearing cages and introduced into each of the five bottles, including the control. The mosquitoes were prevented from escaping by covering the mouth of the bottle and replacing the lid. The number of mortality in each test bottle was recorded at the start (Time 0) and after every 15 minutes until all dead, for up to 30 minutes (Brogdon and Chan, 2014).

Data analysis
Susceptibility test data were analysed based on WHO criteria (WHO, 2013), stating that mortality less than 90% is indicative of resistance, mortality between 90 and 97% is suggestive of probable resistance and needs further investigation and mortality equal or more than 98% is indicative of susceptibility. The mortality of test sample was calculated by adding the number of dead mosquitoes across all four exposure replicates and expressing this as a percentage of the total number of exposed mosquitoes.

RESULTS

Tables 1 and 2, the results showed Deltamethrin resistance at Dadin kowa in the month of May at 84% mortality rate and in June 94% mortality rate as recommended by CDC bottle bioassay criteria.

Table 3, the results indicated suspected resistance at 97% mortality rate in May and Table 4 showed no resistance in June at Sabon Pegi respectively as recommended by CDC bottle bioassay criteria.

In table 5 and 6, at Ungwan Tofa no resistance was observed. At the end of the diagnostic time, 100% mortality was observed which indicated total susceptibility of the mosquitoes to the insecticides as recommended by CDC bottle bioassay criteria.

The resistance intensity assays at X2, X5 and X10 did not indicate any signs of resistance at all sites. The mosquitoes all died within 30minutes in all the sites. This showed that although resistance was observed in Dadin kowa. It is focal and low in intensity.

Table 1: Susceptibility status of *Anopheles* mosquitoes to Deltamethrin insecticide in DadinKowa vegetable farm, Keffi

	x1(12.5µg)		x2(25µg)		x5(50µg)		x10(100µg)	
Time	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
0	100	00(0.0%)	100	00	100	00	100	00
15	46	54(54.0%)	31	69	04	96	00	100
30	16	84(84.0%)	00	100	00	100	00	100
	84(84.0%)		100		100		100	

f.cal = 0.3391, f.tab = 2.5102, df = 7

Table 2: Susceptibility/ resistance status of anopheles mosquitoes using deltamethrin insecticide in DadinKowavegetable farm, Keffi

	x1(12.5µg)		x2(25µg)		x5(50µg)		x10(100µg)	
Time	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
0	100	00	100	00	100	00	100	00
15	52	48	22	78	01	99	00	100
30	06	94	00	100	00	100	00	100
Total Mortality After 30mins	94		100		100		100	

f.cal = 0.3408, f.tab = 2.5102, df = 7

Table 3: susceptibility status of anopheles mosquitoes using Deltamethrin insecticide in SabonPegi vegetable farm, keffi

	x1(12.5µg)		x2(25µg)		x5(50µg)		x10(100µg)	
Time	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
0	100	00	100	00	100	00	100	00
15	54	46	27	63	00	100	00	100
30	03	97	01	99	00	100	00	100
Total Mortality After 30mins	97	99	100		100			

f.cal = 0.3249, f.tab = 2.5102, df = 7

Table 4: Susceptibility status of *Anopheles* mosquitoes using Deltamethrin insecticide in SabonPegivegetable farm, keffi

	x1(12.5µg)		x2(25µg)		x5(50µg)		x10(100µg)	
Time	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
0	100	00	100	00	100	00	100	00
15	28	72	21	79	00	100	00	100
30	02	98	01	99	00	100	00	100
Total Mortality After 30mins	98		99		100		100	

f.cal = 0.3436, f.tab = 2.5102 df = 7

Table 5: Susceptibility status of anopheles mosquitoes using Deltamethrin insecticide in UgwanTofa vegetable farm, Keffi

	x1(12.5µg)		x2(25µg)		x5(50µg)		x10(100µg)	
Time	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
0	100	00	100	00	100	00	100	00
15	50	50	21	79	00	100	00	100
30	02	98	00	100	00	100	00	100
Total Mortality After 30mins	98		100		100		100	

f.cal = 0.3369, f.tab = 2.5102, df = 18

Table 6: Susceptibility/ resistance status of *Anopheles* mosquitoes using Deltamethrin insecticide in Ungwan Tofa vegetable farm, Keffi in Month June 2018

	x1(12.5µg)		x2(25µg)		x5(50µg)		x10(100µg)	
Time	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
0	100	00	100	00	100	00	100	00
15	21	79	04	96	00	100	00	100
30	00	100	00	100	00	100	00	100
Total Mortality After 30mins	100		100		100		100	

f.cal = 0.3778, f.tab = 2.5102, df = 8.

DISCUSSION

Insecticide resistance occurs as a result of mosquitoes being able to survive in an insecticide treated environment after being exposed to insecticides (Alout *et al.,* 2017). This study showed intensity assays at x2, x5 and x10 did not indicate any signs of resistance at all the study sites. Although resistance was observed in Dadin kowa, it is focal and low, in intensity with 85% mortality rate at x1 concentration in month of May and 94% mortality rate in June respectively. This result contrasts the finding of (Brogdon and McAllister, 2014) who reported high resistance in Ghana. The incidence of low toxicity of mosquito population to Pyrethroid (Deltamethrin) in this study is not new as (Awolola *et al.,* 2007) reported similar cases in *Anopheles* mosquitoes in Lagos, Nigeria. Elsewhere in southern Cote d'Ivoire, high resistance of Lambdacyhalothrin, Cypermethrin and Glyphosate by malaria vectors was observed in the study: Influence of the agrochemicals used for rice and vegetable cultivation on insecticide resistance in malaria vectors (Chouibou *et al.,* 2016). This different may be due to environmental changes of the country when compared to Nigeria.

Deltamethrin resistance is more recent and could have resulted from the frequent and uncontrolled use of pesticide in agriculture. Etang *et al.* (2003) reported resistance of *An. gambiae*s.l to Pyrethroid, DDT and Carbamate in Cameroon. Low Vector resistance to Pyrethroids in this study disagreed with the findings of researchers across the Globe including West Africa (Ivory Coast, Burkina Faso, Benin, Senegal) (Diabate *et al.,* 2002), Central Africa (Cameroon) (Etang *et al.,* 2003), East Africa (Kenya), (Vulule *et al.,* 2005) and Southern Africa (South Africa) (Hargreaves *et al.,* 2002).This is due to the fact that the insecticide were used in different concentrations which manifest in effectiveness by killing mosquitoes and also implies that the use of pesticides in vegetable areas in Keffi does not contribute to the resistance in female *Anopheles* mosquitoes at all in any of these areas.

CONCLUSION

The susceptibility of female *An.* Mosquitoes to different locations of the study areas may result in a reduction in malaria transmission within the study areas and this showed that Deltamethrin insecticide is effective for malaria vectors control in the study areas (Agwan Tofa, Dadin Kowa and Sabon Pegi). Although resistance was observed in Dadin kowa it is focal and low in intensity but in different concentrations used, mosquitoes were susceptible to the insecticides and hence showed its effectiveness by killing the mosquitoes.

REFERENCES

Annan, A. A., Owusu-Dabo, E., Baffour-Awuah, S., Nartey, R., Nimako, S., Abonuusum, A. G and Buabeng, O.. K. (2014): Insecticide resistance in malaria vector mosquitoes at 5 selected districts in Ghana, West Africa. *East African Journal of Public Health*. 11: 13.

Alout, H., Roche, B., Dabire, R. K. and Cohuet, A. (2017): Consequences of insecticide resistance on malaria transmission. *PLoS Pathogenic. 13*: e1006499.

Awolola, T.S., Oduola A.C., Cyewole, I.C., Obansa, J.B., Amajoh, C.N., Koekemoerd, L.L., Coetzeed, M. (2007). Dynamics of knockdown pyrethroid insecticide resistance alleles in a field population of Anopheles gambiae s.s. in southwestern Nigeria. J. vect. Borne Dis. 44:181-188.

Brogdon, W.G. and McAllister, J.C. (2014): Insecticide resistance and vector control. Emerging Infectious Diseases, Ghana 4:605-613

Brogdon, W.G. and Chan, A. (2014) Guide for Evaluating Insecticde Resistance in Vectors using CDC Bottle Bioassay.http://www.cdc.gov/malaria/resources/pdf/fsp/ir_mnual

Chouibou, M. S., Fodjo, B. K .and Fokou, G. (2016).Influence of the agrochemicals used for rice and vegetable cultivation on insecticide resistance in

malaria vectors in southern Cote d'Ivoire. *Malaria Journal*, 15, 426.

Diabate, A., Baldet, T., Chandre, F., Akogbeto, M., Guiguemde, T.R., Darriet, F., Brengues, C., Guillet, P., Hemmingway, J., Small, G.J., Houghward, J.M. (2002): The role of agricultural use of insecticides in resistance to pyrethroids in An. gambiaes.l in Burkina Faso. *America Journal of Tropical Medicine and Hygiene*. 67:617-622. [PubMed]

Etang, .J., Manga, L., Chandre, F., Guillet, P., Fondjo, E., Mimpfoundi, R., Toto, J.C. and Fontenille, D. (2003): Insecticide susceptibility status of An. gambiaes.l (Diptera: Culicidae) in Republic of Cameroon. Journal of Medical Entomology; 40:491-497. doi: 10.1603/0022-2585-40.4.491. [PubMed]

French-constant, R.H., Steichen, J.C. and Brun, L.O. (2001): A molecular diagnostic for endosulfan insecticide resistance in the coffee berry borer Hypothemushampei (CleopteraScolytidae). *Bull Entomology Research* 84: 11-16

Hargreaves, K., Koekemoer, L.L., Brooke, B.D, Hunt, R.H., Mthembu, J. and Coetzee, M. (2002): Anopheles funestus resistant to pyrethroid insecticides in South Africa. Medical and VeterinaryEntomology; 14:181-189.doi 10.1046/j.1365-2915.2000.00234.x.[PubMed]

Vulule, J.M., Beach, R.F., Atele, F.K., Roberts, J.M., Mount, D.L. and Mwangi R.W. (2005): Reduced susceptibility of An. Gambiae to permethrin associated with the use of permethrin-impregnated bed nets and cutains in Kenya. *Medical Veterinary Entomology* 8:71-75.

World Health Organization (2012): larval source management –a supplementary measure for malaria vector control. An operational manual. Geneva, Switzerland

World Health Organization (2013a): WHO recommendations for achieving universal coverage with long-lasting insecticidal nets in malaria control. Geneva, Switzerland

World Health Organisation (2013b): Test procedures for insecticide resistance monitoring in malaria vector mosquitoes. Geneva.