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Comparative Knockdown Efficacy of Locally Made Insecticide 'Ota Pia-Pia' and Commercially Available 'Sniper' Against Malaria Vectors Using Deltametrin as the Control Standard in Keffi Local Government Area, Nasarawa, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors IOS and MDO designed the study. Authors TAU and SSE performed the statistical analysis. Authors IOS, MMA and JDCT wrote the protocol and wrote the first draft of the manuscript. Authors MDO and SSE managed the analyses of the study. Author TAU managed the literature searches. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Mosquitoes are vectors of the major diseases of public health concern in the World. These include malaria, dengue fever, lymphatic filariasis, yellow fever, chikwungunya and recently zika virus causing morbidity and mortality in tropical and sub-tropical regions of the world. The success of malarial vector control depends on the susceptibility of *Anopheles* mosquitoes to insecticides. One locally made insecticide (Ota Pia-Pia), and synthetic insecticides Sniper and while Deltamethrin were used as a go standard from WHOPES as the control for the two insecticide to conduct Bioassay test against *Anopheles* mosquitoes in Keffi Local Government Area, Nasarawa the aim is to compare state of knockdown effects. The test papers included Ota pia-pia impregnated with (0.05%, 0.5% and 1.0%), sniper (0.05%, 0.5% and 1.0%), Deltamethrin (0.05%) as control for the

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insecticides and a general control using untreated paper impregnated with 0.05% of olive oil. *Anopheles* mosquito larvae were collected from three locations in Keffi Local Government Area and were returned in plastic bowls to the insectary laboratory of the Department of Zoology, Nasarawa State University, Keffi and reared to adults. One hundred (100) female *Anopheles* mosquitoes were fed with glucose for 3 – 5 days used in the Bioassay per treatment and replicated four times. The post-exposure one hour knockdown and 24hours mortality was assessed. It was observed that at 1%, 0.5% and 0.05% concentrations in sniper had the highest knockdown effect, 96%, 90% and 88% respectively while Deltamethrin had the least knockdown effect of 25%, 28% and 29% in August, September and October respectively. The results indicated that the mosquito populations in the locality were more resistant to Deltamethrin than sniper. A regular monitoring of resistance status is essential to help control mosquitoes in our communities.

Keywords: Mosquitoes; malaria; bioassay; ota pia-pia; sniper and deltamethrin.

1. INTRODUCTION

In Nigeria, malaria accounts for 60% of outpatient visit to health facilities, 30% of childhood death, 25% of death in children less than one year and 11%maternal death [1]. In recent times, Indoor Residual Spray (IRS) has been adapted to protect the entire household and community members who have no access to treated bed nets in Africa [2]. The Federal Government Policy on Malaria control in Nigeria focuses on Long Lasting Insecticide Nets (LLINS), Indoor Residual Spray (IRS), Intermittent Preventive Treatment (IPT) and environmental management [3]. The World Health Organization's Global report on insecticide resistance in malaria vectors (2010-2016) showed that resistance to the 4 commonly used insecticide classes – pyrethroid, organochlorines, carbamates and organophosphates is widespread in all major malaria vectors across the WHO regions of Africa, the Americas, South-East Asia, the East Mediterranean and the Western Pacific [4]. The major challenge in the use of these insecticides in malaria vector control has been the development of resistance to insecticides among the vector populations. *Anopheles* mosquito resistance to insecticides is spreading rapidly across African countries [5] and could reduce the impact of malaria prevention intervention using IRS and LLINS, particularly in Sub-Sahara Africa [4]. The successful implementation of IRS program partly depends on availability of insecticides susceptible *Anopheles* mosquitoes in the local environment. Therefore it is imperative to periodically conduct bioassays tests to assess the susceptibility status of local mosquito species to IRS intervention. The susceptibility of *Anopheles* mosquitoes against insecticides was fairly evaluated in Southern parts of Nigeria [6], although resistance to pyrethroid has been previously found in *Anopheles gambiae* S.l in South West Nigeria but there was death information in Northern Nigeria [7]. It is not known whether the strength and scale up of resistance have increased over time or even extended beyond locations that previous studies investigated. The use of locally available insecticides to control malaria vector is necessary because the treated nets and indoor residual spray are not readily available to the rural poor. Therefore, the present study is to compare the knock down effect of the common locally made insecticide (Ota-Pia-Pia) and two popularly used synthetic insecticides (deltamethrin and sniper) in Keffi Local Government Area, Nasarawa State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in Keffi Local Government Area of Nasarawa State. It is located in Northern part of Nigeria with an area of 138km^2 and a population of 92,664 at the census at Nasarawa State [8], It is located on longitude 7^{o}49'38.10"E and latitude 8^o 50'16.62"N [9]. Keffi has tropical climate with mean annual depth of rainfall of about 1,357 mm/a [10]. The rainfall starts in March and lasts till October while dry season starts from November and lasts till early March. The relief of the study area is relatively undulating highlands to average height of about 850m above sea level [11]. The residents of Keffi are mainly farmers, traders and civil servants.

2.2 Sample Collection

Larval stages of *Anopheles* mosquitoes were collected from High Court Area where Nasarawa State University is located in Keffi Local Government Area. Monthly larval collections

were conducted from August to October, 2016. Mosquito larvae were scooped using a scoop net and emptied into a clean well labeled transparent plastic bottles. These were transported to the Insectary Laboratory of the Department of Zoology, Nasarawa State University, Keffi Nigeria for rearing and testing.

2.3 Experimental Procedures

Susceptibility tests were done simultaneously following WHO [12] standard operation procedure (SOP) on unfed female *Anopheles* mosquitoes, reared from the larval and pupa collections at 25 ± 2^0c and 70 to 90% relative humidity. The emerged adult mosquitoes were identified into Anopheline using identification keys of Gillies and Coetzee, [13] In this study, one locally made insecticide and one synthetic insecticides were tested using one standard pyrethroid insecticide for the control to this two insecticides: Ota Pia-Pia 0.05, 0.5 and 1(%,) and Snipers 0.05, 0.5 and 1(%) and Deltamethrin (0.05%) for the control respectively. The concentration of sniper was obtained through the serial dilution of 0.1ml of sniper to 0.9ml of Acetone to give 1% solution. The principle of WHO [12] bioassay is to expose mosquitoes to a given dose of insecticide for a given time to assess susceptibility or resistance. The standard WHOPES discriminating dosages are twice the experimentally derived 100% lethal concentration of a reference susceptible strain [12]. An aspirator was used to introduce 25 unfed female *Anopheles* mosquitoes (2 – 5 days old) into five WHO holding bottle (four tests and one control) that contained the insecticide impregnated papers. The number of mosquitoes knocked down at the diagnosed time of 10, 15, 20, 30, 40, 50, and 60 minutes and mortalities at 24 hours post treatment were recorded and the experiment was repeated for the period of three months from August to October respectively following the WHO protocol [12].

2.4 Statistical Analysis

The data obtained were subjected to descriptive statistical analysis, percentages were calculated using SPSS package, version 22.0 and the results presented in tables. The P-values < 0.05 were considered statistically significant.

3. RESULTS

Fig. 1 and Table 1 show that Ota pia-pia at 0.05, 0.5 and 1(%) concentrations 92, 100, 100 and 100 (%) mosquitoes were knocked down after 10, 30, 50 and 60 mins of exposure respectively. Similarly it was observed that sniper at 0.05, 0.5, and 1(%).Concentrations96, 100, 100and 100(%) mosquitoes were knocked down after10, 30, 50and 60mins respectively. However, it was observed that Deltamethrin at 0.05% concentrations been the WHOPES dosage standard use for control to the two insecticides are 28,49,68 and 91(%) mosquitoes were knockdown at 10mins, 30mins, 50mins and 60mins of exposure respectively. There was no mortality recorded in the main control group within the three months of study.

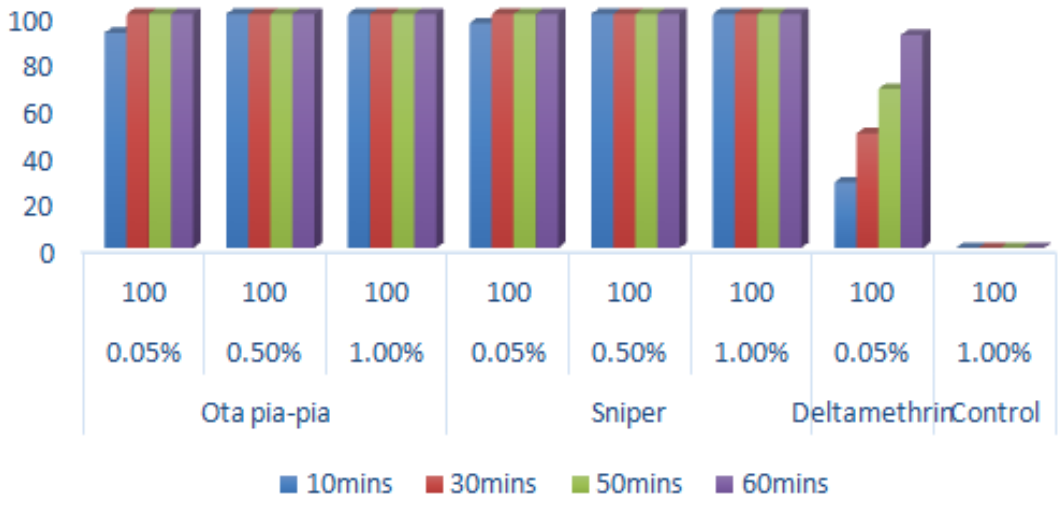

Fig. 1. Mosquito knockdown in month of august

Fig. 2 of Table 2 shows the *Anopheles* mosquito's knockdown in the month of September on exposure to Ota pia-pia, Sniper and Deltamethrin insecticides using 0.05%, 0.5% and 1.0% concentrations for each insecticide at 10mins, 30mins, 50mins and 60mins of exposure. One hundred (100) susceptible mosquitoes were used in each case. For Ota pia-pia, it was observed that at 0.05% concentration 92% knockdown was recorded after 10 mins of exposure while 100% knockdown was observed at 15mins. At 0.5% and 1.0% concentrations. For sniper, it was observed that at 0.05% concentration, 90% mosquitoes were knocked down after 10mins while 100(%) were knocked down after 15mins. At 0.5% and 1.0% concentrations. For Deltamethrin, it was observed that at 0.05% concentration 10, 53, 76 and 88% knockdown were recorded at 10 mins, 30 mins, 50 mins and 60 mins of exposure respectively.

Table 3 shows the result of *Anopheles* mosquito's knockdown in the month of October on exposure to Ota pia-pia, sniper and Deltamethrin insecticides using 0.05, 0.5 and 1.0 (%) concentrations for each insecticide at 10 mins, 15 mins, 20 mins and 60 mins of exposure. One hundred (100) susceptible mosquitoes were used in each case. For Ota pia-pia, it was observed that at 0.05% concentration 80% and 93% mosquitoes were knocked down after 10mins and 15mins respectively, while 100% knockdowns was achieved after 20 mins. For sniper, it was observed that at 0.05% concentration 88% and 99% were knocked down after 10 mins and 15mins respectively, while 100% were knocked down after 20 mins. For deltamethrin it was observed that 0.05% concentration 10, 29, 47 and 98(%) knockdowns were recorded at 10 mins, 15 mins, 20 mins and 60 mins of exposure respectively.

Table 1. *Anopheles* mosquito knockdown to locally made insecticides (Ota pia-pia) and pyrethroid insecticide (Sniper and Deltamethrin) in the month of august

Insecticide	Concentration	No. of Mosquitoes	Time/No Knockdown			
			10 mins	30 mins	50 mins	60 mins
Ota pia-pia	0.05%	100	92	100	100	100
	0.5%	100	100	100	100	100
	1.0%	100	100	100	100	100
Sniper	0.05%	100	96	100	100	100
	0.50%	100	100	100	100	100
	1.0%	100	100	100	100	100
Deltamethrin	0.05%	100	28	49	68	91
Control	1.0%	0	0	0	0	0

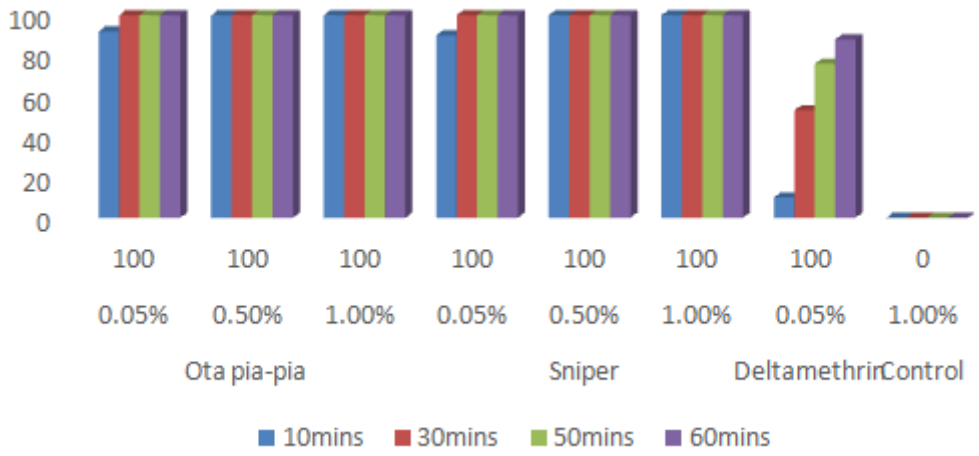

Fig. 2. Mosquito knockdown in month September

Table 2. Knockdown of *Anopheles* mosquitoes exposed to locally made insecticides (Ota pia-pia) and pyrethroid insecticides (Sniper and Deltamethrin) in the month of September, 2016

Insecticide	Concentration	No. of Mosquitoes	Knockdown Period			
			10 mins	30 mins	50 mins	60 mins
Ota pia-pia	0.05%	100	92	100	100	100
	0.5%	100	100	100	100	100
	1.0%	100	100	100	100	100
Sniper	0.05%	100	90	100	100	100
	0.50%	100	100	100	100	100
	1.0%	100	100	100	100	100
Deltamethrin	0.05%	100	10	53	76	88
Control	1.0%	0	0	0	0	0

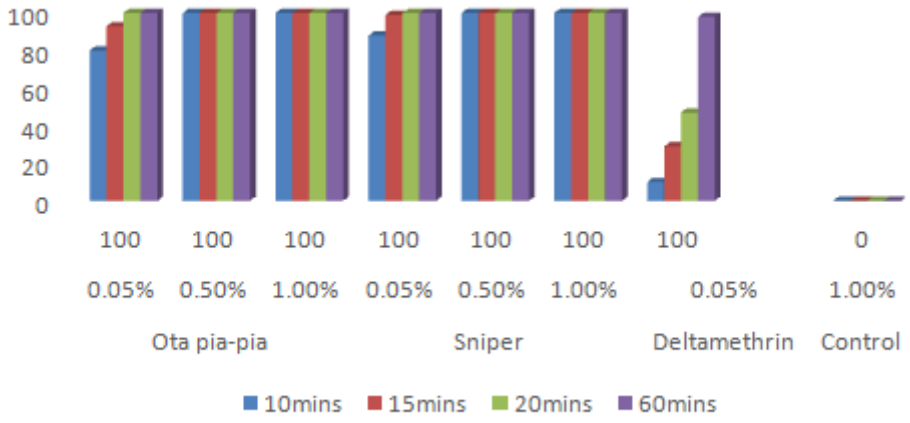

Fig. 3. Mosquito knockdown in month October

Table 3. Knockdown period of anopheles mosquitoes exposed to locally made insecticides (Ota pia-pia) and pyrethroid insecticide (Sniper and Deltamethrin) in the month of October, 2016

Insecticide	Concentration	No. of Mosquitoes	Knockdown Period			
			10 mins	15 mins	20 mins	60 mins
Ota pia-pia	0.05%	100	80	93	100	100
	0.5%	100	100	100	100	100
	1.0%	100	100	100	100	100
Sniper	0.05%	100	88	99	100	100
	0.50%	100	100	100	100	100
	1.0%	100	100	100	100	100
Deltamethrin	0.05%	100	10	29	47	98
Control	1.0%	0	0	0	0	0

4. DISCUSSION

This study observed that sniper had the highest knockdown effect, followed by ota pia-pia while deltamethrin had the least effect. This indicated that mosquito populations in this locality were resistant to deltamethrin. This finding is similar to the research conducted by Kristan et al. [14] who reported high resistance of *Anopheles* species to pyrethroid insecticide in Nigeria and Ghana. Low Knockdown of *Anopheles* mosquito exposed to Deltamethrin indicated the presence of resistance mechanism operating in the population of *Anopheles* mosquitoes in Keffi

possibly due to the frequent use of agricultural chemicals in the area by farmers. This agreed with the findings of Awolola et al*.* [15] Ibrahim et al*.* [5] and Oduola et al*.* [16] in their separate work down in some parts of Nigeria.

It was found that Ota pia-pia locally made insecticide had high knockdown effect on the *Anopheles* mosquitoes compared to Deltamethrin used in this study. This may be due to the use of pesticides which may also be synthetic within the study area by farmers to control pests and may aid mosquitoes to develop resistance to the Deltamethrin used in this study. This report is similar to the work done by Ibrahim et al*.* [5] who reported high efficacy of locally made insecticide on *Anopheles* species in Sudan Savanna, Northern Nigeria. Pyrethroid based aerosols and coils used for control of mosquitoes and domestic pest might contribute to the development of resistance as reported by Nwabor et al*.* [6]. This work is similar to report of Awolola et al*.,* [17] who also reported resistance of *Anopheles gambiae* to pyrethroid as observed in malaria vector surveillance sites in Nigeria. In an attempt to protect their crops, farmers used insecticides such as permethrin, lambdacyhalothrin, deltamethrin which eventually washed into the streams where the vector breed. Researchers have reported that exposure of malaria vectors to crop protection insecticides could result in the development of resistance [18,15,6,19-21]. Also, the resistance of *Anopheles* mosquitoes to deltamethrin in this study is similar to the report of the World Health Organization that malaria vectors resistance is widespread in all major malaria vectors across the WHO regions of Africa, the Americas, South-East Asia, the East Mediterranean and the Western Pacific [4]. The resistance of *Anopheles* species to deltamethrin found in this study did not differ from the report of Awolola et al*.* [17] who also reported high pyrethroid resistance in *Anopheles gambiae*s.l. from Lagos, Ogun and Niger. This is not surprising considering the prevailing insecticide selection pressure on vector populations following the rapid scale up and use of pyrethroid-based vector control interventions and agricultural usage of pyrethroid insecticides in Keffi. Sustainable insecticide resistance management strategy is essential to avoid control failure when resistant insecticides are used for IRS program. The multiple insecticide resistance of *Anopheles* mosquitoes to the tested Deltamethrin may have great implications for the malaria control programme. It may compromise the efficacy of interventions and potentially lead to the failure of IRS and ITNS vector control. Therefore periodic monitoring of insecticides resistance in mosquito is essential to avoid vector control failure.

5. CONCLUSION

The result showed susceptibility to the locally made insecticide Ota pia-pia as observed in this study. The suspected resistance by the *Anopheles* mosquitoes to Pyrethroid (Deltamethrin) as observed in this study showed that more cases of re-occurrence of malaria fever is expected in Keffi. People are advice to use the locally made insecticide which is cheaper and more effective in vector control with properly monitoring.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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