Original Research Article

Comparative knockdown efficacy of locally made insecticide Ota Pia-Pia and Sniper insecticides to Deltamethrin insecticides as control Knockdown Malaria Vectors in Keffi Local Government Area, Nasarawa State, Nigeria

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 Subtropical 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 Deltamethrinwere 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 include Ota pia-piaimpregnated with (0.05%, 0.5% and 1.0%), sniper (0.05%, 0.5% and 1.0%), Deltamethrin (0.05%) as control for the insecticides and a general controlusing 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 bowl to the insectary laboratory of the Department of Zoology, Nasarawa State University, Keffi and reared to adults. 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% while Deltamethrin had the least knockdown effect of 25%, 28% and 29% in August, September and October respectively. This 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, and Deltamethrin

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 (FMOH/NMCP, 2009). 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 (Beier *et al.*, 2008). The Federal Government Policy on Malaria control in Nigeria focus on Long Lasting Insecticide Nets (LLINS), Indoor Residual Spray (IRS), Intermittent Preventive Treatment (IPT) and environmental management (NMCP, 2014). The World Health OrganizationGlobal 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 (WHO, 2020). 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 (Ibrahim *et al.*,2014) and could reduce the impact of malaria prevention intervention using IRS and LLINS, particularly in Sub-Sahara Africa (WHO,2020). 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 (Nwabor*et al.*, 2017), although resistance to pyrethroid has been previously found in *Anophelesgambiae* S.l in South West Nigeria but there was death information in Northern Nigeria (Ndams*et al.*, 2006).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.

Materials and Methods

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 (NPC, 2006), It is located on longitude 7^{o}49'38.10"E and latitude 8^o 50'16.62"N (Akwa *et al*. 2007). Keffi has tropical climate with mean annual depth of rainfall of about 1,357 mm/a (NMA, 2012). 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 (Kana *et al.*, 2014). The residents of Keffi are mainly farmers, traders and civil servants.

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 wereconducted 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.

Experimental Procedures

Susceptibility tests were done simultaneously following WHO (2014) standard operation procedure (SOP) on unfed female *Anopheles* mosquitoes, reared from the larval and pupa collections at 25 $\pm$ 2^{0}c and 70 to 90% relative humidity. The emerged adult mosquitoes were identified into Anophelineusing identification keys of Gillies and Coetzee, 1987. 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 ofthe WHO (2014) 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 (WHO, 2014). An aspirator was used to introduce

25 unfed female *Anopheles*mosquitoesaged 2 – 5 days old into five WHO holding bottle (four tests and onecontrol) 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 monthfrom August to October respectively following the WHO protocol (WHO, 2014).

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.

Results

Chart 1 of Table 1 show that Ota pia-pia at 0.05, 0.5 and 1(%)concentrations 92, 100, 100 and 100(%)mosquitoeswereknockdown was recorded after 10, 30, 50and 60mins of exposure in that order. Similarly it was observed that sniper at 0.05, 0.5, and 1(%).Concentrations96, 100, 100and 100(%)mosquitoeswere knocked down after10, 30, 50and 60mins respectively. However, it was observed thatDeltamethrinat 0.05%concentrations been the WHOPES dosage standard use for control to the two insecticides are28,49,68 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 threemonths of study.

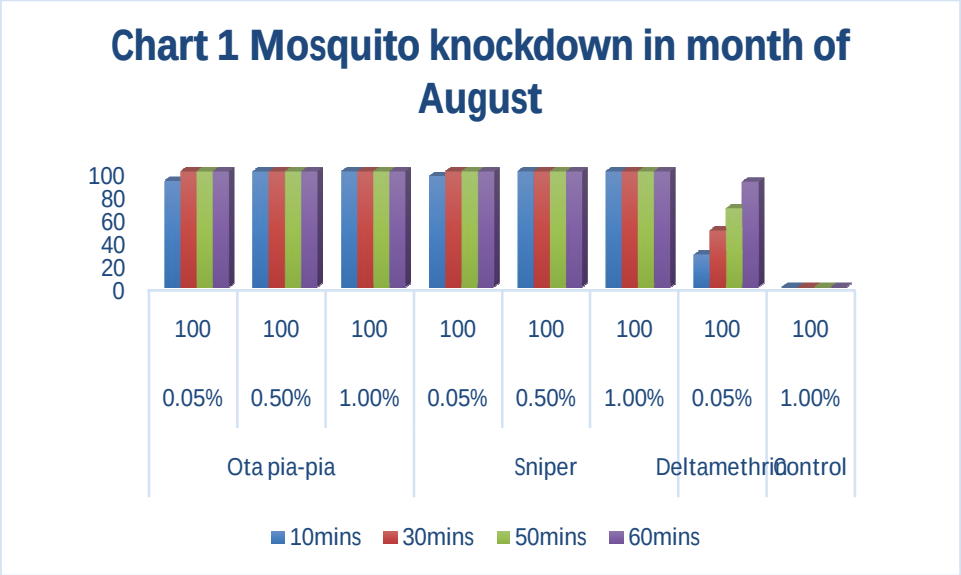

Table 1:*Anopheles* Mosquitoes knockdown to locally made insecticides (Ota pia-pia) and Pyrethroid Insecticide (Sniper and Deltamethrin) in the Month of August.

Insecticide	**Concentration**	**No. of Mosquitoes**	**Time/No Knockdown**			
			10mins	**30mins**	**50mins**	**60mins**
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

Chart 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. 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 10mins 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(%) mosquitoeswere 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 10mins, 30mins, 50mins and 60mins of exposurerespectively.

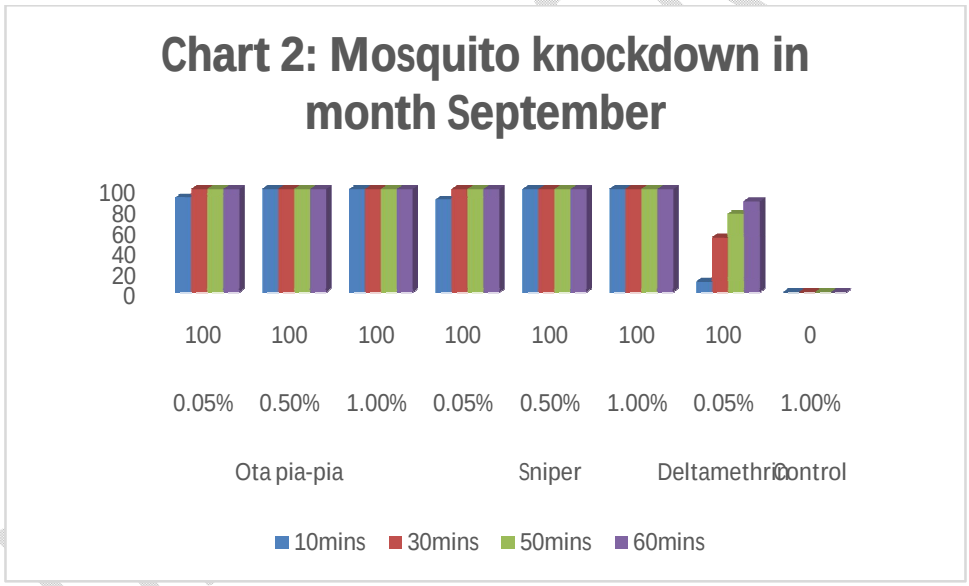

Table 2: Knockdown of *Anopheles* Mosquitoes exposed to locally made insecticides (Ota pia-pia) and Pyrethroid insecticides (Sniper and Deltamethrin) in the month of September, 2016.

Insecticide	**Concentration**	**No. of Mosquitoes**	**Knockdown Period**			
			10mins	**30mins**	**50mins**	**60mins**
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

Chart 3 of 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 10mins, 15mins, 20minsand 60mins of exposure. 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(%) knockdown was achieved after 20mins. For sniper, it was observed that at 0.05% concentration 88and 99(%) were knocked down after 10mins and 15mins respectively, while (100%) were knocked down after 20mins.For deltamethrin it was observed that 0.05% concentration 10, 29, 47 and 98(%) knockdowns were recorded at 10mins, 15mins, 20mins and 60mins of exposure respectively.

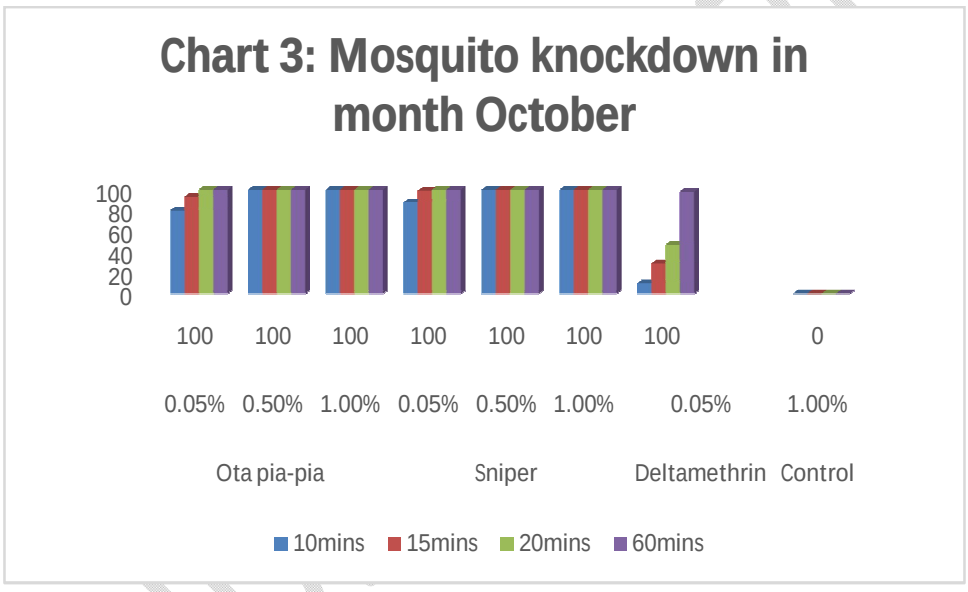

Table 3: Knockdown Period of Anopheles Mosquitoes Exposed to Locally Made Insecticides (Ota pia-pia) and Pyrethroid Insecticide (Sniper and Deltamethrin) in the Month of October, 2016.

Insecticide	Concentration	No. of Mosquitoes	Knockdown Period			
			10mins	15mins	20mins	60mins
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

Discussion

This study observed that sniper had the highest knockdown effect, followed by otapia-pia while deltamethrin had the least effect. Thisindicated that mosquito populations in this locality were resistant to deltamethrin. This finding is similar to the research conducted by Kristan*et al.* (2013) 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 Awololae*t al.*(2007), Ibrahim *et al.*(2014) andOduola *et al.*(2016) in their separate work down in some parts of Nigeria.

It was found that Otapia-pia locally made insecticide had high knockdowneffect 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 pestsand 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.* (2014) 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.* (2017). This work is similar to report of Awolola *et al.*, *(*2018)who also reported resistance of *Anopheles gambiae*to pyrethroid as observed in malaria vector surveillance sitesin Nigeria.In an attempt to protect their crops farmersused 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 (Etang*et al.*, 2003; Awolola *et al.*, 2007; Nwabor *et al.*, *2017*; Chouaibou *et al.*, 2008; Bigoga*et al.*, 2012; Philbert*et al.*, 2014). 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 (WHO, 2020).The resistance of *Anopheles* species to deltamethrin found in this study did not differ from the report of Awolola *et al.* (2018) who also reported high pyrethroid resistance in *Anopheles gambiae*s.l.from Lagos, Ogun and

Niger.These 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.

Conclusion

The result showed susceptibility to the locally made insecticide Otapia-pia as observed in this study. The suspected resistance by the *Anopheles* mosquitoes toPyrethroid(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.

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