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ORIGINAL ARTICLE

Comparative Studies on the efficacy and Mode of action of Chlorpyrifos, Cypermethrin and 'Tofeto' against *Anopheles spp* (*Diptera: Culicidae*)

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Abstract

The efficacy of 'Tofeto' and two synthetic insecticides, chlorpyrifos and cypermettrin were compared as fumigants and repellants against *Anopheles spp.* Knockdown, mortality and repellency responses were noted and compared. 'Tofeto' had a significantly higher knockdown effect on mosquitoes, while chlorpyrifos had the least. Cypermethrin had the fastest mortality time. 'Tofeto' compared favourably with cypermethrin and chlorpyrifos as a repellant having the highest percentage repellence and repellency index.

Keywords: Synthetic insecticides, Repellants, Haematophagus, Anthropophilic, Knockdown

Introduction

Mosquitoes are common household pest in Nigeria. They have through human history constituted problem to man and animals (Nduka and Nwosu, 2006). About 60 different species of mosquitoes are found worldwide (Crans and Farida, 2004). These species are members of the *Anopheles, Culex, Aedes, Hemagogus and Mansonia* complexes are important pests in Nigeria (Igbinosa, 1990). Mosquitoes develop in pools of water formed by raining season storms and permanent swamps of the wetlands (Nduka and Nwosu, 2006; Medlock and Vaux, 2011). Female mosquitoes bite human and animals because they need blood proteins for the development of their eggs (Sutherland and Crans, 2004) while males are short-lived, do not suck blood but nectars and plant juices and die soon after mating. These haematophagus and anthropophilic habits of mosquitoes (Oyewole *et al*, 2005) have made them unquestionably the most medically important arthropod vector of diseases (Brenda *et al*, 2000). They have been implicated in the transmission of pathogens of some major human diseases like Bancroftian filariasis, yellow fever, airboviruses (Nwosu *et al*, 2011), dengue and haemoraphagic fever (Amusan *et al.*, 2005), West Nile Virus (Lapointe, 2007) and Malaria (Ajayi *et al*, 2010) some of which now constitute a global health crisis (WHO, 2008).

The vector of human malaria all belong to the genus *Anopheles* (Nwosu *et al*, 2011) whose adults are recognized by their dappled wings in most tropical species, 'tail in the air' posture and long pair of palps beside the proboscis in females (Imms, 1957). Studies on the biology of Anopheles species in Nigeria had described *A. gambiae, A. arabiensis, A. funesus, A*. *rivulorum and A. lesoni* as the vectors of malaria (Onyabe and Conn, 2001; Awolola *et al.*, 2002). Malaria remains one of the most serious health problems worldwide (Narain, 2008) and it is a major public health problem in Nigeria (FMOH, 2005). It accounts for about 60% of all outpatient visit and 30% hospitalization (FMOH, 2007, USEN, 2011). Malaria increases morbidity and mortality, an estimated 110 million clinical cases and 300,000 deaths per year, including 11% maternal mortality occurs in Nigeria (NMCP, 2005). It is the only insect borne parasitic disease whose devastating impact is comparable to AIDS in Nigeria (Cutis, 2002; UNEN, 2011). The economic impact includes cost of health care, working day loss due to sickness, day loss in education, decrease productivity due to brain damage from cerebral malaria, loss of investment, tourism and diversion of household resources (Greenwood *et al*, 2005). In Nigeria, monetary loss in terms of treatment cost, prevention and loss of man-hours is estimated to be 132 billion naira (FMOH, 2007; FMOH, 2011). In fact, the loss in 2011 it was estimated to be 7.3% of the GDP (Salihu and Sanni, 2013)

The realization of the public health and economic burden malaria placed on the continent as well as the barrier it constitutes to development and poverty alleviation made Africa heads of States to meet in Abuja on April 25, 2000 to express their commitment to the Roll Back Malaria (RBM) initiative (Chukwuocha, 2012). RBM focuses on three major interventions which include case management, promotion of intermittent preventive treatment and vector control. Effective control of mosquito borne diseases including malaria is greatly linked with radical approach to combat mosquitoes today (Gallies *et al.*, 2003). Opting for vector control seems more feasible in preventing the disease in that it prevents individual from mosquito bite (Oyewole *et al.*, 2011). Many mosquitoes rest on indoor walls before or after feeding therefore indoor residual spraying with insecticides seems effective against mosquitoes (Henk, 2008). This relative effectiveness of insecticide control (Nduka and Nwosu, 2006) has made the public to use all sorts of chemicals for the control of mosquitoes not withstanding what their scientific details are.

One of such new entrant chemicals is 'Tofeto" whose mode of action, composition and efficacy against mosquitoes have not been reported is compared with two conventional insecticides, Chlopyrifos and cypermethrin in this study.

Materials and Methods

Anopheles larvae were collected into an earthen pot from a stagnant drainage point at Ilorin (Longitudes 4º 30` and 4º 45` E and Latitudes 8º 25` and 8º 40` N) kwara State, Nigeria. The larvae were maintained in earthen pots housed in a large cage screened with mosquito net under ambient temperature and humidity. The emergent adults were maintained on 10% sucrose solution (McAllister and Adams, 2010). Care was taken to ensure that adults used for the experiment were of the same age and from the same litter.

Two synthetic insecticides, Cypermethrin (Superthrin) a pyrethroid (100g/litre) and Chlorpyrifos (Pyrenex) distributed by Osi Agro Industry Chem. Co. Ltd Kano and Dizenyoff W.A. Nig. Ltd respectively were procured from an Agro chemical shop along Murtala Mohammed Road Ilorin. 'Tofeto' a relatively new local insecticide dilution of unknown chemical property was procured from a shop in sawmill area Ilorin. Full strength of each insecticide was prepared as directed by its manufacturer.

Peety-Grady like chamber (Busvine, 1971; Alipour *et al.*, 2005) of dimension 40x40x40 centimeter cube was constructed using a paper carton. Three side walls of the chamber were replaced by transparent glass to allow assessment of events within the chamber. The fourth side

had a tightly fitted rectangular door (16cmx13cm) for assess into the chamber or for introduction of adult mosquitoes. 5% and 10%v/v fumes from each insecticide were introduced into each chamber in which ten randomly selected adult mosquitoes had been put. The door was closed immediately and surveillance was kept on the mosquitoes for hypersensitive reaction, knockdown and mortality. Mortality was confirmed after 10minutes of non-recovery knockdown. Four replicates were run for 120minutes for each concentration on mortality while the average time to produce 100% knockdown (KT_{100}) was recorded for each insecticide.

The repellency chamber has a dimension of 40cm x 40cm x 40cm with a tightly fitted door of 16cm X 13cm. at the top of the chamber is a circular outlet of diameter 5cm to allow irritated mosquitoes out of the chamber. Ten randomly selected adult mosquitoes were introduced into the chamber. 1ml of each insecticide was subsequently introduced onto a cotton wool hung within the chamber. 1ml of distilled water was introduced onto cotton wool for control experiment. The door to the chamber was immediately shut and escape outlet opened. Four replicates were run for each test. The numbers of mosquitoes that escaped from the chamber after 10 minutes were noted. Repellency index was calculated as described by Mace (1969) and percentage repellency as described by Steltenkamp *et al.,* (1992)

Knockdown, mortality and repellency data were analyzed using one-way Analysis of Variance (ANOVA) and the mean comparison were made using Least Significance Difference (LSD) at $P<0.05$

Results and Discussion

Figure 1 shows the average 100% knockdown times (KT_{100}) of adult mosquitoes when exposed to 5% and 10%v/v fumes of the insecticides. The earliest KT_{100} occurred in 'Tofeto' treatment under both concentrations while the longest occurred in chlorpyrifos treatment. The values were significantly different from those of chlorpyrifos and cypermethrin at $P<0.05$.

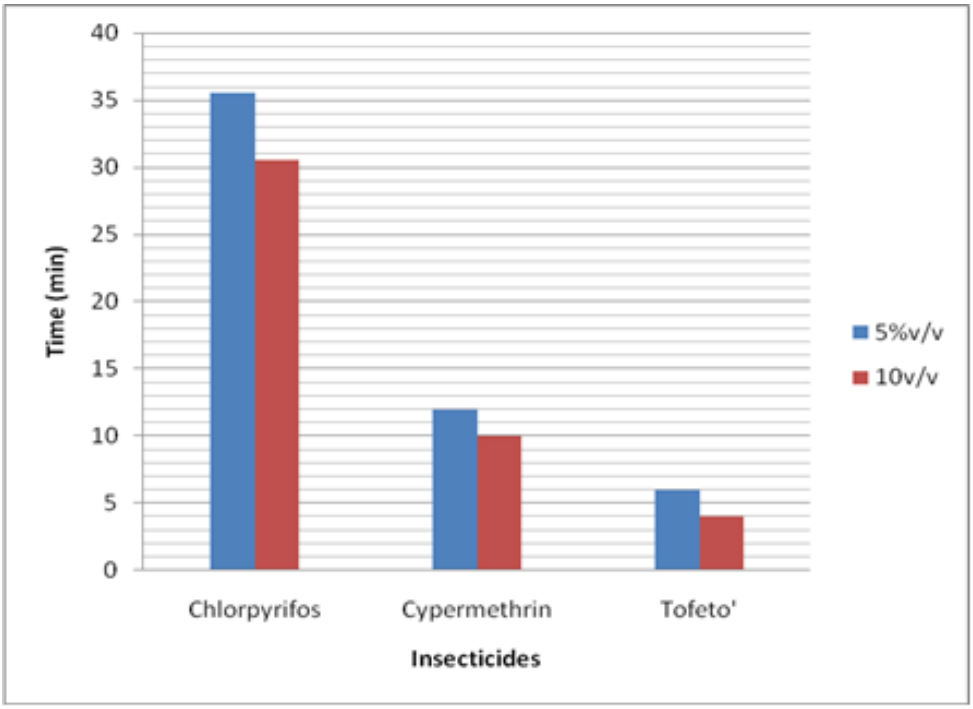

Figure 1: Average 100% Knockdown (KT100) of Adult *Anopheles spp* exposed to fumes of Chlorpyrifos, Cypermethrin and 'Tofeto'

Figure 2 shows the mortality rates of adult mosquitoes exposed to insecticide fumes over 120minutes. Cypermethrin treated mosquitoes had 100% mortality after 40 and 60 minutes respectively under 5% and 10%v/v concentrations. Chlorpyrifos treated mosquitoes had LT_{100} after 80minutes under 10%v/v concentration while it took 145min to achieve LT_{100} in 5%v/v concentration. 'Tofeto' treated mosquitoes at 10%v/v recorded 100% mortality after 165min exposure while 5%v/v treatment achieved 100% mortality after 140minutes of exposure. In all cases, mortality was preceded by hypersensitive agnostic behaviour and knockdown of the mosquitoes.

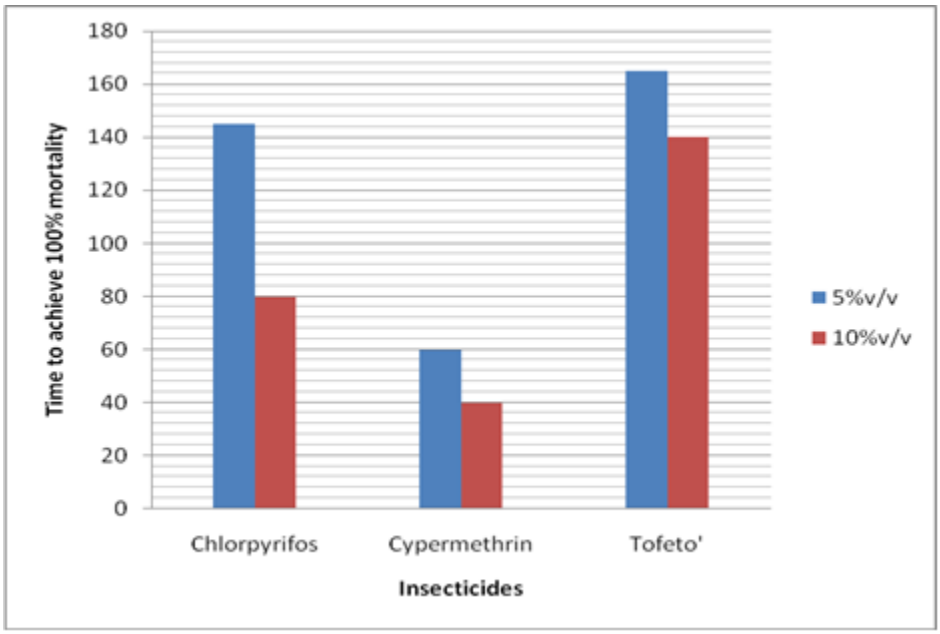

Figure 2: Mortality time of Anopheles spp exposed to fumes of Chlorpyrifos, Cypermethrin and 'Tofeto'

Table 1 shows the mean number of mosquitoes repelled from the insecticide treated chambers. 'Tofeto' treated chamber had the highest percentage of repelled mosquitoes; however this was not significantly different from those from chlopyrifos and cypermethrin chambers at $P<0.05$.

Table 1: Insecticidal Repellence against *Anopheles spp.*

Insecticide	**Av. No repelled**	**X ± SD % repellence**	**R. index**
Chlorpyrifos	3.33 ± 0.57[a]	48.69 ± 0.96[a]	-0.05
Cypermethrin	4.33 ± 0.58[a]	52.70 ± 0.66[a]	0.08
'Tofeto'	4.67 ± 1.53[a]	54.28 ± 0.50[a]	0.12
Control	3.67 ± 1.52[a]	-	-

Values in the same column followed by the same letter are not significantly different (P<0.05; ANOVA)

Exposure of mosquitoes to insecticide fumes showed that 'Tofeto' was the most potent knockdown agent irrespective of concentration. However, mortality data revealed cypermethrin (a pyrethroid) to be the most effective; while 'Tofeto' was least effective at concentration of 5%v/v. The knockdown effects of these insecticides on mosquitoes are significantly different from each other at both concentrations, mortality results after two hours were also significantly different at

both concentrations of 5% and 10%v/v with exception of 'Tofeto' at 5%v/v. 'Tofeto' seems to have comparatively quicker knockdown and longer mortality period similar to the report of Walker and Meisch (1982) when testing some pyrethroid insecticides against mosquitoes. 'Tofeto' and cypermethrin fumes exerted hyper sensitization and general change in the behavior of mosquitoes such as continuous flight as described by Palmquist *et al.,* (2012). This was similar to the observations of Helson and Surgeoner (1983) when they compared the effectiveness of permethrin with cypermethrin as residual insecticides against mosquitoes.

Higher repellency index and percentages were recorded in mosquitoes treated with 'Tofeto" and cypermethrin than those of chlorpyrifos, though these were not significantly different at $P<0.05$. Similar result was observed by Helson and Surgeoner (1983) and Taylor *et al* (1981) where they both said that permethrin and cypermethrin irritated or repelled *Anopheles spp*, causing their exodus from the apartment.

Conclusion

Conclusively, 'Tofeto' a locally sold insecticide dilution compared favourably with chlorpyrifos and cypermethrin and in some cases proved to be more efficient. Considering it potency and affordability, 'Tofeto' could conveniently be used against mosquitoes because it could offer a high level of protection from mosquito bite because of its quick knockdown effect.

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