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Efficacy of Commonly Used Mosquito Coils Containing Pyrethrin against Lymphatic Filariasis Vector *Culex quinquefasciatus* (Say) in Gombe

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Authors' contributions

This work was carried out in collaboration among all authors. Authors ABS and MI designed the study, performed the statistical analysis and wrote the protocol. Author AB wrote the first draft of the manuscript. Authors KPY and EA managed the analyses of the study. Author MUU managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Mosquito coil is a common insect repellant used in many homes to repel and kill mosquitoes that transmit diseases and another insect pest. The present study was conducted to explore the potency of the commonly used brand of mosquito coil containing pyrethroids against *Culex quinquefasciatus* in Gombe and its communities.
Place and Duration of Study: Department of Biological sciences insectary laboratory of Gombe State University, Gombe, Nigeria between August and December 2017.
Methodology: Four (4) different brands tagged; C1, C2, C3 and C4 containing 0.08% Merperflutrin, 0.2% Pyrethroids, 0.05% Transflutrine + 0.1% Esbiothrin and 0.25% d-Trans-allethrin respectively were investigated. Ten (10) reared adult mosquitoes were transferred separately into

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various containers using an aspirator. Data on knockdown time and Adult mortality were recorded. All the data collected were analyzed using SPSS version 24.0. Analysis of Variance (ANOVA) was used to determine the significant difference between the treatments at *P*=.05.

Results: Merperflutrin 0.08%, Transflutrine 0.05% + Esbiothrin 0.1% and 0.25% d-Transalletrin recorded highest mortality of 100% each and 0.2% Pyrethroids recorded 96% mortality at 24hours of exposure to the treatment respectively. The mortality is time- dependent and all the treatments show significant mortality at P=.05. Transflutrine 0.05% + Esbiothrin 0.1% recorded the lowest KT_{50} value of 2.41 min.

Conclusion: Merperflutrin 0.08%, and Transflutrine 0.05% + Esbiothrin 0.1% have the highest efficacy; faster knockdown rate and could be used as a repellent in minimizing the population of the indoor resting density of mosquitoes' species in our homes.

Keywords: Culex quinquefasciatus; knockdown ti; mortality; mosquito coil; pyrethroids.

1. INTRODUCTION

Mosquito-borne diseases continue to be a major cause of illness and death in developing countries despite many control strategies deployed to kill the vector. Diseases transmitted by mosquitoes remain a major source of morbidity and mortality worldwide. The worldwide threat of mosquito transmitted-diseases includes; malaria, lymphatic filariasis, avian malaria, and arboviruses such as Dengue virus, Chikungunya virus, Yellow fever, West Nile Fever, and Zika virus,with their associated morbidity and mortality underscores the need for effective mosquito control [1,2]. Vector borne diseases account for more than 17% of all infectious diseases, with 700000 deaths every year. Nigeria is among the twenty nine countries accounted for 95% of global Malaria cases with 27% cases [3]. The Director Public Health Gombe State Ministry of Health stated that, '11% of maternal death, 60% of general out patient, 30% of hospital admission, 30% of under-five death as well as 25% infant death in Gombe is due to malaria' [4]. It is a matter of fact that the transmission of these infections to humans depends upon the abundance and density of mosquito vectors; hence, mosquito control strategy remains the most successful method for mosquito-borne diseases prevention and control. Among the efforts that have been made in recent decades in seeking to reduce mosquito bite and disease- transmission is the introduction and use of insecticides, repellants, aerosols, mats, mosquito coils containing pyrethroids as the active ingredient, to enhance protection against mosquito bite. Pyrethroids/pyrethrins are the most common active ingredients of various mosquito coils that are effective against many genera of mosquito including *Aedes, Anopheles,* and *Mansonia* [5]. For more than 40 years pyrethroid insecticides have been used because of their wide availability in low-income communities' mostly Asian and African countries and they account for 25% of the world insecticide market [6].

Several studies were carried out to test the insecticidal potency of pyrethrin/pyrethroids containing mosquito coil [7,8,9,10,11,12 and 13]. Similar studies have not been reported in Gombe, hence this study was aimed at exploring the potentials of widely used mosquito coil containing pyrethroids in Gombe and its neighboring communities for proper selection of the most effective coil in the control of mosquitoes in our homes.

2. MATERIALS AND METHODS

2.1 Study Area

The research was carried out in Gombe local government area, located within the sub – Sudan climatic zone between latitude 12^0 8´and $10^0$24´N longitudes 11^0 22´ and 11^0 24´E. The experiment was carried out in the Department of Biological Sciences insectary, Gombe State University under the ambient conditions of temperature 28±2°C and relative humidity 70±5%.

2.2 Mosquito Coil

The mosquito coils were obtained from individual shops in Gombe main market and their formulations were 0.08% Merperflutrin, 0.2% Pyrethroids, Transflutrine 0.05% + Esbiothrin 0.1%, and 0.25% d-Trans-allethrin containing pyrethroids insecticides. Four brands of the coils and the control incense were selected based on the consumer high demand and household uses in Gombe and its environment. Information about the different brands of the coils was summarized (Table 1).

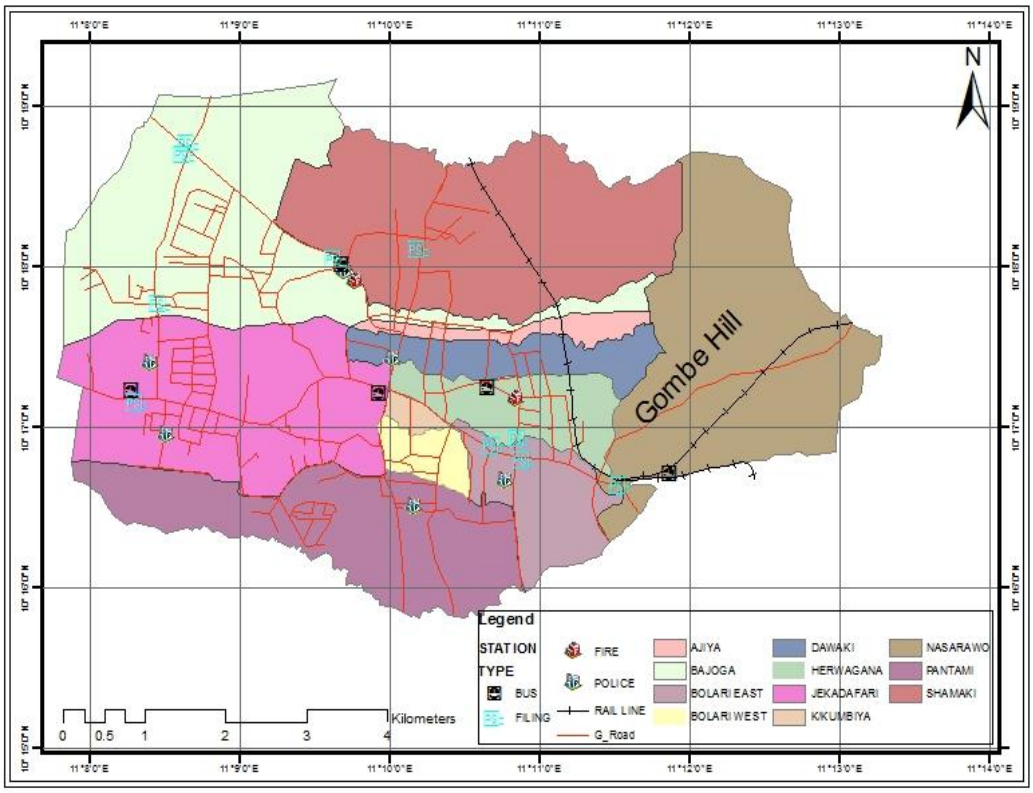

Fig. 1. Gombe local government (Source: GIS Lab Gombe State University)

2.3 Mosquito Collection and Rearing

Blood fed female Anopheles mosquitoes were collected from four different locations within the study area using aspirator after human bite while resting in the wall between 06:00- 07:00 am. All collected adult mosquitoes were transferred into a container (Collecting cups) and transported to Insectaries laboratory. The mosquitoes were released into the rearing cage and were fed with 10% glucose following WHO standard protocol [14]. Ovipositor cup was put in the rearing cage containing de-chlorinated water with a filter paper for the mosquito to lay eggs. Yeast tablets and cabin biscuits were used to feed the larvae in 3:1. Emerged adult mosquitoes were used for the experiments.

2.4 Bio- efficacy Test

The test was done in transparent plastic rubber measuring 27x24cm with a small window sliding closure at the top under a laboratory condition. The test coil was lighted and extinguished as it begins to smolder and placed into the chamber. Non-blood fed *Culex quinquefasciatus* were introduced into the chamber and their knockdowns were recorded at 5min, 10min, 20min, 30min, and 1hour. After (1) hour of exposure, the mosquitoes were transferred into the holding cup provided with 10% sugar solution soaked in cotton wool and held for 24 hours mortality period. Mortality was recorded at the end of the holding period following the WHO standard. Control was set along with no coil. The experiment was set in a complete randomized design (CRD) with three replications.

2.5 Statistical Analysis

Mortality data obtained from the experiment were subjected to one-way Analysis of Variance (ANOVA) using application software IBM SPSS version 24.0 for the window. The Least significant difference (LSD) was also used to separate the means of mortality at P=.05. Probit analysis was also carried out using mini tab software version 16.0 to determine the effective knockdown time for 50%, 90%, and 99%.

Table 1. Summarized information of the tested brand of mosquito coils

Coil Identification Number	Active Ingredient	w/w(%) of a.i	Colour	Country of Production	Weight per Coil(g)	Burning Time(hours)
C1	Merpeflutrin	0.08	Light grey	China	10	12
C2	Pyrethroids	0.2	Light grey	Nigeria	10	8
C3	Transflutrine + Esbiothrin	0.05 + 0.1	Light grey	Nigeria	10	8
C4	d-Transalletrin	0.25	Black	China	10	10

3. RESULTS AND DISCUSSION

3.1 Effect of Pyrethrins Containing Coil on Adult Mortality of *Culex Quinquefasciatus*

The result shows that, 0.08% merperfluthrin, 0.05% Transflutrine + 0.1% Esbiothrin and 0.25% d-Trans-allethrin of the active ingredient recorded 100% mortality after 24 hours while only 0.2% Pyrethroids recorded 96% mortality after 24hours (Table 2). 100% knockdown was achieved after 30 min of exposure for 0.08% Meperfluthrin. The knockdown at 60 min and 24 hour was the same across all the treatments except the control. It also shows that knockdown and mortality are time-dependent. There was a significant difference in all the treatments and the control at *P* =.05 (Table 2). Similarly study carried out by Murahwa et al. [15] in Zimbabwe showed 100% mortality of *An. gambiae sl.* after 60 min exposure period. Yap et al. [16] reported a similar result of about 95% mortality rate of mosquitoes using coil against *Cx. quinquefasciatus*. Xue et al. [17] reported the highest mortality of >90% of all the mosquito tested using pyrethroid coil containing 0.08 meperfluthrin as an active ingredient and lowest mortality > 85% of the test was achieved with coil containing 0.03% dimefluthrin and 0.3% rich-d- trans allethrin. Low Mortality ranged from 36% - 72% was achieved with D-allethrin based mosquito coils against *Anopheles gambiae* sensu lato [12]. Lukwa and Chandiwana [18] recorded 99% and 98.5% mortality for 0.4% and 0.3% pyrethrin mosquito coil after two (2) hours of exposure to *An. gambiae* sl.. The mean mortality effects for the *Ae. aegypti* as a result of exposure to the smoldering coils were between 57% and 96% [13]. The range of mortality responses of the Anopheles mosquitoes is similar to mortality studies for *Ae. aegypti*, *Cx. quinquefasciatus* and *Cx. p. pallens* and *Cx. p. quinquefasciatus* [15,19,20] though there were also some very low mortality values for *Cx. p. quinquefasciatus* (4%), *Cx. quinquefasciatus* (6%) and *Ae. aegypti* (11.67%) [15,20]. The similarity might be as a result of differences in the ingredient and direct evidence that burning mosquito coil prevent mosquito biting nuisance.

3.2 Knockdown Time of Mosquito Exposed to Pyrethrins Containing Coil

The result obtained shows the effect of knockdown time per minutes (Table 3). The minimum time of 2.41 min to achieved 50% knockdown of the entire mosquito tested for 0.05% Transflutrine+0.1% Esbiothrin. Mosquito exposed to 0.08% Meperfluthrin as active ingredient has the lowest KT_{90} and KT_{99} value of 15.31min and 23.68 min respectively All the treatment showed a significant difference of KT_{50}, KT_{90} and KT_{99} (Table 3). Transflutrine 0.05%+Esbiothrin 0.1% recorded lowest KT_{50} value of 2.41 min of the entire mosquito tested and all the treatment recorded less than 8 min KT_{50}. Similarly, [13] study reported median knockdown time of less than 7 min in *Ae. aegypti* with the coil containing highest active ingredient. Yap et al. [16] reported similar result using d-trans alletrin containing coils. This is also inconsistent with the work of Ogoma et al. [21]; the knockdown time is positively influence by high dose of the active ingredient. High KT_{50} was obtained with 0.1% d-trans alletrin containing coil exposed to *Cx. quinquefasciatus* in a glass chamber. The lowest value for this study may be attributed to the difference in the study chamber used. However, in the present study, the KT_{50} of *Cx. quinquefasciatus* exposed to the smoldering of0.2% Pyrethroids and 0.25% d-Trans alletrin containing coil were high. Efunshile et al. [22] in Ghana recorded about 5.23 min (KT_{50}) of mosquitoes using 0.2% pyrethroids. Similarly, *Ae. aegypti and Cx. quinquefasciatus* populations had a KT_{50} of less than 3 min and 9 min respectively [15,18]. Avicor, 2013 [12] reported higher value KT_{50} and KT_{90} of 34.92 - 73.88 min and 143.78-447.54 min respectively. 0.3% pyrethrins containing coils recorded 15-20 min of median time KT_{50} and 40-50 min of KT_{90} [23]. Hudson and Esozed [24] showed that coil containing 0.2-0.5% pyrethrins had KT_{90} of 60 min. Median knockdown time was 15 min and 35 min and 27min and 63min of KT_{90} for 0.4% and 0.3% pyrethrin containing coil respectively [18]. Knockdown times of *Cx. pipens pallens and An. dirus* subjected to dl*, d-T80 allethrin* (0.27% - 0.50% w/w) mosquito coils under a 25 m 3 room experimental setup were also fairly low, ranging between 20.8 -28.3 min and 8 min respectively [20]. This could be as a result of different concentrations of the active ingredient and time interval.

Table 2. Percentage mean knockdown time and mortality of *Culex quinquefasciatus* exposed to pyrethrins containing coil

Active Ingredient(AI)%W/W		Knockdown Time(%) ± Standard Error% Mortality					
		5mins	**10mins**	**20mins**	**30mins**	**60mins**	**24hours**
Merpeflutrin	0.08	50±0.00^{bc}	73±0.33^{bd}	96±0.33^{b}	100±0.00^{d}	100±0.00^{b}	100±0.00^{b}
Pyrethroids	0.2	30±0.00^{c}	36.6±0.34^{c}	53±0.33^{d}	80±1.00^{b}	96±0.33^{b}	96±0.00^{b}
Transfluthrine Esbiothrin	0.05+0.1	50±0.00^{bc}	70±0.00^{b}	80±0.00^{c}	86±0.33^{bcd}	100±0.00^{b}	100±0.00^{b}
D- Transallethrin	0.25	56±0.30^{b}	70±0.00^{b}	90±0.00^{b}	96±0.00^{cd}	100±0.00^{b}	100±0.00^{b}
Control	00	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.33^{a}	1.33±0.33^{a}

% Mean ± Standard Error with the same letter are not significantly different by LSD

Table 3. Knockdown Time of *Culex quinquefasciatus* exposed to pyrethrin containing coil

Active ingredient	%w/w a.i	KT_{50}(min)	KT_{90}(min)	KT_{99} (min)
Meperfluthrin	0.08	5.02	15.31	23.68
Pyrethroids	0.2	7.92	37.94	75.34
Transflutrine + Esbiothrin	0.05+0.1	2.41	30.38	53.19
d-Transalletrin	0.25	6.34	28.94	46.45

4. CONCLUSION

The mosquito coil containing 0.08% meperfluthrin was more effective and shows rapid Knockdown time under laboratory conditions using small containers. This could provide great protection against mosquito bites and could be more effective when used with a high percentage of the active ingredient indoor. Further studies should also be conducted in rooms to ascertain its efficacy.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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