

# Pilot Study of “EG Mosquito Repellent Bracelet” for Malaria Vector Control in Selected Communities in North-Central Nigeria

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## Abstract

The National Malaria Elimination Programme conducted a mini-pilot study, in One-Man village and New Nyanya, both in Karu Local Government Area of Nasarawa State, on the EG Mosquito Repellent Bracelet to determine its efficacy as an innovative technique for vector control. Advocacy visits were carried out to the community leaders while verbal consents were obtained from adult members of the households where the product was deployed. Households were randomly selected from each community. The EG Mosquito Repellent Bracelets were issued to identified adult members of each household in each community. Baseline entomological survey was carried out using structured questionnaires, inter personal communication (IPC) with occupants and Pyrethrum Spray Catch (PSC). The baseline data showed that the indoor resting density (IRD) ranged from 1.2/room/man in One-Man village to 2.2/room/man in New Nyanya and that a few of the *Anopheles* mosquitoes caught were fed with human blood meal in both sites (IRD of 1.0 and 1.6 in One Man village and New Nyanya, respectively). Furthermore, between 73% - 80.9% of *Anopheles* mosquitoes collected were fully fed. Post intervention entomological monitoring showed that no *Anopheles* mosquitoes were caught in the households sampled 48 hours after the EG Mosquito Repellent Bracelets were deployed. *Anopheles* species were caught on subsequent days of the entomological monitoring, with the highest number on day 7, showing increase in indoor resting density. However, fewer fed mosquitoes were caught from both sites compared to baseline data.

## Keywords

Mosquito Repellent, Bracelets, Malaria, Vector Control

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## 1. Introduction

Mosquitoes are vectors of many diseases among which is malaria, a life-threatening parasitic disease that kills, on an annual basis, about 445,000 persons globally [1]. About 91% of these deaths occur in Africa mostly among children and pregnant women. It contributed 24% of malaria deaths attributable to the 15 countries with nearly 80% of malaria deaths globally in 2016 [1].

The global strategic plan for Roll Back Malaria recommends

that by 2010, 80% of the population at risk should be protected using effective vector control measures [2]. To achieve this there is a need to scale up effective components of the Integrated vector Management (IVM) of malaria control for maximum impact.

Integrated Vector Management as an implementation strategy is multi-faceted and has always been the tool that drives elimination, in countries at that stage of malaria control. Activities within the integrated vector management strategy includes distribution of Long-Lasting Insecticidal Nets (LLINs), Indoor Residual Spraying (IRS), and Larviciding.

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In Nigeria, despite the heavy investment in the procurement and distribution of over 100 million Long Lasting Insecticidal Nets for malaria control activities since 2009, varied degrees of acceptability have been observed across the breadth of the country. Current LLIN ownership (described as percentage of households with at least one LLIN per two persons who stayed in the house the night before the survey) is 68.7%, and actual use by children under five years of age stands at 43.4% [3]. At this rate, attainment of target 3.3 of the Sustainable Development Goals, which is “By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis<sup>1</sup>” will definitely be a herculean task if strategies for malaria control are not refined based on operational research.

In a bid to develop innovative technology aimed at eliminating malaria, various applications such as bracelets, sonic devices, clothing, and skin patches have arisen. Topical application of insect repellent, 15% deet (N, N - diethyl - 3 - methylbenzamide), to feet and ankles reduced the overall biting rate of *An. arabiensis* by 69% [4]. Applications containing essential oils, though deemed to effectively repel mosquitoes, have been noted to be less efficacious than the N,N-diethyl-meta-toluamide (DEET)-containing ones [5]. Hence, to align with the current National Malaria Elimination Strategic Plan 2014-2020 on malaria vector control towards malaria elimination in the country, which encourages the promotion of innovative techniques for vector control, the National Malaria Elimination Programme commissioned a mini-pilot study on the “EG Mosquito Repellent Bracelet” from 1<sup>st</sup> to 14<sup>th</sup> September 2014 in order to determine the efficacy of “EG Mosquito Repellent Bracelet” on mosquitoes in selected communities in Karu Local Government Area of Nasarawa State, North-Central Nigeria. EG’s production techniques are based on effective formulation of two natural essences: Citronella Oil and Geranoil<sup>2</sup>.

Specifically, we sought to determine the efficacy of the “EG Mosquito Repellent Bracelet” for malaria prevention.

## 2. Methodology

### 2.1. Study Sites and Sampling

The study was conducted in two communities of Karu LGA in Nasarawa State, namely One-man village and New Nyanya. Following an advocacy visit to the leadership of Karu Local Government headquarters and to the community leaders, consent forms were administered to the members of the households where the product was piloted. Selection of

households was done using systematic random sampling from each community. A total of ten households were selected from each site, giving a total of twenty households.

The “EG Mosquito Repellent Bracelets” were issued to identified adult members of each household in each community. Health education on the causes, prevention and control of malaria was also provided at the household level. In addition, appropriate training on the use of the bracelet was provided.

### 2.2. Duration of Study and Highlights of Activities

The trial was implemented and monitored for 14 days, to cover the activities of advocacy, dialogue at community and household levels, administration of questionnaires, household listing and baseline data collection.

### 2.3. Baseline Entomological Study and Entomological Monitoring

Baseline survey was carried out in the two sites using the Pyrethroid Spray Catch (PSC) to ascertain the malaria vector indoor resting density. Pyrethrum Spray Catch (PSC) was conducted on the first day of the study to obtain basic entomological information on the mosquito species, their density, and behaviour. Furthermore, entomological monitoring was carried out on the sixth and the twelfth days of the study, respectively. Monitoring checklists were also administered during the study.

None of the households selected had Long Lasting Insecticidal Nets (LLINs). They were also informed, the previous day, not to apply/use any form of malaria vector control device.

### 2.4. Monitoring

The monitoring was done for a total of two weeks. PSC was used to determine presence of mosquitoes

The product efficacy was determined as follows:

1. Use of structured Questionnaires
2. Inter personal communication (IPC) with occupants
3. Pyrethrum Spray Catch (PSC).

## 3. Results

### 3.1. Baseline Data

Tables 1 and 2 show the indoor resting density (IRD) of *Anopheles* species in the two study sites. The baseline data collected from both sites showed that the IRD ranged from 1.2/room/man in One-man village to 2.2/room/man in New Nyanya respectively. A few of the *Anopheles* species caught

<sup>1</sup> <https://sustainabledevelopment.un.org/sdg3>

<sup>2</sup> <http://www.accendo.com.sg/eg>

were fully fed with human blood meal in both sites (IRD) of 1.0 and 1.6 in One Man village and New Nyanya respectively). See figure 1.

Nyanya, 19 (73%) of them were fully fed. Similarly, 17 (80.9%) of the 21 *Anopheles* species caught from One Man village were fed.

Out of the total of 26 *Anopheles* species collected from New

**Table 1.** Baseline data on Indoor Resting density of *Anopheles* species in New Nyanya, Karu LGA, Nasarawa State.

Households No	No of Occupants	No of <i>Anopheles</i> species caught	No of <i>Anopheles</i> species fed	No of <i>Anopheles</i> species Unfed
HH 1 Room 1	3	7	6	1
HH 1 Room 2	3	5	3	2
HH 2 Room 1	2	3	3	0
HH 2 Room 2	2	6	4	2
HH 3 Room 1	1	3	2	1
HH 3 Room 2	1	2	1	1
Total	12	26	19	7
Indoor Resting Density		2.2	1.6	

**Table 2.** Baseline Data on Indoor Resting density of *Anopheles* species in One Mane Village, Karu LGA, Nasarawa State.

Households	No of Occupants	No of <i>Anopheles</i> species caught	No of <i>Anopheles</i> species fed	No of <i>Anopheles</i> species Unfed
HH 1 Room 1	5	8	6	2
HH 1 Room 2	1	3	2	1
HH 2 Room 1	2	2	2	0
HH 2 Room 2	4	2	2	0
HH 3 Room 1	2	4	4	0
HH 3 Room 2	3	2	1	1
Total	17	21	17	4
Indoor Resting Density		1.2	1.0	

### 3.2. Entomological Monitoring

Tables 3 and 4 shows that no *Anopheles* mosquitoes was caught in the households sampled 48 hours after the “EG Mosquito Repellent Bracelets” were deployed to the households in the two sites studied during the entomological

monitoring. In addition, *Anopheles* species were caught on subsequent days of the entomological monitoring, with the highest number on day 7, showing increase in indoor resting density. However, fewer fed mosquitoes were caught from both sites compared to baseline data.

**Table 3.** Post intervention Indoor Resting Density of *Anopheles* mosquitoes by PSC in New Nyanya, Karu LGA, Nasarawa State.

Households No	No of Occupants	No. of <i>Anopheles</i> species caught per day							Fully fed	Not fed
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7		
HH 1 Room 1	3	0	0	0	1	0	0	1	0	2
HH 1 Room 2	3	0	1	1	0	1	0	0	0	3
HH 2 Room 1	2	0	0	0	0	0	0	0	0	0
HH 2 Room 2	2	0	0	2	0	0	0	1	1	2
HH 3 Room 1	1	0	0	0	0	1	0	1	0	2
HH 3 Room 2	1	0	0	1	0	0	1	2	0	4
Total	12	0	1	4	1	2	1	5	1	13
Indoor Resting Density		0	0.08	0.32	0.08	0.16	0.08	0.4	0.08	

**Table 4.** Post intervention Indoor Resting Density of *Anopheles* species by PSC in One Man Village, Karu LGA, Nasarawa State.

Households No	No of Occupants	No. of <i>Anopheles</i> species caught							Fully fed	Not fed
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7		
HH 1 Room 1	3	1	0	0	0	0	1	1	0	3
HH 1 Room 2	3	0	0	2	0	1	1	0	0	4
HH 2 Room 1	2	0	0	0	0	0	0	2	0	2
HH 2 Room 2	2	0	0	0	1	0	2	0	1	2
HH 3 Room 1	1	0	0	0	0	2	0	1	1	2
HH 3 Room 2	1	0	0	1	0	0	1	2	0	4
Total	12	1	0	3	1	3	5	5	2	17
Indoor Resting Density		0.08	0	0.25	0.08	0.25	0.4	0.4	0.16	

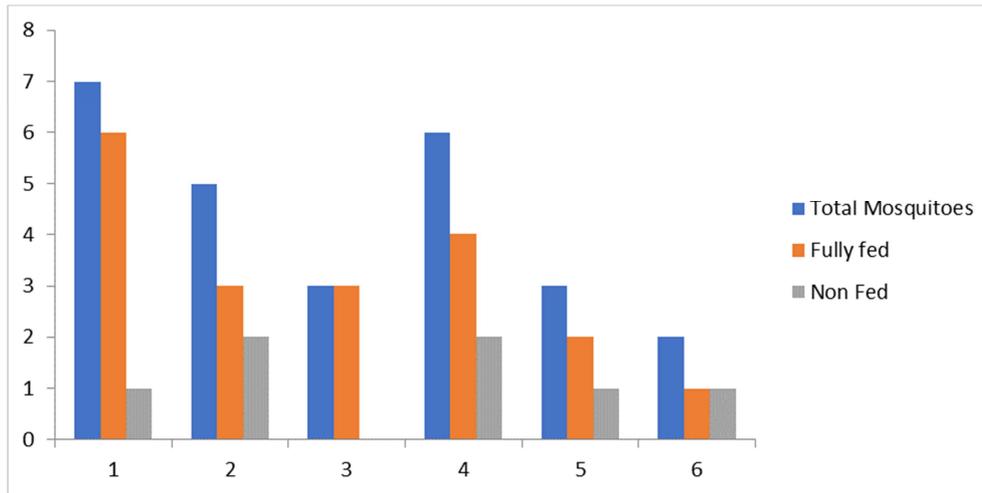
The results of the monitoring in Tables 5 and 6 also showed that the respondents that used the “EG Mosquito Repellent Bracelets”, felt protected from mosquito bites on the nights they used the “EG Mosquito Repellent Bracelets.”

**Table 5.** Outcomes of the monitoring Checklist in New Nyanya, Karu LGA, Nasarawa State.

S/N	Households	No. Rooms	No. Respondents	Bracelets Used	Comments
1	1	2	6	6	Very effective
2	2	2	4	4	Very effective
3	3	2	2	2	Effective

**Table 6.** Outcomes of the Monitoring Checklist in One Man Village, Karu LGA, Nasarawa State.

S/N	Households	No. Rooms	No. Respondents	Bracelets used	Comments
1	1	3	6	6	Very effective
2	2	3	6	6	Very effective
3	3	1	5	5	Very effective

**Figure 1.** Baseline data of total mosquitoes caught versus fully fed and non-fed in New Nyanya.

## 4. Discussion

The baseline data collected from both sites shows that the Indoor Resting Density (IRD) ranged from 1.2/room/man in One-man Village to 2.2/room/man in New Nyanya respectively. A few of the *Anopheles* mosquitoes caught were fed with human blood meal in both sites. The presence of fed *Anopheles* species in these two study sites suggests that malaria transmission was likely on-going at both sites.

The indoor resting density in both sites showed a great decline post intervention. This also suggests that the deployment and use of the EG Mosquito Repellent Bracelets in the two communities resulted in the decline. In its long-range host-seeking behaviour, the mosquito's sense of smell has been shown to be effectively deployed [6]. Several wearable repellent devices are available, including bracelets, sonic devices, clothing, and skin patches [7]. Though the EG Mosquito Repellent Bracelets seems effective as a barrier between man and the mosquito vector, only products containing DEET or p-menthane-3,8-diol have been shown to have long-lasting repellent effects and therefore providing good protection from mosquito-borne diseases [8].

In Africa, there is, generally a dearth of evidence on essential-oil containing repellents thus, they have not yet

been adequately evaluated in peer-reviewed studies for their efficacy in preventing vector-borne disease<sup>3</sup>. Some studies have posited that vendors of various repellent devices exaggerate claims of effectiveness [9-13].

The respondents interviewed all stated that the EG Mosquito Repellent Bracelets prevented mosquitoes from biting them, this is in tandem with results obtained using other insecticide-containing bracelets [4]. However, a few of the respondents who used the product stated that the fragrance from the EG Mosquito Repellent Bracelets was rather too strong especially during sleeping when the wrist is placed close to the head. Despite this, they still appreciated the usefulness of this product with the possibility of preventing malaria. This leaves room for evaluation of the strength of repellent strengths vis-à-vis mosquito vector control.

During sleep with the bracelet in use, there is a possibility of obliterating the smell with clothing overlaying it, thereby preventing it from exhibiting optimal effects. This underscores the need for proper behavioural change communication before and during deployment of the EG Mosquito Repellent Bracelets to ensure the effective use of the product.

<sup>3</sup> <https://www.nc.cdc.gov/travel/yellowbook/2018/the-pre-travel-consultation/protection-against-mosquitoes-ticks-other-arthropods>

## 5. Conclusion and Recommendations

The EG Mosquito Repellent Bracelets has shown some repellent effects on mosquito vectors, hence its potential for use in malaria vector control. There is however a need for scale-up of this study across Nigeria in order to determine true efficacy as a repellent as the sample size may have limited the power of the study. Additionally, the mosquito killing power of the natural essential oils should be studied against known insecticides.

If found effective on a larger scale, this product would contribute to malaria prevention by interrupting malaria transmission, and it would also align with the current strategy of Nigeria’s National Malaria Elimination Programme of promoting the use of new technologies for malaria vector control through evidenced-based decisions. Furthermore, it would be useful to explore the effectiveness of the essential oil components of the bracelet as an intervention for malaria vector control.

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Data supporting this article is reposed at the National Malaria Elimination Programme.

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