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Short Report

First field and laboratory trial of VectorBac® WG around the airport zone of the capital city of Libreville, Gabon

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Abstract: Context/Purpose: The urban ecosystem of Akanda behind the airport of the capital city of Libreville in Gabon, harbors diverse and dense mosquito larval habitats and hotspots for malaria and arboviruses transmission. To effectively conduct vector control, it is imperative to adopt an integrated approach by adding biolarvicides to the toolbox. The main objective of this study is to evaluate the efficacy of a biolarvicide under laboratory and field conditions. **Methods:** In Gabon, this current pilot and preliminary study sought to test the efficacy of the biolarvicide VectorBac® Water dispersable Granule (WG) (VBG) during the rainy season period (March to May 2024) under field and laboratory conditions following the 2005 World Health Organisation protocol. **Results:** For the bioassay of VBG, in the laboratory, the required dose to kill 88% and 100% of the larvae in rearing cups was 0.001 g/mL and 0.01 g/mL respectively. Under field conditions, the percentage larval density reduction irrespective of the microhabitat type ranged from 90 to 100% and the mosquito larval density reduction between test and control groups in the field differed statistically (X^2=34; p = 0.026). **Conclusion:** The larvae from Akanda tested under field and laboratory conditions were very sensitive to the standard dose recommended by the manufacturer after 24 hrs post-treatment with VBG. This pilot study provides baseline information that is required to conduct a longitudinal study to evaluate the residual effect of VBG in different ecological settings in Gabon.

Keywords: Aedes; Anopheles; Culex; larva; VectorBac®; Akanda

1. Introduction

Malaria and arboviruses are transmitted by mosquitoes and these insect larvae have been identified in different microhabitats in urban areas [1,2] and in protected areas beside the city [3]. The control of mosquitoes in Gabon is being carried out using some strategies such as indoor residual spraying, use of insecticide treated bed nets and public hygiene (construction of urban drainage systems and regular emptying of waste bins). To effectively and sustainably tackle this important public health parasitic and arboviral diseases transmitted by mosquitoes, it is imperative to combine different antivectoral fight strategies alongside biolarvicides. Larviciding has been reported as possible control measure for malaria (*Anopheles gambiae*) and filariasis (*Culex quinquefasciatus*) vector control particularly in managing pyrethroid-resistance in African malaria vectors [4]. However, this approach has not yet been tested in Gabon especially in areas such as the airport area of Akanda that have already been reported to be densely infested with mosquito larvae.

2. Methodology

2.1. Study area

This study was conducted in the Zone of Akanda and its environs (**Figure 1**). The area is characterized by high construction works such as the construction of a new airport road to ease traffic and this activity expands mosquito breeding grounds. The equatorial rainforest of Gabon favors the proliferation of several species of mosquitoes and some have already been identified to be vectors of arboviruses [5].

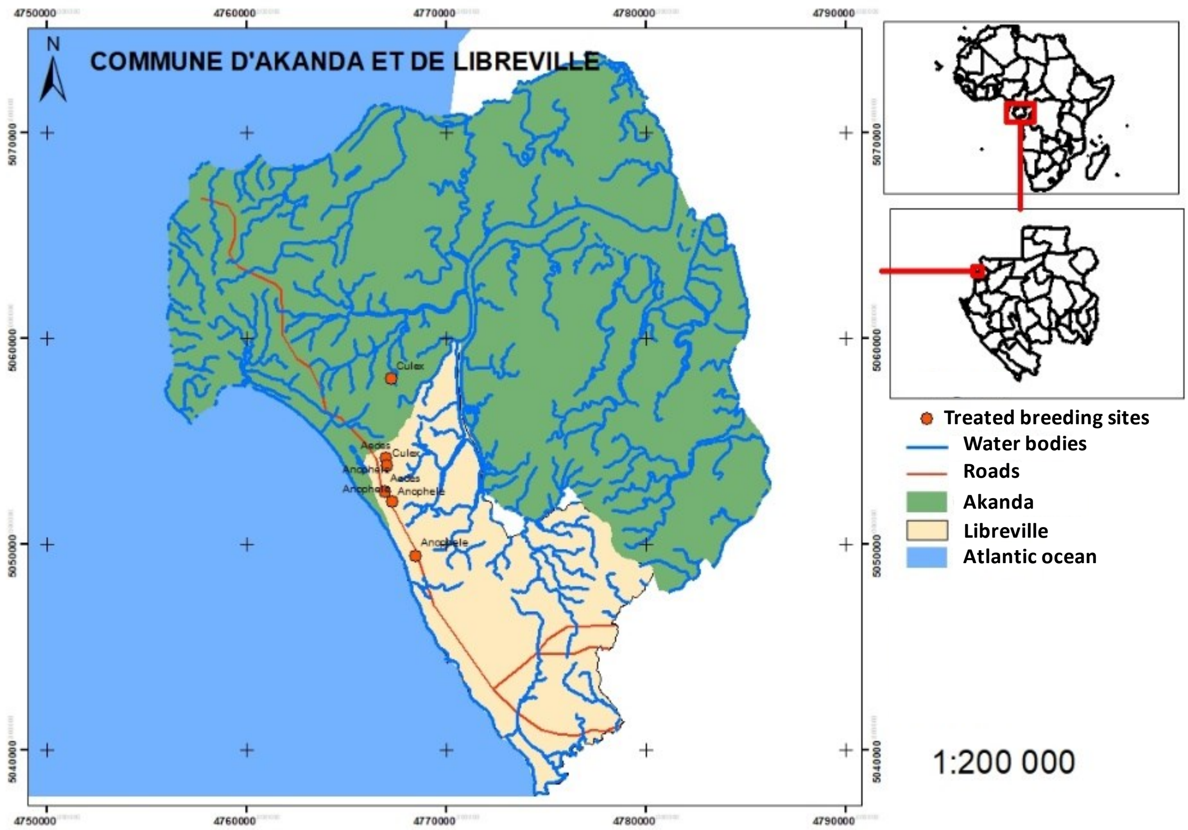

Figure 1. Map of breeding sites of the three mosquito genera treated with VBG.

2.2. Mosquito collection

The field and laboratory testing of VBG was conducted as stated in WHO [6]. All three instar (L3) larvae collected and belonging to the genera *Anopheles*, *Aedes* and *Culex* were used to test for the larviciding effect of VBG in the laboratoire d'ecologie des maladies transmissibles (LEMAT) (**Figure 2**). In the field, different microhabitats harboring the larvae of the three genera were targeted for the application of this biolarvicide.

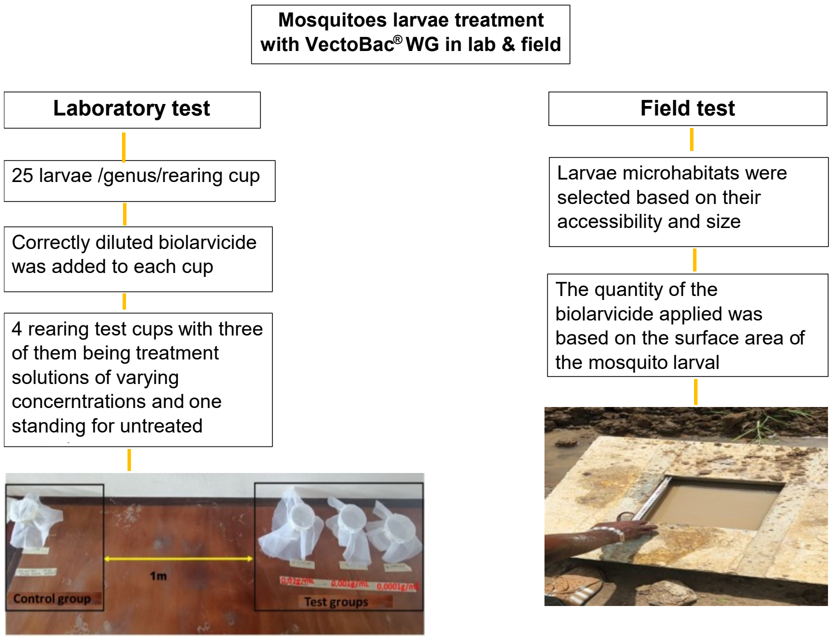

Figure 2. Display of experimental setup to test for the efficacy of VBG on three genera of mosquitoes. 25 larvae were placed in four rearing cups, cup 1 (untreated control group) at a distance of 1m from three treatment groups (group 2: 0.01 g/mL; group 3: 0.001 g/mL; group 4: 0.0001 g/mL). This was carried out for each of the three genera and repeated twice. However, in the field, VBG was dispensed based on the surface area of the different types of larval microhabitats.

2.3. Determination of larval reduction rate

The larval density in the field was measured by counting larvae in five dips [1]. Its efficacy both in the laboratory and in the field was measured in terms of mortality rate, 24 hrs post larval exposure. The larval reduction rate (LRR) was calculated as in Sevidzem et al. [7] as such:

$$LRR = (iD - fD)/iD \times 100$$

where: LRR = Larval reduction rate; iD = initial density; fD = final density.

3. Results

3.1. Characteristics of study population

A total of 872 larvae were reared in the laboratoire d'écologie des maladies transmissible (LEMAT), from March to May 2024 during the rainy season. The number reared and tested by genus is presented in **Table 1**.

Table 1. Mosquito larvae reared and tested in this experiment.

Genus	Number reared and identified	Number tested
Aedes	347	200
Anopheles	266	200
Culex	259	200
Total	872	600

3.2. Bioassays to test the efficacy of VBG

For the bioassay of VBG, in the laboratory, the required dose to kill 88% and 100% of the larvae in rearing cups was 0.001 g/mL and 0.01 g/mL respectively (**Figure 3**). Under field conditions, the percentage density reduction irrespective of the larval microhabitat type ranged from 90% to 100% and the mosquito larval density reduction between test and control groups in the field differed statistically (X^2=34; p = 0.026) (**Table 2**).

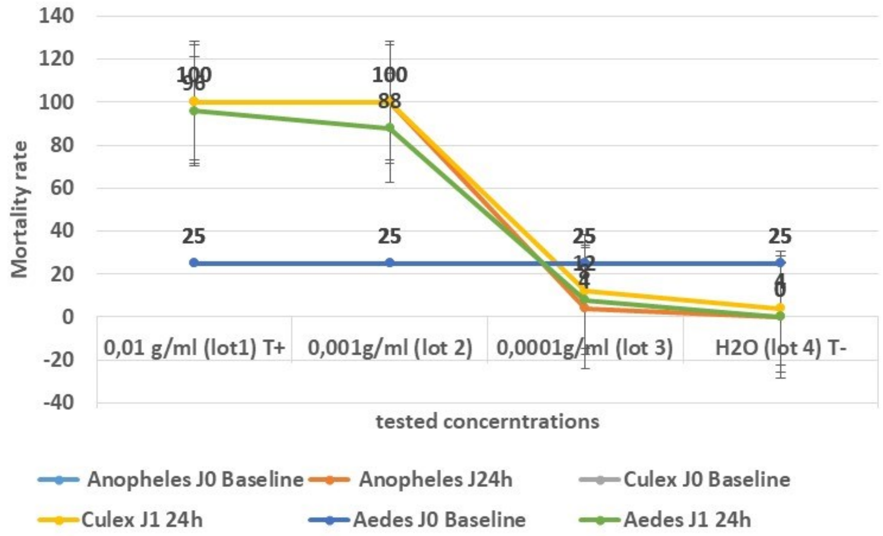

Figure 3. Mortality curve for the three genera of mosquito larvae 24hrs post-exposure to VBG. J0: Treatment day; J24: 24hrs post treatment.

Table 2. Field testing of VBG in different mosquito larval breeding sites behind the Libreville international airport area.

Code	Type	GPS coordinates North	GPS coordinates East	Genus	Surface (m^2)	Quantity (g)	Density D0	Density D24h	LRR (%)
1	Water canal	00°28.236	009°24.549	*Anopheles*	1.1	0.022	17	0	100
2	bucket	00°28.237	009°24.546	*Anopheles*	0.2001	0.004	16	0	100
3	bucket	00°28.235	009°24.547	*Anopheles*	0.0855	0.017	1	0	100
4	Surface water	00°28.208	009°24.584	*Anopheles*	0.35	0.069	6	0	100
5	Surface water	00°28.149	009°24.597	*Anopheles*	1.21	0.024	5	0	100
6	Surface water	00°28.120	009°24.601	*Anopheles*	0.029	0.006	1	0	100
7	slab	00°28.112	009°24.602	*Anopheles*	0.015	0.003	5	0	100
8	surface water	00°28.113	009°24.598	*Anopheles*	0.407	0.008	6	0	100
9	car tire tracks	00°28.115	009°24.592	*Anopheles*	0.1	0.002	8	0	100
10	car tire tracks	00°28.116	009°24.590	*Anopheles*	0.027	0.054	1	0	100
11	surface water	00°28.119	009°24.587	*Anopheles*	0.033	0.065	1	0	100
12	surface water	00°28.278	009°24.496	*Anopheles*	0.058	0.012	5	0	100
13	tire	00°28.515	009°24.347	*Aedes*	0.302	0.006	15	0	100
14	tire	00°29.363	009°24.381	*Aedes*	0.302	0.006	10	1	90
15	bucket	00°29.374	009°24.381	*Aedes/Anopheles*	0.102	0.046	8	1	90

Table 2. (*Continued*).

Code	Type	GPS coordinates		Genus	Surface (m^2)	Quantity (g)	Density D0	Density D24h	LRR (%)
		North	East						
16	cut container	00°29.362	009°24.408	*Culex/Anopheles*	0.071	0.011	8	0	100
G 01	tire	00°28.515	009°24.347	*Aedes*	0.302	0.006	29	0	100
G 04	basin	00°29.192	009°24.407	*Culex*	0.204	0.041	45	0	100
G 05	cut container	00°29.374	009°24.381	*Aedes/Anopheles*	0.071	0.011	15	0	100
17	untreated control	00°29.339	009°24.418	*Culex*	0.302	0	15	12	20

The Chi-square test revealed a statistically significant difference ($X^2 = 34$; $p = 0.026$) of VBG effect on the 19 different treated larval breeding sites compared to the control. However, no statistically significant difference ($X^2 = 16$; $p = 0.067$) was recorded when the effect of treatment with the biolarvicide was compared for the 19 treated larval breeding sites. LRR: Larval Reduction Rate.

4. Discussion

The aim of the study was to test the efficacy of VectorBac® in an urban setting. Overall, the mean mortality rates obtained in this study fall within the sensitivity range (80% to 100%) defined by the WHO [6]. Similar studies have been carried out in Senegal, on the genus Anopheles with a mortality rate greater than 80% [8]. Also in Niger, biolarvicides based on *Bacillus thuringiensis* subsp. israelensis (Bactivec and Griselesf) have also proven their effectiveness on *Culex* and *Anopheles* genera even at its very low concentration [9]. As the present pilot study could not evaluate the residual effect of this biolarvicidal formulation, future studies will integrate this aspect.

5. Conclusions

This preliminary study revealed superior sensitivity of the three local genera of mosquito's larvae to VBG in the field and laboratory. However, its residual effect at mosquito larval generic levels still need to be established for Gabon.

Conflict of interest: The authors declare no conflict of interest.

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