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Impact of propoxur (BAYGON®) use in indoor residual spraying (IRS) on malaria transmission in the commune of Aguégués in Benin

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Abstract

The countries affected by malaria have adopted new vector control strategies focused primarily on the use of insecticide-treated nets and indoor residual spraying. The commune of Aguégués was chosen to evaluate the impact of the use of Baygon® in malaria transmission. Entomological, clinical and parasitological parameters are studied. The effect of Baygon® is about 4 to 5 hours in the rooms sprayed. The results show that there is no significant difference regarding the entomological and parasitological parameters in the village treated with Baygon® and the village without nets. Baygon® has an important role in reducing the mosquito population. Baygon® has a knock-down and irritant effect on mosquitos. But the effect of this power is short because after 1 am mosquitoes begin to enter the sprayed rooms. The use of Baygon® must be accompanied by the long lasting impregnated mosquito nets.

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Introduction

Mosquitoes hold first place in the transmission of pathogens to humans and animals. Of all the diseases transmitted by mosquitoes, malaria, malaria is still one of the most dangerous (Gerard, 1993). It remains the leading cause of morbidity and mortality in tropical countries where there has been over 3 ½ million deaths annually (Carnevale & Mouchet, 1991). Children less than five years and pregnant women are the population group most threatened by this endemic disease (MinSanté, 2001). In Senegal, for example, according to the data of the National Program against Malaria, nearly 23 million pregnancies are threatened each year and more than 200,000 newborns suffering the consequences of this disease. The countries most threatened by this scourge loose an average of 1.3% annual growth rate (MinSanté, 2001). The gross domestic product (GDP) in African countries south of the Sahara would be 32% above its level in 2000 if malaria had been eradicated 35 years earlier, which is about 100 billion U.S. dollars, 9 times more than development assistance given to Africa in 1999 (MinSanté, 2001). Malaria is thus seen as one of the leading causes of poverty in Sub Saharan Africa. Malaria control in sub-Saharan Africa has long been hampered firstly due to the expansion of malaria strains resistant to anti malarial (Ridley *et al*., 2002), and secondly because of vector resistance to insecticides (Carnevale & Mouchet, 2001). This problem has led the countries affected by this scourge to define new vector control strategies focused primarily on the use of insecticide-treated nets and indoor residual spraying (Carnevale & Mouchet, 2001). While the use of insecticide treated bednets present certain deficiencies related to the fact that the vector is able to bite and transmit the germ out of hours of sleep (Rickenbach *et al*., 1972), None the less true that this control method is currently the only alternative for the prevention of mass. Its effectiveness depends more on the proportion of people agreeing to use insecticide-treated nets correctly (Darriet *et al*., 2000; Nguessan *et al*., 2001). The integrated control approach adopted by Cameroon mainly associated the use of insecticide treated bed nets to indoor residual spraying. This approach makes the need for_Cameroon to have an entomological database updated urgent. It is in this logic that a preliminary entomological and parasitological investigation was conducted in the commune of Aguégués on the impact of indoor residual spraying on malaria morbidity. This is in the perspective to make a reliable database and updated need for planning, monitoring and evaluation of vector control operations available to actors in the control of diseases caused by mosquitoes that the commune of Aguégués was chosen to evaluate the impact of the use of Baygon® in malaria transmission.

Materials and methods

Study area

Aguégués is a commune of Ouémé located in the lowest part of the valley of Ouémé. The lakeside commune of Aguégués presents a humid tropical climate characterized by two (02) rainy seasons and two (02) dry seasons of unequal importance. This commune has twenty-one villages divided into three boroughs: Avagbodji, Houédomè, Zoungamè. The intervention occurred from June to October 2011. The village of Bembè I in the borough of Avagbodji is chosen for the treated village and the villages of Akodji and of Donoukpa were selected in the boroughs of Houédomè and Zoungamè as control villages. The village of Bembè I is situated at the right bank of the river Ouémé and has the forest of Bamèzoun. The village is as a whole and favorable to mass effect. The village of Akodji is located between two arms of the river Ouémé and has grassland in favor of developing *Anopheles gambiae*. This village is as a whole and favorable to mass effect. The village of Donoukpa is a large agglomeration located between two arms of the river Ouémé.

Interventions

From June to October 2011 we used baygon® insecticide to spray the rooms of the village of Bembè I which is considered treated. 289 rooms located side by

side are counted. 12 rooms among the 289 not using mosquito nets were selected for indoor residual spraying. 36 children younger than 5 years lived in these rooms. Throughout the study, the rooms were sprayed. At 20 hrs 30 the doors and windows of these rooms were closed. Jars of water and food were covered. The insecticide is applied. 30 minutes later, the inhabitants have access to the rooms. All rooms in the village of Donoukpa received the distribution of nets performed in June 2011 by the Benin government. 4 rooms that were chosen in this village are considered control village N° 1. This village has not been sprayed. 12 children younger than 5 years live in these four rooms. In the village of Akodji, two rooms were recorded using no nets. 7 children younger than 5 years live in these two rooms. These two rooms have not received the spray. This village is taken as a control village N° 2. Two catchers are chosen for each room that is 82 catchers for 4 sessions per month that is 576 men-nights for the study. The insecticide was bought in the markets of Porto Novo.

Characteristics of BAYGON®

Chemical Name: 2-(1-methylethoxy)phenol methyl carbamate

Common Name: propoxur

CAS Number: 114-26-1

Empirical Formula: C11H15NO3

Chemical Structure: Molecular

Types of outcome measures

Entomological parameters

The captures of mosquitoes were conducted from 21 am to 6 pm inside the rooms using conventional vacuum cleaner. Study parameters are:

• Human aggressive density (m.a) was determined

• Parity rate (%) was calculated

• Sporozoite index was determined

• Entomological inoculation rate

Parasitological and clinical parameters

The following parameters were studied in children less than 5 years living in selected rooms in these three villages:

• Severe malaria anemia is defined as fixed at 5.1 g / l).

• The clinical episodes of uncomplicated malaria were evaluated: The site-specific definitions, including fever, usually with parasitological confirmation;

• The prevalence of the parasite was obtained using a site-specific method for estimating parasitemia, blood smears usually thick and / or thin;

• hemoglobin levels (g/dl) were determined.

Statistical analysis

Significant tests were carried out using the analysis of variance (ANOVA) of the Statistical Package for Social Sciences (SPSS) computer programme. Means were separated using the Duncan Multiple Range Test. Statistical analysis (ANOVA) showed significant differences ($P < 0.05$).

Results

Entomological parameters

In all rooms that received the indoor residual spraying with Baygon®, the catch was zero from 9 pm to 1 am. From 1am mosquitoes begin to bite and reach their peak at 4 am. Up to 6 hrs, they continue to catch mosquitoes while in rooms with no net at 6 am we do not find mosquitoes. The rooms without mosquito net beat the bailiff in numbers of caught mosquitoes with a peak at 1 am. In the rooms with mosquito net the captures are low in mosquitoes with a maximum of five mosquitoes at 2 am and 3 am (Fig. 1).

The table 1 shows a significant difference in the number of caught mosquitoes in the control village No. 2 without net and the village treated with Baygon®. The effect of Baygon® is therefore 4 to 5 hours. Olyset Net is a more important barrier in the mosquito-human contact than Baygon® (average of 12 mosquitoes collected in a room with Olyset Net against 21 in a room sprayed with Baygon®. However the

Baygon® has an important role in reducing the mosquito population in the sprayed rooms. So there is a significant difference between the capture of mosquitoes in sprayed rooms and the rooms without nets (average of 21 mosquitoes collected in sprayed rooms against 53 in the rooms without mosquito net (Table 1).

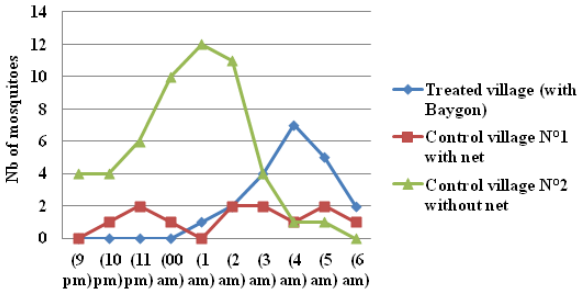

Fig. 1. Number of caught mosquitoes per man-nights per village.

Table 1. Summary table of the number of caught mosquitoes per day by catcher and the total number of collected mosquitoes per village.

Parameters	Treated village with Baygon®	Control village N°1 with net	Control village N°2 without net
Nb of catchers per village	24	8	4
Men-nights	384	128	64
Nb of mosquitoes per village	8064	1536	3392
Nb of mosquitoes per catchers per night	21	12	53

The table 2 shows that there is no significant difference regarding the parity rate in the village treated with Baygon® and the village without net (58.3% against 60.1%). Whereas there is a significant difference regarding the parity rate in the treated village and control village No. 1 with mosquito net (58.3% against 14.4%). Concerning the sporozoitic index there is a slight significant difference between treated village and village control No. 2 (12.63% against 15%). The significant difference is very large between the treated village and the village control No. 1 (12.63% against 2.52%). The entomological inoculation rate is very low in the village with net (0.3%) and very high in the village without net (7.95%). It is 2.65% in the treated village. (Table 2).

Table 2. Summary table of the parity rate, the sporozoitic index and the entomological inoculation rate.

Entomological parameters	Treated village with Baygon®	Control village N°1 with net	Control village N°2 without net
Nb of thorax dissected	451	320	316
Nb of parous	263	47	190
Parity rate	58.3%	14.4%	60.1%
Nb of gland dissected	380	316	360
Nb of positive	48	8	54
Sporozoitic index	12.63%	2.52%	15%
EIR	2.65%	0.3%	7.95%

EIR: Entomological Inoculation Rate.

Parasitological and clinical parameters

The table 3 summarizes the percentage of children whose parasitemia test is positive according to the age group and village. The village with Olyset Net presents low prevalence with 4.85% and a peak of 5.2%. The highest prevalence was recorded in the village without nets (33.20%). The prevalence was 20.32% in the treated village. Table 3.

The village without mosquito net recorded more cases of fever 87 against 62 for the treated village and 18 for the village with Olyset Net. The prevalence for fever cases gives 4.58% for the village with Olyset Net, 33.20% for the village without mosquito net and 22.30% for the treated village. Table 4.

Table 3. Percentage of positive parasitemia test of children by age and village.

Age groups ((months)	Treated village with Baygon®	Control village N°1 with net	Control village N°2 without net
6-11	30%	4%	30%
12-23	20.4%	5.2%	37%
24-35	19.2%	4.8%	36%
36-47	21.2%	5%	30%
48--59	20.8%	3.9%	33%
Total	22.32%	4.58%	33.2%

In the village treated with Baygon®, about 156 malaria cases were recorded, 12 cases of severe malaria or a percentage of 7.69%. In the village without net about 47 malaria cases were recorded, 4 cases of severe malaria is 8.5%. In the village with mosquito net no cases of severe malaria were recorded about 11 malaria cases recorded.

The use of Olyset Nets in the control village No. 1 corrected the hemoglobin level more than in other villages. There is no significant difference between the treated village with Baygon® and the village without mosquito net as regards hemoglobin levels. Table 5.

Discussion

Malaria remains a leading cause of death in sub-Saharan Africa. Starting from the Abuja Declaration of 2000, African governments, supported by the "Roll Back Malaria" have undertaken to reduce 50% of the burden malaria in terms of mortality, morbidity and socioeconomic impacts for the period 2001-2010. The development of new control tools is vital, it is also recognized that much of the morbidity and mortality associated with malaria could be reduced, provided that existing tools are made accessible and are actually used (RBM, 2000). Preventing mortality and disease reduction by improving access to prompt diagnosis and effective treatment remain the key targets of the current Global Malaria Control strategy (WHO, 1993). But against all expectations, the disease remains the first consultations about health and due over 45% of hospitalizations.

Table 4. Number of collected slides and positive cases of plasmodium of fever cases.

Parameters	Treated village with Baygon®	Control village N°1 with net	Control village N°2 without net
Nb of fever cases	62	18	87
Nb of thick film/ blood smears made	700	240	141
Nb of positive slides with plasmodium	156 (22.3%)	11 (4.58%)	47 (33.2%)

Table 5. Hemoglobin level according to villages.

Hemoglobin level	Treated village with Baygon® (% of children)	Control village N°1 with net (% of children)	Control village N°2 without net (% of children)
Mild (10.0-10.9 g/dl)	24.21%	69%	24%
Moderate (8.0-9.9 g/dl)	48.43%	29%	48%
Severe (<8.0 g/dl)	27.34%	6%	28%

In this paper, we report the results of a comparative study of the use of Baygon® and Olyset Net. The results show that the irritant, knockdown and killing effect of Baygon® is very strong but it is short. The catches of mosquitoes are zero from 9 pm to 1 am. The effect of Baygon® is 4 hrs to 5 hrs long. This can also be caused by the construction of model bamboo huts in the commune of Aguégués. The insecticide is a gas, and could escape through the bamboos. Another cause could be related to the entry of mosquitoes in the rooms through the bamboo after the effect of the insecticide. Mosquitoes are attracted by the CO2 (carbon dioxide) that is generated by humans, they can detect substance over 6 feet away. Then, to ensure that CO2 is not from a car or a smokestack, the mosquito identifies secondary attractants such as heat, lactic acid or water vapor, which are produced by humans through the transpiration and muscle activity and are released into the air by respiration and skin. However the use of Baygon® has a significant impact in reducing the anopheline population and has significantly reduced the entry of mosquitoes. After 1 am the sprayed rooms are as the rooms without nets and unsprayed by Baygon®. This is justified by Figure 1 which shows the same number of mosquitoes collected at 3 am in the village treated with Baygon® and in the control village No. 2. Olyset Net is a more important barrier in the mosquito-human contact. The Baygon® has no impact on the parity rate of mosquitoes captured because in the village treated with Baygon® and the in village without a mosquito net the values obtained are almost similar (58.3% against 60.1%). This could be related to the fact that after1 am we note the presence of mosquitoes in the short duration of the effect of Baygon®. Whereas there is a significant difference concerning the parity rate in the treated village and control village No. 1 with mosquito net (58.3% against 14.4%). The Olyset Net is thus a real barrier in the mosquito-human contact. However, on the sporozoite there was a slight significant difference between the treated village and control village No. 2 (12.63% against 15%). The significant difference is very large concerning the treated village and the control village N ° 1 (12.63% against 2.52%). The entomological inoculation rate is very low in the village with and very high in the village without net. The health impact of insecticide-treated bednets was determined in research trials in the Gambia (Alonso *et al*., 1991), Ghana (Binka *et al*., 1996), the Kenyan coast (Nevill *et al*., 1996), and Burkina Faso (Hablutetzel *et al*., 1997). It is estimated that 6 lives could be saved for every 1,000 children protected under bednets – translating to approximately 336,000 malaria deaths averted if every child slept under ITNs (Lengeler, 2003). In the same lines WHO suggests that successful malaria prevention using ITNs could also decrease demand for new drugs and slow down the spread of resistance (WHO, 1999). Other studies have produced contrary results. In area at low risk of malaria infection such as South Africa and the highlands of East Africa, IRS has proved to be a highly effective protective measure against the parasite of malaria (De Zulueta *et al*., 1964; Robert, 1964; Curtis *et al.,* 1999). The spraying activities in Gucha in 2000 demonstrated that this activity can reduce the risk of malaria infection by 75%, a higher protective efficacy than ITN's (63%) (Guyatt *et al*., 2002). It has also been shown that working together with the district Health Management Team and the communities, it is possible for an NGO to support the implementation of spraying activities within a district. In Gucha that year it was estimated that 21% of the population were protected by the spraying activities targeted at "priority areas". The use of Baygon® must be accompanied by the long lasting impregnated mosquito nets.

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