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Efficacy of Lambdacyalothrin Impregnated Bednets Against Mosquitoes with Particular Reference to Anopheles Moucheti at Ebogo, Cameroon

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Abstract: The efficacy of bed nets impregnated with lambdacyalothrin at 15 mg/l, in reducing mosquitoes bites especially those from *Anopheles moucheti* was assessed during a two year at Ebogo, south Cameroon. Mosquito were captured using human baits at two nights per month, throughout the two-year study period. The impregnated bed nets were installed in the second year. The impregnated bed nets reduced the aggressive rate of mosquitoes in general by 69.7% and that of *Anopheles moucheti* in particular by 70%. The residual effect of the insecticide was more or less constant during the first seven months post-impregnation, but reduced irregularly during the last five months. The prevalence of malaria parasites also reduced significantly 40.3% (Z = 4.54), in subjects less than 15 years after the installation of impregnated bed nets. The parasitic densities of malaria reduced from 10 000 parasites/µL of blood to 1 000 parasites/µL of blood, in absence and presence of impregnated bed nets, respectively.

Key words: *Anopheles moucheti*, lambdacyalothrin, impregnated bed nets

INTRODUCTION

Malaria is the most devastating disease in the world at large and in Africa in particular, at the beginning of the 21st century. In 1992, the World Health Organisation (WHO) estimated the cases of clinical malaria to be 350 millions annually. Much resource has been invested on research towards the reduction of malaria and this remains a challenge to international solidarity[1].

The apparition and spread of resistant strains of *Plasmodium falciparum* as well as non-destruction of vectors by the classic insecticides[2], have rendered the fight against this illness more difficult. This is accentuated by the economic difficulties endured by, and their limited medical facilities. While waiting for the discovery of a malaria vaccine[3,4], it is necessary to put in place a method that will limit contact between the vector, *Anopheles* sp. and man, to eliminate these vectors by the use of persistent insecticide, which could reduce the spread of disease.

Vector control by insecticide spraying has proven to be limited with the apparition of mosquito resistance to these chemicals. The setting up of impregnated bed nets reducing man-anopheles contact gave a new impetus to this struggle; their impregnation with pyrethrioïd insecticide (permethrin, deltamethrin, lambdacyalothrin,...) confer them a better efficacy, due to their persistence.

Many tests carried out in Africa south of the Sahara, with either permethrin or deltamethrin impregnated bed nets revealed several advantages over the classic method of intra-domiciliary sprays[5] in Congo[6], Burkina Faso[7,8] and in Cameroon[9].

A one-year study conducted at Ebogo on the transmission dynamics of malaria and its impact on the population of Ebogo indicated that the Culicidae were highly aggressive and that *Anopheles moucheti* transmits malaria in this locality[9]. The use of the lambdacyalothrin at concentrations of 30 and 10 mg of active ingredient per m^2[10,11] resulted in a 100% mortality of *Anopheles gambiae* during six months. In the present study we used concentration between these two values (15 mg of active matter by m^2) to test the effect of this insecticide (lambdacyalothrin) on the Culicidae of Ebogo in general and *Anopheles moucheti* in particular.

MATERIALS AND METHODS

Study site: The research was carried out at Ebogo. A locality situated at 60 km from Yaounde, the capital of Cameroon, in the forest zone of south of Cameroon. It is drained abundantly by two big permanent rivers, the Nyong and So'o, one of the major affluent of Nyong.

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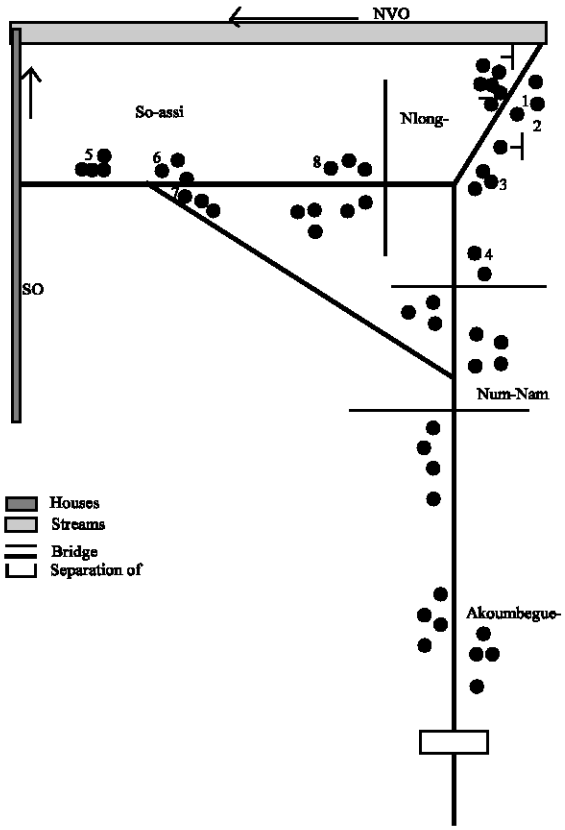

Fig. 1: Schematic representation of ebogo village (cameroon)

Temporary rivers appeared during the rainy season (Fig. 1). Ebogo has an aquatorial climate of Guinean type, characterized by the existence of four seasons, including two dry and two rainy seasons[12].

Impregnation of bednets: Three categories of bed nets were used for the study, they included a large (17.28 m^2); average (14.58 m^2) ; small (10.2 m^2).

The mass impregnation of bed nets was done according to the method by LE GOFF[13]. Bed-nets were impregnated with Lambdacyalothrine insecticide. Bed-nets of nylon material were soaked in the insecticide contained in big bowl. The impregnation was done at a dose of 15 milligrams per litter (mg l^{-1}) of active ingredient of Lambdacyalothrin per meter square (m^2) of bed nets for 5 minutes. Bed-nets were spread on a field to allow them to get dry.

The bed-nets were set up at the end of March 1992, after a one-year study (April 1991 to march 1992), on the dynamics of mosquitoes as well as parasitological assessment involving all human subjects at Ebogo[9].

Bioassay: The remanence of Lambdacyalothrin insecticide was assessed through a series of bioassay on laboratory

Table 1: Mortality of *Anopheles gambiae* exposed for three minutes to different sizes of bednets impregnated with lambdacyalothrin at 15 mg/l in the laboratory

Temps post-impregnation (in month)	Impregnated bednets 1	2	3
M_0	100%	100%	100%
M_6	93,7%	92,5%	89,7%
M_7	76,2%	75%	73%
M_8	50,6%	49,3%	48,7%
M_9	38,7%	37%	35,5%
M_{10}	23,2%	21,6%	21,2%
M_{11}	19,4%	18,8%	18,1%
M_{12}	13,7%	12%	11,1%

Key :Bednets 1 = 17,28 m^2; Bednets 2 = 14,58 m^2; Bednets 3 = 10,2 m2
M_1 = one month after impregnation; M_6 = two months after impregnation;…

with *Anopheles gambiae* using students WHO transparent cones. Fifteen females were introduced in each cone at different sizes of bed6nets. The knock down effects can be observed after 24 hrs.

Entomological inoculation and parasitological indices: Anopheles mosquitoes that fed on human baits were captured during two consecutives nights every month. They were dissected to assess the entomological inoculation rate. The aim of the dissection was to determinate the presence or absence of sporozoïtes in the salivary gland, the state of female ovaries in order to estimate the life span of each species, in the community of Ebogo. The parasitological index was assessed by the taking blood from the human population (thick drop and frottis blood). The method permits to estimate the prevalence of *Plasmodium* sp. And the parasitological density from the human population of Ebogo.

The efficacy of impregnated bed-nets was evaluated by comparing the entomological and parasitological parameters recorded before and after impregnation.

RESULTS

After the impregnation, the laboratory bioassay on *Anopheles gambiae*, showed that the persistence of Lambdacyalothrin insecticide in bed-nets begins to decrease six months after impregnation (Table 1). This decrease was observed by the diminution of mortality rate of *A. gambiae*. The decrease became less than 50% of mortality, seven months after the impregnation of bed-nets with Lambdacyalothrin at 15 mg l^{-1}.

The installation of impregnated bed-nets reduced the aggressive rate of the Culicidiae community at Ebogo by 69.7% (i.e. from 113.5 bites/man/night (bmn) before impregnation to 34.35 bmn, respectively. The aggressive rate of the Culicinae in this community decreased by a comparable proportion (65.7%). Nevertheless, it is necessary to note that there was in the slight increase

Table 2: Aggressive rate of the Culicinae before and after the installation of bednets impregnated with lambdacyalothrin at 15 mg l^{-1}

	Before impregnated bednets *		After impregnated bednets **	
Months	*Culex quinquefasciatus*	*Mansonia sp.*	*Culex quinquefasciatus*	*Mansonia sp.*
April	1.38	21.25	0	1.13
May	0.13	1.94	0	0.5
June	0.06	1.44	0	1.25
July	0.13	1.44	0	0.38
August	0	0.75	0	1.13
September	0.06	0.69	0	2.63
October	0	1.13	0	0.5
November	0	0.5	0.13	2.63
December	0	2.25	1.75	2.38
January	0	7	0	4.63
February	0	2.75	2	6.13
March	0	51.38	0.5	5.13

* = period understood between April 1991 and March 1992 * * = period understood between April 1992 and March 1993

Table 3: Aggressive (ma) and of entomological inoculation (h) rates of anopheles before and after the installation of bednets impregnated with lambdacyalothrin at 15 mg l^{-1}, at Ebogo

	Before impregnation*		After impregnation**							
	A. moucheti		A. gambiae		A. moucheti		A. gambiae		A. paludis	
	ma	h	ma	h	ma	h	ma	h	ma	h
April	115.1	1.5	0.06	0	18.12	0	0.63	0	-	-
May	73.5	0.6	-	-	22.25	0.25	0.38	0	-	-
June	60.6	1.6	-	-	49 0.4	-	-	-	-	
July	59.6	0.24	-	-	26.9	0.13	-	-	-	-
August	123.2	3.4	-	-	38 0.12	-	-	-	-	
September	183.9	1.5	-	-	46.5	0	-	-	-	-
October	132.6	0.4	-	-	24.6	0	-	-	-	-
November	103.1	0.5	-	-	40.1	0.24	-	-	-	-
December	124.7	0.7	-	-	29.5	0	0.63	0	0.63	0
January	123.6	0.2	0.37	0	18.6	0.4	-	-	-	-
February	67	1	3.25	0	30.2	0.5	2.38	0.19	-	-
March	92.1	2.1	20.25	0.1	29.4	0.23	1.63	0	-	-

* = period understood between April 1991 and March 1992 * * = period understood between April 1992 and March 1993 A. = Anopheles - = not of achieved manipulation (absence of anopheles)

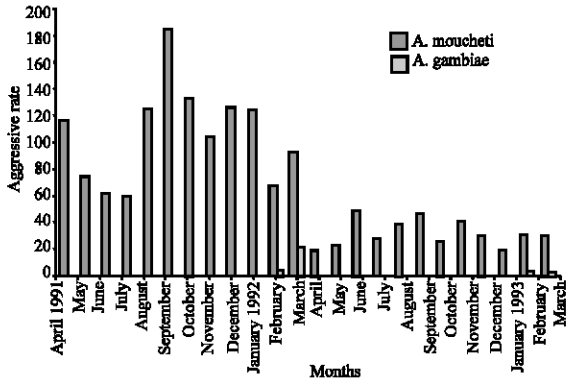

Fig. 2: Aggressive rate of anopheles at Ebogo (Cameroun), before and after impregnated bednets with lambdacyalothrin at 15 mg/l, from April 1991 to March 1993

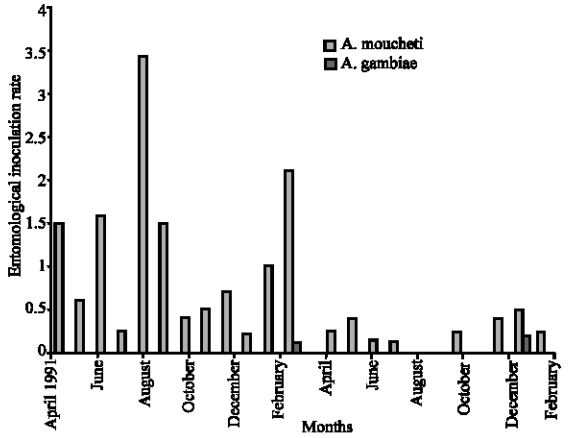

Fig. 3 : Entomological inoculation rate of anopheles at Ebogo (Cameroun), before and after impregnated bednets with lambdacyalothrin at 15 mg/l, from April 1991 to March 1993

Culex quinquefasciatus, these species appeared only eight months after the setting up of impregnated bed-nets. On the other hand, *Mansonia sp.* representing the other Culicinae, recorded a reduction of 69.3% in aggressive rate (Table 2).

The anopheles community responsible for the transmission of malaria suffered and overall decrease of 70% in aggressive rate, the main malaria vector (*Anopheles moucheti*) recorded a reduction of 70.1%. It is

Table 4: Parasitological rate during the different seasons, for the two periods separating the installation of bednets impregnated with lambdacyalothrin at 15 mg l^{-1}, at Ebogo

	Before impregnation*			After impregnation**		
	Period	< 15 years	≥ 15 years	Period	< 15 years	≥ 15 years
N	April 1991	49	100	April 1992	39	103
IP		69,4%	25%		30,5%	20,4%
IG		6,12%	1%		5,1%	0%
N	July 1991	51	84	July 1992	49	115
IP		58,8%	17,9%		34,7%	14,8%
IG		5,9%	0%		2%	0,8%
N	November 1991	50	112	October 1992	43	81
IP		62%	22,3%		37,2%	17,3%
IG		4%	1,8%		18,6%	2,5%
N	February 1992	37	91	February 1993	36	69
IP		67,6%	40,7%		52,8%	20,3%
IG		5,4%	3,3%		2,8%	1,4%

N = number of subjects appropriated ; IP = Plasmodic index ; IG = gametocytic index * = period understood between April 1991 and March 1992 * * = period understood between April 1992 and March 1993 (≥ = greater or equal than)

Tableau 5: Changes in the parasitological densities (number of parasites by microlitre of blood), before and after the installation of screens impregnated with lambdacyalothrin at 15 mg l^{-1}, among human populations of two different age groups at Ebogo

Parasitologic Densities (number of parasites per ?µL of blood)	Before impregnation*			After impregnation**		
	Period	< 15 years	≥ 15 years	Period	< 15 years	≥ 15 years
< 500	April 1991	19	78	April 1992	33	101
500 – 1000		7	3		5	2
1000-10000		23	0		1	0
> 10000		0	0		0	0
< 500	July 1991	23	81	July 1992	47	115
500 – 1000		11	2		2	0
1000-10000		17	1		0	0
> 10000		0	0		0	0
< 500	November 1991	21	95	October 1992	18	81
500 – 1000		4	17		0	0
1000-10000		19	0		0	0
> 10000		6	0		0	0
< 500	February 1992	21	45	February 1992	36	66
500 – 1000		9	44		2	3
1000-10000		7	2		0	0
> 10000		0	0		0	0

* = period understood between April 1991 and March 1992 * * = period understood between April 1992 and March 1993 (≥ = greater or equal than)

worth mentioning that *Anopheles paludis* appeared nine months after installation of bed-nets impregnated. *Anopheles gambiae* reappeared nine months after the setting up of the impregnated bed-nets (Fig. 2). The reduction of the anopheles community was more pronounced obvious during the first seven months post - impregnation. The entomological inoculation rate of the main vector (*Anopheles moucheti*) reduced by 75.9% after the installation of impregnated bed-nets (Table 3 Fig. 3). This entomological inoculation rate was 0.83 infected bites/man/night (bimn) and 0.2 bimn before and after installation of bed-nets, respectively. Owing to the late appearance of *Anopheles gambiae*, the transmission rates were similar before and after installation of bed nets. The parasitological index also decreased after the setting up of impregnated bed nets with Lambdacyalothrin at 15 mg l^{-1}. This index decrease by 40.3% (Z = 4.54) after the installation of bed-nets for subjects less than 15 years old (Table 4). Nevertheless, blood samples collected at one, four and seven months after the impregnation, showed a meaningful reduction in prevalence of *Plasmodium* sp. of 56% (Z = 3.54) ; 35% (Z = 2.4) and 40% (Z = 2.5), respectively. In the month of February (11 months after impregnation), plasmodic index was comparable between the two periods (Z = 1.5). Blood samples from older subjects (≥ 15 years) indicated that the presence of impregnated bed-nets index for these subjects. These index passed from 25% to 20.4% (Z = 0.83), one month after installation of bed nets, from 17.9% to 14.8% (Z = 0.6), four months after impregnation and from 22.3% to 17.3% (Z = 0.83), seven months after installation of bed-nets. On the other hand, a significant reduction is recorded in February, 11 months after impregnation (Z = 3).

Parasitological densities also followed the same trends like the plasmodic index with higher densities recorded in subjects of less than 15 years old before installation of impregnated bed-nets (Table 5). These parasitological densities generally reduced from 1,000 parasites/µL of blood to more 10,000 parasites/µL of blood for individuals in this young age group.

DISCUSSION

The installation of impregnated bed nets, led to a substantial decrease of the aggressive rates of the Culicidian fauna in general and anopheles responsible of the transmission of the malaria at Ebogo, in particular. This reduction limited contact between the vectors and the human population. It also implicated in the decrease of the number of parasites in humans, especially in the young individuals that, although receiving three times less stings than adults, were more infected[6]. The transmission rates by *A. gambiae* remained comparable during the two periods, for reasons similar to the same reasons that those of the evolution of the aggressive rate of this anopheles.

The appearance of *Anopheles paludis* eight months after impregnation could be explained by a passive transportation (wind, objects) either by a prompt presence from the temporary resting places, after the decrease in insecticide persistence.

After the analysis of bioassay and the global decrease of Culicidian community, these bed-nets impregnated bed nets with Lambdacyalothrin at 15 mg/l, led to a substantial reduction of aggressive and entomological inoculation rates, lasting about 7 months. This decrease constitutes a considerable advantage for vector control struggle because of the reduction of parasites transmission and the nuisance to the human population and the transmission. These results are in agreement with tests conducted in Tanzania on *Anopheles gambiae*. In this study dose of the insecticides tested were 30 mg and 10 mg of active ingredient of Lambdacyalothrin per m^2 of cloth. They indicated that a mortality of 100% was observed during six months[10,11]. Other authors also confirmed the effect insecticide persistence on Culicidian using other insecticides. For example, deltamethrin was used severed African countries including, Burkina Faso[8,7], Cameroon[9] and Congo[6].

The high decrease of heavy parasites load was especially efficient in the young subjects. The reduction of the high parasite density without total elimination of the infestation constitutes an important factor. Because of the constant presence of the infestation a certain premunition is maintained in the human population, especially at subjects of less than 15 years enabling the that way the reduction of mortality and the morbidity I this region.

This method is cheap and is easily be used the people living in the farming zones. Its not only allows to limit contacts between malaria's vector (anopheles) and the man, but also reduces the aggressive rates as well and parasite transmission by anopheles. The decrease of plasmodic index is very discernible for subjects of less than 15 years.

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