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Comparative study on the efficacy of lambdacyhalothrin and bifenthrin on torn nets against the malaria vector, *Anopheles stephensi* as assessed by tunnel test method

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Malaria is one of the most serious vector-borne diseases, affecting millions of people mainly in the tropics. In spite of major efforts undertaken for its control, through drug treatment and vector control, an increase in malaria incidence has occurred in the last 30 years, due to poor socio-economic conditions and development of drug and insecticide resistance in parasites and vectors, respectively[1]. Insecticide treated nets have been introduced in several countries for protection against mosquitoes and for malaria control. Treated nets not only provide a considerable degree of personal protection to individual net users, but, if used by whole community, can substantially reduce the infective vector population[2]. Insecticide treated bednets using pyrethroid insecticides are effective in reducing malaria morbidity and overall child mortality in a variety of epidemiological conditions[3].

To date, six pyrethroid insecticides (alpha-cypermethrin, cyfluthrin, deltamethrin, etofenprox, lambdacyhalothrin and permethrin) have been recommended by WHO for the treatment of mosquito nets[4]. Bifenthrin, a non-alpha-cyano pyrethroid, is used against a broad range of agricultural pests and has emerged as a promising candidate for malaria vector control[5]. The present study was undertaken to evaluate the efficacy of bednet impregnated with lambdacyhalothrin or bifenthrin against the malaria vector, *Anopheles stephensi* and to determine whether bifenthrin has any advantage over other pyrethroids in this regard.

Bifenthrin Talstar® 80 g/l SC and lambdacyhalothrin (ICON 2.5 CS) were used in the present study. Tests were carried out at WHO-recommended concentrations for impregnation of bed nets against malaria vectors and at one-quarter and one-eighth of these recommended concentrations, as it was thought that these lower concentrations would remain after repeated washing and might be a more sensitive indicator for detecting difference among products. The reference susceptible strain, *An. stephensi* originating from India (IND-S), that has been colonised for many years and is free from any detectable resistance mechanism to pyrethroids, was used in the present study.

The basic equipment with a section of square glass tunnel (25 × 25 cm), 60 cm in length similar to that used by Elissa & Curtis[6] was used. A disposable cardboard frame mounted with a treated netting sample

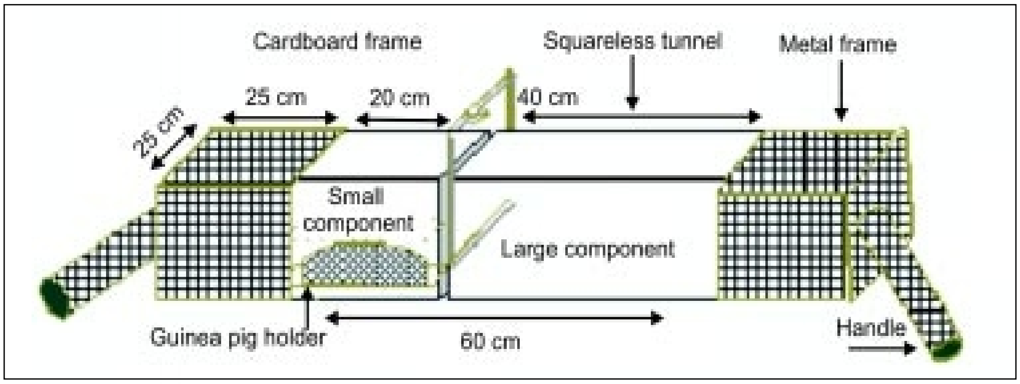

Fig. 1: Tunnel chamber

was placed across the tunnel 25 cm from one end. The surface area of netting accessible to mosquitoes was 400 cm^2 (20 × 20 cm) with nine holes, each 1 cm in diameter: one hole was located at the centre of the square, the eight other were equidistant and located at 5 cm from the border. Inside the shorter section of the tunnel, a holed bait (Guinea pig) was placed, unable to move but available to be bitten by the mosquitoes. At each end of the tunnel, a 30-cm cube cage was fitted, covered with polyester netting. In the cage placed at the end of the longer section of the tunnel, 100 unfed, 5 to 8 day-old females were introduced at 1800 hrs. Females were free to fly in the tunnel but they must contact the treated netting and locate a hole before reaching the bait. After taking a blood meal, females usually fly to the cage at the end of the same section of the tunnel and rest. The following morning, at 0900 hrs, females were removed and counted separately from each section of the tunnel and the immediate mortality was recorded. Live females were put in plastic cups with 5% sucrose solution and delayed mortality was recorded after 24 h. During exposure, cages were maintained in an environmental chamber at 27 – 2°C and 80 – 10 % RH under subdued light. Three tunnels were used simultaneously in the same climatic chamber, one serving as the control. Each net sample was used no more than once, within the same week and then was discarded.

Reduction in blood feeding was assessed by comparing the proportion of blood-fed females, whether they were alive or dead in tunnels with treated and control nets. Irritability (entry index) was measured as the proportion of mosquitoes that did not pass through the netting, by comparing treated and control tunnels. Overall mortality was measured by combining both immediate and delayed (24 h) mortality of mosquitoes from the two sections of the tunnel (Fig. 1). Percent mortality and blood feeding inhibition rate were compared using an ANOVA test. All tunnel tests were made in parallel with a control where no insecticide was applied to the net and results were corrected accordingly.

In the control with untreated netting, 95–98% of female mosquitoes passed through the holes overnight, 94–97% blood-fed successfully and only 1–4% died. Table 1 shows the results with treated netting. Bifenthrin was highly effective in preventing mosquito passing through the netting for inhibiting blood feeding even at 12.5% of the WHO recommended dose. Lambdacyhalothrin was equally effective at the higher dose but showed lower effectiveness at the lower dose. When the netting was treated with bifenthrin at doses of 3.125, 6.25 and 25 mg/m^2, the proportion of mosquitoes that passed through the holes overnight were 3, 7 and 12%; mortality rates were 94.5, 95.5 and 94.5%; inhibition of blood-feeding was 100, 100 and 97% respectively. When the netting was treated with lambdacyhalothrin at doses of 2.5, 5 and 20 mg/m^2, the pro-

Table 1. Percent entry, mortality and inhibition of blood feeding in tunnel tests against susceptible strains of *An. stephensi* for two pyrethroid insecticides used to impregnate mosquito nets

Insecticide	Concentration (mg/m^2)	% entry	% mortality	% inhibition of blood feeding
WHO-recommended concentration				
Bifenthrin	25	12	94.5	97
Lambdacyhalothrin	20	5	97	100
25% WHO-recommended concentration				
Bifenthrin	6.25	7	95.5	100
Lambdacyhalothrin	5	12.5	88	97.5
12.5% WHO-recommended concentration				
Bifenthrin	3.125	3	94.5	100
Lambdacyhalothrin	2.5	21.5	45.5	98

Note: Sample size were 200 for measurements of % entry, mortality and inhibition of blood feeding.

portion that passed through were 21.5, 12.5 and 5%, the mortality rates were 45.5, 88 and 97% and the inhibition of blood-feeding obtained was 98, 97.5 and 100%, respectively.

Hougard *et al*[7] had the same experience using bifenthrin and lambdacyhalothrin for susceptible strain of *An. gambiae*. We consider that bifenthrin is to be recommended as an effective insecticide for net treatment.

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