

## Reducing Mosquitoes in Homes in Akuse, Ghana

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**Abstract:** Mosquito-borne diseases continue to be a threat to mankind, having killed more people than all wars combined. Developing effective, low cost environmentally friendly methods of reducing mosquito populations will save countless lives while protecting the environment. The ProVector pesticide system is the first technology to use an applicator to deliver a pesticide bait that kills both adult and larvae mosquitoes, with the added benefit of being non-toxic. The ProVector has been tested globally. Here we describe the effectiveness of the ProVector Flower with Entobac in reducing mosquito populations for 12 weeks, using surveys of homeowners in the city of Akuse, Ghana.

**Keywords :** Arbovirus, Malaria, Vector Control, *Bacillus thuringiensis israelensis*, Pesticide

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### I. Introduction

The major vector-borne diseases in Ghana are malaria, dengue fever, and yellow fever [1]; Chikungunya, West Nile virus and filariasis are also endemic. Malaria accounts for the third highest cause of death in Ghana, ranking just below respiratory infection and stroke [2]. The reduction of mosquito vectors is critical for reducing the risk of these mosquito-borne diseases to communities. Indoor residual spraying (IRS) and the use of insecticide treated nets (ITN) are integral in malaria vector control programs in Ghana, and other African countries. However, pesticide resistance in mosquito populations is a growing problem in several countries and in Ghana high survival rates of identified by WHO bioassay tests were recorded for all insecticide classes except the organophosphates [3]. As a part of an integrated vector control program, applying repellents, wearing long sleeves and pants, reducing breeding sites, and providing screens are non-pesticide alternatives to spraying and insect treated bed nets but they do not sufficiently reduce mosquito populations. In addition to the growing problem of pesticide resistance, indoor mosquito control has put selective pressure on mosquitoes to feed earlier in the evening and to feed more often outdoors [4]. The ProVector with Entobac pesticide, active ingredient *Bacillus thuringiensis israelensis* (Bti), has been used in several countries, to reduce medically important species both indoors and outdoors. Entobac is unique in that it is non-toxic and is the only available pesticide that kills both adult and larvae mosquitoes [5, 6].

### II. Methods And Results

One ProVector Flower with Entobac bait pads (Bti plus honey formulation) were provided to each of 15 home owners in Akuse, Ghana. Homeowners were surveyed every two weeks for three months to evaluate the effectiveness of the ProVector Flower in homes. The number of mosquitoes in each home were estimated using lingual descriptors and assigned to fuzzy memberships, then defuzzified to numeric values [7]. Mosquito numbers decreased after two weeks of use of the ProVector Flower, with a significant reduction at 6 weeks over the pre-estimate [Table 1] with the start of recovery by the mosquito population after week 10 [Figure 1].

### III. Discussion

Mosquito-borne diseases will continue to be a problem, particularly with diseases that are incurable or where no vaccines are available, e.g. dengue and malaria. Effective methods to reduce mosquito populations below the threshold of disease transmission without selecting for pesticide resistance will also be a continual challenge. The ProVector system is a unique technology that uses a colored applicator to attract mosquitoes where the vector feeds on the pesticide. An advantage of using an applicator with bait is that pesticides affect only target organisms at a rate that may reduce the development of resistance. In Akuse, the number of mosquitoes was significantly reduced but at a slower rate of decrease than found in other studies [5, 6]. This may be attributed to variations in habitat or perception of home owners. Interestingly, the mosquito population

in Akuse began to increase slightly between weeks 10 and 12 [Figure 1]; this same increase was found in Kibera, Kenya, indicating the Entobac bait pad was used up [7]. This pattern should be helpful for informing homeowners when to replace the bait pad and for distributors to plan the numbers needed to support each community.

In addition to outdoor spraying of pesticides, ingenious methods have been developed to reduce adult mosquito populations, such as placing ITN's outdoors around cattle enclosures [4]. Like ITN's, the ProVector Flower with Entobac can be placed inside or outside homes. However, with the ProVector, non-target species such as bees and butterflies will not be negatively impacted and pesticides will not be released into the environment by rain. Entobac is the first pesticide that is effective on both adult and larvae mosquitoes. Adult mosquitoes are attracted to the colors on the device, feed on the Bti bait and succumb within a few days. The adult mosquitoes die within a few days and if they land in water, larvae mosquitoes are also killed. This can result in a 250% expansion of reduction over the expected coverage area. One concern with using outdoor ITN's is the emergence of resistance. ProVector with Entobac reduces the risk of resistance developing because resistance to Bti has not been detected in wild populations of mosquitoes [8]. In addition, only small amounts of Bti are directly released to the individuals of the target species not sprayed in the environment, reducing the risk of resistance to Bti developing in wild populations.

Home owners often use coils to supplement mosquito control or when ITN's and IRS are not available or affordable. Mosquito coils for indoor use have been shown to be ineffective in reducing mosquito populations and to have negative health impacts on the persons in the home [9]. One of the problems with ITN's is that users may not use them when the night is hot and people cannot eat dinner or go to the latrine while under the bed net, this is one reason people use coils. As mentioned earlier, temporal and spatial changes in host seeking behavior by vector species further add to the need to use supplemental vector management solutions. The ProVector Flower has been shown to be effective in reducing mosquito species outdoors in several countries.

Malaria transmission is high in several regions in Ghana, often in urban areas with rural characteristics [10]. Malaria is highly prevalent in Akuse due to high humidity and rainfall but prevalence is also related to the proportion of middle income households in the area and the proportion with no formal education [11]. Homeowners should be encouraged to use more than one method to control mosquitoes in and surrounding their homes. Previous studies suggest the ITN be used with coils, and that colored nets are more attractive to users [12]. This same recommendation is suggested for the ProVector System. The ITN is effective in reducing mosquito populations and protecting people from vectors at night. The ProVector system is a new, safe, and effective supplement to ITN's, helping to provide protection 24 hours a day without development of pesticide resistance. The ProVector can use a number of pesticides with bait, e.g. Entobac (Bti), Entobac D (Bti plus Deltamethrin), Entobac M (Bti plus Methoprene). The incorporation of Bti into the control strategy may help reduce pesticide resistant mosquito populations, the use of deltamethrin provides rapid knockdown and the use of methoprene reduces fecundity of female mosquitoes and larva development.

#### **IV. Conclusion**

The ProVector Flower was readily accepted into homes as it is colorful, safe and effective. In some cases, the ProVector should incorporate the Entobac D bait for rapid knockdown for the first month, with a switch to Entobac or Entobac M to have efficacy over a large area. Additional ProVector systems are being tested, including the ProVector Super Netty, which uses empty water bottles, thus reducing cost, waste and breeding sites. Further development of new technologies and pesticides which are effective against pesticide resistant mosquito species will be an ongoing effort as mosquito-borne diseases increase globally.

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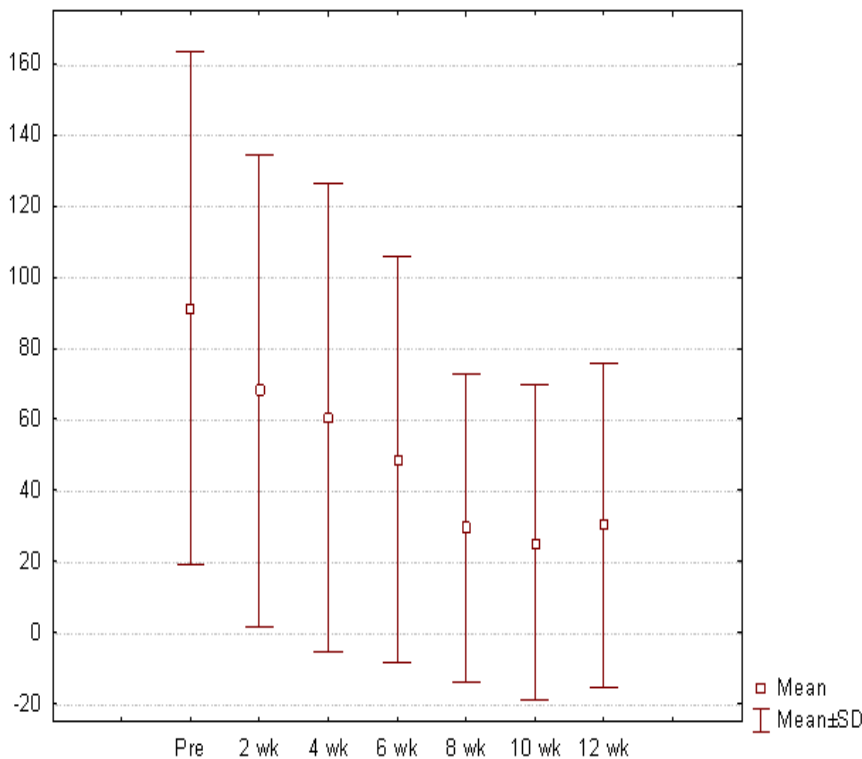
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**Table 1.** Comparison between Pre and Bi-Weekly Estimates of Mosquito Numbers in Home in Akuse, Ghana.

	Valid N	Mean	Std.Dev.
Pre Estimate	15	91.3	72.3
2 wk Estimate	15	68.1	66.4
4 wk Estimate	15	60.6	65.9
6 wk Estimate*	15	48.7	56.9
8 wk Estimate*	15	29.4	43.4
10 wk Estimate*	15	25.3	44.3
12 wk Estimate*	15	30.3	45.6

**Figure 1.** Defuzzified Estimates of Mosquito Numbers Based on Home Owner Surveys in Akuse, Ghana.



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