Plant-based Attractants in Toxic Sugar Baits (ATSB): A New Approach to the Control of Malaria Vectors in Africa

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Introduction

The need for new vector control approaches to further reduce malaria transmission is indicated by the shortcomings of common vector control methods.

The fact that mosquitoes are dependent on plant-derived sugar and are selectively attracted to sugar sources has practical implications to control. We exploited the need for sugar to develop the novel "attract and kill" methods that use plant-based attractants, with sugar and oral low risk toxins, for control.

Method

In laboratory experiments, low risk toxins like Spinosad or boric acid and other tested substances were blended with sugar and tested for oral toxicity. In parallel, we checked attractiveness of hundreds of flowers, fruits, and seedpods in the field by using samples as baits for mosquito traps. Comparisons of the catches of baited traps indicated the relative attraction.

In early experiments, we sprayed the blossoms of highly attractive plants with an unattractive sugar bait (USB) spiked with an oral toxin to control mosquitoes. Later, we blended the same mixture with extracts of attractive plants and sprayed the now attractive toxic sugar baits (ATSB) on small patches of green non-flowering vegetation or presented the mixture soaked in cloth in constructed simple bait stations.

Preparations used in the control sites were sugar baits without toxin (ASB) but with food dye that marks feeding mosquitoes and non-target insects. Mosquito populations were monitored at all sites continuously with traps in fixed locations from 7 days before the treatment to 30 days or more afterwards.

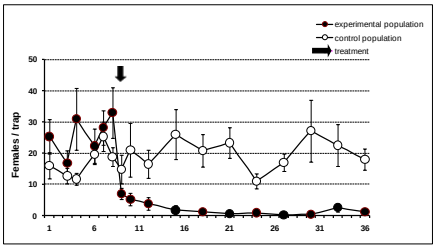
Spraying of ATSB spots on vegetation

ATSB bait stations hung in trees and bait station with protective grid to keep out large insects such as bees

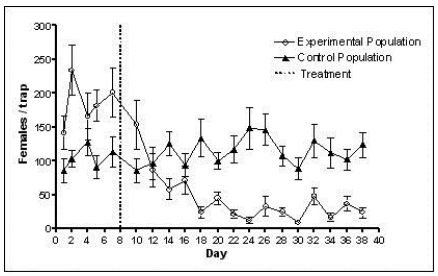
Results

We identified 10 highly attractive flowers mainly desert bushes and trees. In early control experiments, using such blossoms to guide mosquitoes to feed on sugar and toxin, the local mosquito populations were decreased by 90% or more. Similar good results were obtained by using ATSB (see graphs) sprayed on about 10% of the vegetation near mosquito breeding sites, in Mali and in Israel, or presented in bait stations. Surviving mosquitoes were mostly very young and thus unable to transmit pathogens.

The ATSB method was effective against *Anopheles*, *Culex* and *Aedes* spp. in Israel and against *An. gambiae* in Mali. Experiments demonstrated that properly applied ATSB has little or no effect on non-target insects.



An. claviger females in ATSB bait station treated cisterns and untreated control cisterns in Israel



An. gambiae females in ATSB treated rice paddies and untreated control rice paddies in Mali

Discussion

Present mosquito control methods mainly use residual indoor spraying and impregnated bed nets to kill blood searching mosquitoes whereas our studies are centered on the relatively neglected field of mosquito-plant relationships. Our studies show that ATSBs are a new and effective tool for mosquito control, particularly in arid areas such as the African Sahel where malaria is prevalent. ATSB can be an industrial product but also be made of fermented juice of local fruits which are grown locally and are readily available. ATSB method allows limited effect of non-target sugar feeding insects compared to widely applied, common contact insecticides. However, the use of ATSB may be impractical in some habitats with abundant attractive and competing flowers.

Cx. pipiens fed on green colored ATSB *An. gambiae* approaching ATSB drops

Conclusion

The new ATSB method can be an effective, cheap, and environmentally friendly addition or replacement for conventional methods that have a limited arsenal. As well, increasing problems with resistance to different types of residual insecticides is becoming a real concern. By switching to oral toxins, we can now use completely different classes of toxins to which there is no resistance, and usually with low toxicity for vertebrates. The ATSB method has still to be adapted and suited to large-scale use nevertheless, we assume that it can be a significant contribution to the control of malaria vectors.

Cx. pipiens fed on flowers colored with ASB (see color in abdomen)

Selected References

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