

Essential Oil from Bush Mint, *Hyptis suaveolens*, is as Effective as DEET for Personal Protection against Mosquito Bites

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Abstract: Concern about the deleterious effects associated with synthetic chemicals has revived interest to explore plants as a source of natural insecticides for mosquito control. Ethnobotanical studies conducted in Kenya on plant species including bush mint, *Hyptis suaveolens* Poit., showed that many of them repel mosquitoes effectively when burned overnight in rooms. Recent field works conducted with *H. suaveolens* essential oil have demonstrated the potential of this essential oil as mosquito repellent. The present work is a comparative study on the persistence of 30% DEET and 10% *H. suaveolens* essential oil for personal protection against mosquitoes in field conditions. Twenty volunteers who have given their informed consent have been involved for each of the products and control (no treatment). Results showed that the mean number of mosquitoes that landed on treated volunteers 6 hours post-application was 0.50 and 0.45 for 10% *H. suaveolens* essential oil and DEET respectively, against 6 mosquitoes for the control people. Statistical analysis revealed that there is no significant difference between 10% *H. suaveolens* essential oil and DEET indicating that both products are similarly effective. The possibility to use *H. suaveolens* essential oil as integrated malaria vector management has been discussed.

Keywords: DEET, *Hyptis suaveolens*, essential oil, repellent, mosquito control.

INTRODUCTION

Chemical repellents are important in protecting people from blood-feeding insects, ticks, mites, and other arthropods and may therefore also reduce transmission of arthropod-borne diseases [1]. *N,N*-diethyl-3-methylbenzamide (DEET) is one of the most well-known arthropod repellents and has been on the market for almost half a century [2, 3]. DEET is effective against many different blood-sucking arthropods [2, 4]. The protection efficacy depends on the type of formulation, application pattern, species, and feeding behavior of the arthropod [4]. DEET is generally safe for topical use if applied as recommended, although adverse effects such as serious neurologic effects have been reported [4, 5]. Many people consider that DEET and related compounds are a health and environmental hazard [6]. DEET does not readily degrade by hydrolysis at environmental pHs and has been identified as a ubiquitous pollutant in aquatic ecosystems [6, 7]. Concern about the deleterious effects associated with synthetic chemicals has revived interest to explore plants as a source of natural insecticides, acaricides, and repellents for medical, veterinary and crop protection use [1].

Ethnobotanical studies conducted in Kenya on plant species including *Hyptis suaveolens* Poit. showed that many of them repel mosquitoes effectively when burned overnight in rooms [8]. Duke [9] also includes *H. suaveolens* in his

phytochemical and ethnobotanical database as an insect repellent. Laboratory study has assessed the repellency rates of various concentrations of *H. suaveolens* essential oil and 6% of the oil was said to induce a high repellency rate in laboratory conditions [10]. Recent field works conducted with *H. suaveolens* essential oil showed that the effects of a solution containing 8% of the oil persisted and repelled up to 97.56% of mosquitoes by 5 hours post-application [11]. Here we report results of a comparative study carried out in field conditions on 10% *H. suaveolens* essential oil and *N,N*-diethyl-3-methylbenzamide (DEET).

MATERIALS AND METHODS

Extraction of *H. suaveolens* Essential Oil

The extraction of *H. suaveolens* essential oil was made from leaves collected from plants cultivated according to Ahoton *et al.* [12]. The harvested leaves were air-dried in the shade for three days. The extraction of the essential oil was made by steam distillation using 1 m³ still. To carry out the tests, the essential oil was dissolved in isopropanol (99.8% pure).

Study Areas

The field works took place in Ladji, Towéta and Vossa districts located in Cotonou (Benin, West Africa). These are wetlands and floodable locations without modern infrastructures and contain many mosquitoes breeding sites. These locations are unhealthy and unfit for human accommodation, nevertheless thousands of people live there in poor health and social conditions.

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Field Study on the Effect of 10% *H. suaveolens* Essential Oil Immediately after Application

To study the effect of 10% *H. suaveolens* essential oil immediately post-application, a total of 20 replicates were carried out through the study areas. The product was applied directly on both feet (from toes to knee) of each of the volunteers who gave their informed consent. The application was made using cotton soaked in the essential oil solution. For the observations, treated volunteer and the control (untreated person) were installed at a distance of about 3 m from each other on a stool. Mosquitoes coming to rest on the feet of the volunteers were then captured using a mouth vacuum during a period of 15 minutes. The collected mosquitoes are brought to the laboratory for counting and identification, using a stereomicroscope (Motic China). The experiments have been carried out between 8 pm and 10 pm in May-June 2010.

Comparative Study on the Persistence of 10% *H. suaveolens* Essential Oil and DEET in Field Conditions

The persistence of the effect of 10% *H. suaveolens* essential oil as well as DEET has been investigated 6 hours post-application. To assess the persistence of these products on mosquito populations after this period of time, the feet of volunteers were treated 6 hours before the start time of the observations in the study areas. Twenty replicates were performed for each product and the control (untreated volunteers). The field observations and mosquito counts were made in the same manner as described above. These experiments have been carried out in July-August 2010. The commercial formulation of N, N-diethyl-3-methylbenzamide (DEET) called ‘Ungava’ has been used. ‘Ungava’ contains 30% DEET and is manufactured by the Company ‘Aerokure International Inc.’ (Canada).

Statistical Analyses

Non-parametric tests (Mann-Whitney U) were performed to determine whether there is significant difference between the number of mosquitoes coming to rest on the feet of volunteers in tested variants. These tests were performed since the data did not meet the ANOVA hypotheses. Statistical analyses have been performed using SPSS statistics package version 16.0.

RESULTS

Effect of 10% *H. suaveolens* Essential Oil Immediately after Application

The total number of mosquitoes that landed on treated and control feet during the first 15 minutes post-application in all replicates is 0 and 375, respectively (Fig. 1). In terms of percentage, these results show that 100% of the mosquitoes were repelled the first 15 minutes post-application of the solution containing 10% of *H. suaveolens* essential oil. Statistical analyses showed that there is significant difference between essential oil treated volunteers and the control. Two species of feeding female mosquitoes were captured and identified namely *Culex quinquefasciatus* and *Anopheles gambiae*; the *Culex* mosquitoes prevailing, however, in the study areas (Table 1).

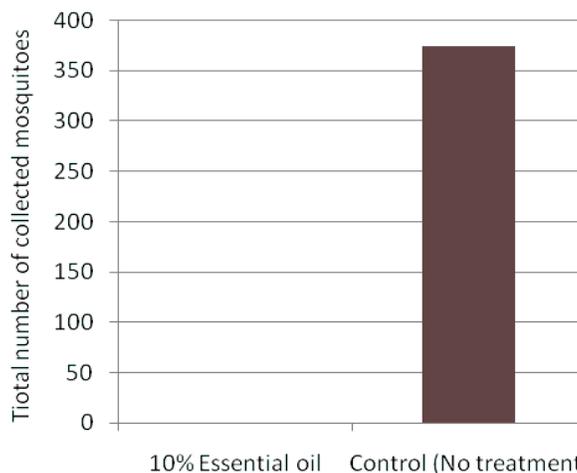


Fig. (1). Effect of 10% *H. suaveolens* essential oil on mosquitoes populations in field conditions immediately post-application.

Table 1. Biodiversity and Number of Collected Mosquitoes on Untreated Controls Immediately after Application of 10% *H. suaveolens* Essential Oil

Mosquito species	Number of collected individuals
<i>Culex quinquefasciatus</i>	367
<i>Anopheles gambiae</i>	8
<i>Aedes</i> sp.	0

Persistence of the Effect of 10% Essential Oil and DEET in Field Conditions

The mean number of mosquitoes that landed on treated volunteers 6 hours post-application was 0.50 and 0.45 for 10% *H. suaveolens* essential oil and DEET respectively, against 6 mosquitoes for the control (Fig. 2). This corres-

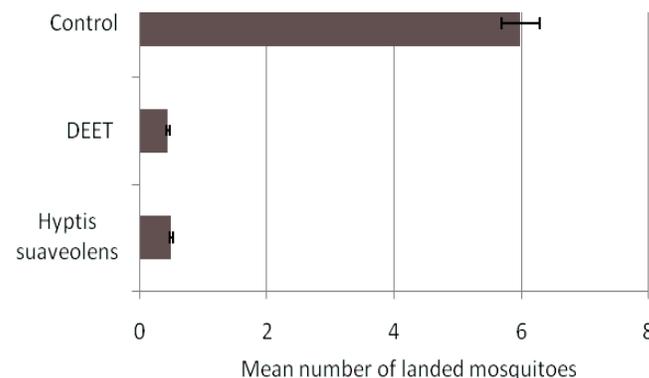


Fig. (2). Mean number of collected mosquitoes on treated volunteers 6 hours post-application.

ponds to a repellency rate of about 92% for both products. Statistical analyses showed that there is no significant difference between 10% *H. suaveolens* essential oil and DEET indicating that both products are similarly effective.

During these field experiments, *Culex*, *Anopheles* and *Aedes* mosquitoes have been captured on treated and untreated volunteer feet; *Culex* mosquitoes prevailing, however, in the study areas (Table 2).

Table 2. Biodiversity and Number of Mosquitoes Collected on Treated and Control Volunteers in all Field Trials 6 Hours Post-Application

Treatment	<i>Culex</i> sp.	<i>Anopheles</i> sp.	<i>Aedes</i> sp.
Hyptis	10	0	0
DEET	8	0	1
Control	102	8	4

DISCUSSIONS

The concentration of 6% of *H. suaveolens* essential oil produced the best results in laboratory tests since it has repelled about 97% of tested mosquitoes. When tested in field conditions, this concentration repelled 100% of mosquitoes present in the test areas the first 15 minutes post-application [11]. In the present study, 10% *H. suaveolens* essential oil induced also the maximal repellency rate. This confirms once again that low concentration of this essential oil is highly effective against mosquito populations, the first hour post-application. Comparative study conducted on the efficacy of insect repellents against mosquito bites demonstrated that higher concentrations of DEET provided longer-lasting protection [13]. As for DEET, higher concentration of *H. suaveolens* essential oil provided also longer-lasting protection [11]. In the present study, 10% *H. suaveolens* essential oil and a formulation containing 30% DEET provided similar protection time amounting to at least 5 hours. Our data are in agreement with Fradin and Day [13] results that revealed a mean complete protection time of 5 hours with a formulation containing 23.8% DEET. Based on these data, we conclude that 10% *H. suaveolens* essential oil is as effective as 30% DEET for personal protection against mosquito bites.

The majority of mosquitoes captured in the present study on untreated volunteers were predominantly *Culex quinquefasciatus* and occasionally *Anopheles gambiae*, the major malaria vector in Sub-Saharan Africa. Laboratory works have also demonstrated that low concentration (6%) of *H. suaveolens* essential oil induced maximal repellency rate against *A. gambiae* [10]. In Sub-Saharan Africa, it is actively recommended to people to spend night in impregnated mosquito nets in order to avoid malaria infection. Nevertheless, people who usually sleep under insecticidal nets, still contract malaria from time to time. For instance, in a study conducted in Somalia, it was demonstrated that the protective efficacy of insecticidal nets against malaria transmission is barely 54% among people who regularly use mosquito nets [14]. Moreover, Toe-Pare *et al.* [15] have shown that people's motivation to use mosquito nets considerably decreased less than a year after the campaigns and

people prefer to spend night without insecticidal nets. Therefore, mosquito net is not sufficient to effectively control malaria vectors, especially in the West African countries where urbanization promotes the proliferation of mosquitoes [16]. Consequently, to achieve successful vectors control and reduce substantially the prevalence of malaria and other vector-borne diseases, an integrated management of these vectors must be adopted as recommended Okech *et al.* [17]. In this perspective, the present study shows that a formulation containing 10% essential oil of *H. suaveolens* is a way that may be taken into account for the integrated management of disease-vectors mosquitoes.

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