

Full Length Research Paper

Field evaluation of naturally occurring mosquito repellents in Mt. Kenya Region, Kenya

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Malaria continues to claim about 2 million lives annually worldwide. In Kenya, malaria equally depicts a morbid picture. It poses a major threat to the lives and health of 20 million people in Kenya and is a major killer mainly of children under five years and expectant mothers. This research was aimed at identifying plants used by communities in repelling mosquitoes. Community meetings were held at the District Culture Office, Embu with participants from Nyeri, Kirinyaga and Embu counties. The plants that were used by the community in repelling mosquitoes were identified.

Key words: Mosquito, repellence, malaria, Mt Kenya region.

INTRODUCTION

For the last 60 years, the world community has been putting a lot of effort in getting rid of malaria globally. However, these attempts have not been very successful, especially in the developing countries, where malaria is still a major killer (Tognotti, 2009; Biscoe et al., 2004). Apart from management of the malaria by chemotherapy and clearing of mosquito breeding sites, prevention of bites is a strategy that is also applied. Avoiding bites is achieved by shunning infested habitats, wearing protective clothing, and using insect repellent whereby, applying repellent to the skin may be the only feasible way to protect against insect bites (Fradin and Day, 2002). Tawatsin et al. (2001) also reported mosquito control and personal protection from mosquito bites as

the most important measures in controlling mosquito borne diseases. The World Health Organisation has been involved in popularizing the usage of insecticide treated mosquito nets (World Health Organization (WHO), 2013), which though a good approach, may not be entirely sustainable since supply of free nets is not guaranteed. Further, mosquitoes are also likely to develop resistance to chemicals in treated nets and it is not possible to be under nets the whole day. It has been reported that resistance has been widely identified to pyrethroids by the mosquito vector, and these are the chemicals that are highly relied upon in long lasting insecticide treated nets (WHO, 2011).

When African Heads of State and Government met in

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Table 1. County of origin of participant herbalists.

County	Frequency	Percent
Embu	10	59
Kirinyaga	3	18
Nyeri	4	24
Total	17	100.0

Nigeria in the year 2000, they declared a total war against malaria, which is an initiative of the World Health Organization (WHO and UNICEF, 2003). This initiative was started due to the recognition of the great health, social and economic importance of malaria. The disease is estimated to cost Africa up to US\$ 12 billion annually. This has slowed economic growth by up to 1.3% and the entire Africa's population is at risk (World Bank, 2007). Pregnant women and young children are known to be at the highest risk. Many drugs are used in treating malaria, with artemisinin combination ranked best, but still the parasite is capable of developing resistance to many of these drugs. One of the best approaches to controlling malaria is the development of cheap natural repellents.

N,N-diethyl-3-methylbenzamide (deet) is the most commonly used chemical in most repellent formulations in the market which has remained the case since 1954 when it was discovered (Tawatsin et al., 2001; Chen-Hussey et al., 2014). There are many concerns about the safety of use of deet, with toxicity concerns ranging from mild to severe, more so in children (Tawatsin et al., 2001; Isman, 2006; Park et al., 2005). Psychosis, immediate contact dermatitis following dermal application, generalized pruritus and angioedema and conjunctival damage from application to the eye have been noted from the use of deet (Ellenhorn, 1997 as cited in Koren et al., 2003). Accordingly, many chemists consider an effective alternative to deet for personal protection against mosquitoes and biting flies to be the holy grail (Isman, 2006).

Many plants have been used as mosquito repellents. Among the common plants used as repellents include citronella, cedar, verbena, pennyroyal, geranium, lavender, pine, cajeput, cinnamon, rosemary, basil, thyme, allspice, garlic, peppermint, eucalyptus, lemongrass and soybean, usually due to the presence of essential oils (Trongtokit et al., 2005; Fradin and Day, 2002). In many studies that have been done, these plant based repellents have been found to provide less protection times than deet (Fradin and Day, 2002; Isman, 2005). A good repellent should be effective against a wide array of biting arthropods for at least 8 hours, be non-toxic, non-irritating, odorless, and non-greasy and such a repellent is yet to be developed (Fradin, 1998; Bissinger and Roe, 2010 as cited in Karunamoorthi, 2012).

In this regard, continued research on new repellents is important. Therefore, the purpose of the study was to

identify the plants used by communities around Mt. Kenya in repelling mosquitoes, with an aim of establishing whether there is potential for new but effective repellents.

METHODOLOGY

Herbalists were invited to a stakeholder meeting where information about the use of herbs in producing mosquito repellents was collected with assistance from Department of Culture, Embu county. A structured questionnaire was also administered to individual herbalists. The information constituted the local name of the herb, the habitat, form, part of the plant harvested, preparation and administration. This was followed by a field visit to the localities mentioned by the herbalists to verify the plants mentioned. Plant specimens were further taken to herbarium at Egerton University for authentication.

RESULTS AND DISCUSSION

From the participants in the discussion it was found that the majority were from Embu county, where the meeting was held (Table 1).

Most commonly used plant species

A list of plant repellents was given by the practitioners. The species were ranked by their frequencies. *Tagetes minuta* was the most commonly used (52.9%) repellent. The other commonly used repellents were *Azandracta indica* oil (35.3%), *Azandracta indica* plant material (23.5%) and *Caesalpinia volkensii* (23.5%). Cowdung though not a plant was also reported to be used as a repellent by 23.5% of the practitioners. From this list, *Azandracta indica* was used more frequently than the others since it was used in two forms; as an oil and the plant material itself. The use of the plant in both forms was reported by 58.8% of the participants. This was higher than the per cent reported for *Tagetes minuta* (52.9%). These results are summarised in Table 2.

Families of repellents

From the list of repellents that were reported, the frequency of the plant families was determined (Figure 1). The Lamiaceae family had the largest proportion of the repellents (21.7%). The families: Asteraceae, Caesalpinaceae, Meliaceae, Solanaceae and Verbenaceae were each represented by two plant species, while all the other families were each represented by just one species. According to Isman (2005) the mint family (Lamiaceae) provide most of the essential oils produced commercially from plants. Similarly in this study, the largest proportion of repellent plants belonged to this family.

Table 2. List of all the repellents ranked by frequency

Local name	Scientific Name	Family	Frequency	Per cent	Ranking
Mubangi	<i>Tagetes minuta</i>	Asteraceae	9	52.9	1
Neem oil	<i>Azandracta indica oil</i>	Meliaceae	6	35.3	2
Neem plant	<i>Azandracta indica</i>	Meliaceae	4	23.5	3
Mubuthi/Mucuthi	<i>Caesalpinia volkensii</i>	Caesalpinaceae	4	23.5	3
Cowdung	-	-	4	23.5	3
Mutaa	<i>Ocimum basilicum</i>	Lamiaceae	3	17.6	4
Gacuki	<i>Ocimum americanum</i>	Lamiaceae	2	11.8	5
Wanjiru wa Ruriii/weru	<i>Ajuga remota</i>	Lamiaceae	2	11.8	5
Mwenu/Mwinu	<i>Senna didymobotrya</i>	Caesalpinaceae	2	11.8	5
Muthiriti	<i>Lippia kituensis</i>	Verbenaceae	2	11.8	5
Kavovo/Muvovo	<i>Leonotis mollisima</i>	Lamiaceae	2	11.8	5
Queen of the night	<i>Lippia caviodora</i>	Verbenaceae	1	5.9	6
Muchuki	<i>Epilobium hirsutum</i>	Onagraceae	1	5.9	6
Sodom apple	<i>Solanum incanum</i>	Solanaceae	1	5.9	6
Muthuthi	<i>Mytenus senegalensis</i>	Celasteraceae	1	5.9	6
Muthiga	<i>Warburgia ugandensis</i>	Canellaceae	1	5.9	6
Muringa	<i>Cordia abyssinca</i>	Boraginaceae	1	5.9	6
Muretha	<i>Gnidia glauca</i>	Thymelaeaceae	1	5.9	6
Mukau	<i>Melia volkensii</i>	Meliaceae	1	5.9	6
Mukanga	<i>Antidesma venosum</i>	Euphorbiaceae	1	5.9	6
Muhua	<i>Tithonia diversifolia</i>	Asteraceae	1	5.9	6
Mbaki	<i>Nicotiana tabacum</i>	Solanaceae	1	5.9	6
Kareria	<i>Mormodica foetida</i>	Cucurbitaceae	1	5.9	6
Gatambogo	<i>Caparis sepiaria</i>	Capparaceae	1	5.9	6
Aloe	<i>Aloe species</i>	Aloaceae	1	5.9	6

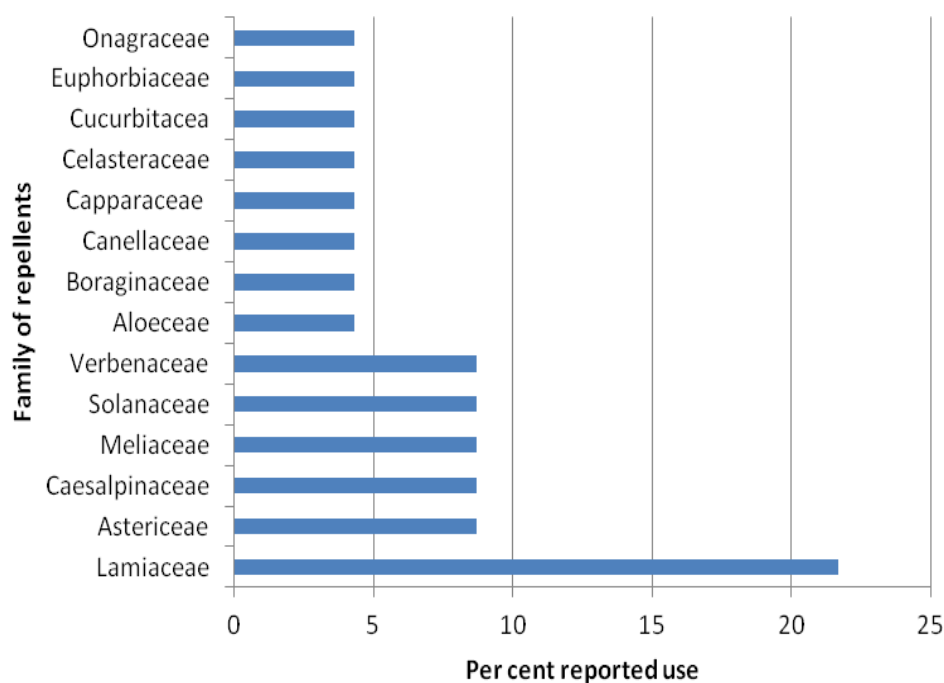
**Figure 1.** Family of the repellents used.

Table 3. Perceived 'most effective' repellent.

Repellent	Scientific Name	Frequency	Percent	Rank
Neem oil	<i>Azandracta indica</i> oil	3	17.6	1
Muchuki	<i>Epilobium hirsutum</i>	3	17.6	1
Mubuthi	<i>Caesalpinia volkensii</i>	2	11.8	2
Mubangi	<i>Tagetes minuta</i>	2	11.8	2
Neem plant	<i>Azandracta indica</i>	1	5.9	3
Gatambogo	<i>Capparis sepiaria</i>	1	5.9	3
Queen of the night	<i>Lippia caviadora</i>	1	5.9	3
Muthiriti	<i>Lippia kituensis</i>	1	5.9	3
Mabaki	<i>Nicotiana tabacum</i>	1	5.9	3
Mutaa	<i>Ocimum basilicum</i>	1	5.9	3
Muretha	<i>Gnidia glauca</i>	1	5.9	3
Total		17	100	

Most effective repellent

The participants were requested to each give the repellent that was most effective. This is because what is commonly used may not necessarily be most effective, as use may be influenced by availability. The repellents perceived as most effective were *A. indica* oil (17.6%), *E. hirsutum* (17.6%), *C. volkensii* (11.8%) and *T. minuta* (11.8%) (Table 3). When both forms of use of *A. indica* (plant material and oil) were considered its reported per cent as most effective was highest (23.5%). Some of the plants identified in the study are also reported in other studies as repellents and some as pesticides. Neem plant (*A. indica*) and its products and *Ocimum basilicum* have been cited as natural repellents demonstrating good efficacy against some malaria species (Tawatsin, 2001). Isman (2006) stated that *Nicotiana tabacum* has a long history of use as an insecticide against soft-bodied pests but because of extreme toxicity of pure nicotine to mammals has seen its use declining gradually. Other plants reported as repellents include *Lippia* spp., *Ocimum* spp., *Tagetes minuta* (Maia and Moore, 2011; Shooshtari, 2013). *Lippia kituensis* was reported to have acaricidal activity (Kosgei et al., 2014 as cited in Nyabayo, 2015) while it was reported as having mosquito repellent properties (Amer and Mehlhorn, 2006 as cited by Manimaran and Cruz, 2014). No mention of use of *Capparis sepiaria* as a repellent was found in literature though a plant in the same family, *Capparis tomentosa*, has been reported as a repellent (Kishore et al., 2011). Similarly *C. volkensii* was reported as an antimalarial in literature (Ochieng' et al., 2012 as cited in Haque et al., 2012).

Method of use of the repellents

For the repellents that were commonly used, the

respondents were requested to elaborate on how they were utilised. The plant materials were used by placing in the room while fresh, smoking, as an infusion, powder and by boiling. Smoking method was applied to more repellents than the other methods with a total of six plant species being smoked. Smoking was done in different ways for instance, using repellent oil in lamps as was the case with neem oil and placing on wood stoves to produce smoke as was the case with *C. sepiaria*. Some fresh plants were placed in the room or near the bed and their strong smell would keep away the mosquitoes for example, *O. basilicum*, *T. minuta* and *O. americanum* (Table 4).

The neem plant, *C. volkensii* and *T. minuta* were used as powder which was applied on the body to repel the mosquitoes. Some of the repellents were used as an infusion whereby the plant was placed in boiled water and allowed to cool and the water was then used in a bath, which was the case for *Lippia kituensis* and *Lippia caviadora*. Boiling was also done where the plant was placed in boiling water and the steam was used to repel the mosquitoes. While most of the repellents could only be used in one way, others were used in more than one way. These include *O. americanum* that could be smoked, *T. minuta* used as a powder and both could be placed in room while fresh. Neem plant was smoked and was as well used as a powder. Maharaj (2010) recognized that communities in Africa had historically employed traditional methods to keep away mosquitoes by ways such as burning of cow dung or certain plants, or the placement of specific plant parts in and around the sleeping area. Innocent et al. (2014) reported that repellent plants were used by communities in Tanzania by: burning charcoal in containers placed at different locations inside the homesteads to generate smoke and volatile emissions, application of ground fresh materials or small pieces at selected places within the homesteads and soaking plant parts or powder in water and then spraying.

CONCLUSION AND RECOMMENDATIONS

From this study, it was noted that there are many indigenous plants in use by communities within Mt. Kenya region with potency for repelling mosquitoes, with some not reported previously as potential repellents. Further research is recommended on these plants to verify the chemistry of the compounds in the different species which can be extracted, formulated and dispensed in the control of malaria. It is also important for empirical studies to be done on efficacy of the repellents and potential toxicological properties of the plants.

Conflict of Interests

The authors have not declared any conflict of interests.

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