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Traditional sources of mosquito repellents in southeast Nigeria

Nsirim L. Edwin-Wosu, Samuel N. Okiwelu and M. Aline E. Noutcha

ABSTRACT

Information was obtained over two-years, in randomly-selected villages across six states *viz.*, Abia, Akwa Ibom, Bayelsa, Cross River, Enugu and Rivers in southeast Nigeria, from key informants (herbalists) on plant species used as repellents against malaria vectors. Twenty-four species in 16 families were identified. The Verbenaceae yielded 5 species, the Meliaceae 3 species and the Malvaceae and Labiatae 2 species each. *Duranta repens*, *Duranta plumeri* (Verbenaceae) and *Ocimum gratissimum* (Labiatae) were the most widely used. *Sida acuta* (Malvaceae) was used in four states. The data were compared to plant species used in other countries across the globe as mosquito repellents; this showed that southeast Nigeria has a potential array of plant species that may be sources of plant-based malaria vector repellents.

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INTRODUCTION

It is estimated that about 1 million deaths (range, 744,000-13,000,000) from the direct effects of malaria occur annually in Africa, more than 75% of them are often children (Snow *et al.*, 2001). There are two main strategies for malaria management: malaria prevention (vector control, prophylaxis and potential use of vaccines) and treatment (drugs and blood transfusions, among others). Two forms of vector control: Indoor Residual Spraying (IRS), Insecticide-Treated nets (ITNs) are generally applicable for reducing disease transmission (Enayati and Hemingway, 2010). IRS is currently being complemented by larval control measures in Integrated Vector Control Management (IVM). The threat of insecticide resistance, major operational and logistical challenges in many ecological settings in the use of larval control measures where high coverage of breeding sites is required to achieve impact (Pampana, 1969), have necessitated innovations in vector control for malaria. These include the development of new insecticides, attractants and repellents (Cordova *et al.*, 2006; Eko *et al.*, 2013).

For many chemists, an effective alternative to DEET (N, N-Diethyl-m-foluamide) for personal protection against mosquitoes and biting flies is the Holy Grail (Isman, 2006). In spite of five decades of research, no chemical has been found that provides the degree of protection against biting mosquitoes or persistence on human skin afforded by DEET (Peterson and Coats, 2001). Concerns with the safety of DEET, especially in children have resulted in the search for natural alternatives (Isman, 2006).

Scientific literature in the past 3 decades describes many isolated plant secondary metabolites that show feeding deterrent or toxic effects to insects in laboratory bioassays, and botanical insecticides have been the subject of several recent publications (Koul and Dhaliwal, 2001; Regnault-Roger and Philogene, 2005). A recent study investigated the efficacy of a mixture of the repellent DEET and a non-pyrethroid insecticide (Propoxur) under laboratory conditions, against both pyrethroid-resistant and pyrethroid-susceptible mosquitoes with the knockdown resistance (kdr) mutation. The results showed that a combination of propoxur and DEET induced a knockdown effect and mortality as high as those by deltamethrin (a standard pyrethroid) against the susceptible strain and significantly higher efficacy against the pyrethroid resistant strain (Pennetier *et al.*, 2006). There was apparently a strong synergistic interaction between DEET and propoxur in mosquitoes. The study constituted a first step towards an alternative strategy for improving mosquito control in areas with pyrethroid resistance. Hill *et al.* (2007) confirmed the efficacy of a mixture of plant-based

insect repellent and insecticide treated nets to protect against malaria in high risk areas. Against this background, a study was undertaken over a 2-year period, 2011-2012, across 6 States in Southeast Nigeria to identify plant species used as repellents against mosquitoes.

MATERIALS AND METHODS

Near the coast, Mangrove and freshwater swamps are the dominant vegetation zones in the south; contiguous to these zones is the lowland rainforest; the most northerly zone is the savanna woodland. Data were obtained from the following States: Abia, Akwa-Ibom, Bayelsa, Cross River, Enugu and Rivers. Information collected over 2-years from 20011 to 2012, during fieldwork associated with Environmental Impact Assessment (EIA), for about 3-5weeks in the dry and rainy seasons at towns and villages in the 6 States. Data on plants were collected from identified key informants (herbalists) in these communities. Representative samples of named plant species underwent preliminary identification in the field. Confirmation was obtained by the use of several keys (Hutchinson and Datziel, 1954, 1958, 1963, 1968; Iven *et al.*, 1972; Burkill, 1997, 2000).

RESULTS AND DISCUSSION

Twenty-four plant species belonging to 16 families were identified: 5 species in the Verbenaceae, 3 in the Meliaceae, 2 in the Malvaceae and Labiatae while the other families were each represented by a single species each. Various parts of the plant were used: leaf, fruit, bark, seed and whole plant (Table 1). *Duranta repens*, *Duranta plumeri* (mosquito plants) in the Verbaceae and *Ocimum gratissimum* (scent leaf) in Labiatae were the most widely used across the 6 States as repellents. *Sida acuta* (wire weed) in Malvaceae was used in 4 States, while *Stachytampheta kayennensis*, *Stachytampheta jamauensis* (Verbenaceae), *Heinsis orinita* (Rubiaceae), *Citrus aurantifolia* (Rutaceae), *Paulllinia pinnata* (Sapindaceae), *Hyptis suaveolens* (Labiatae) and *Napoleonaea comporalis* (Lecychidaceae) were each used in 3 States.

In Tanzania, a species of the most widely-used genus in southeast Nigeria, *O. kilimandscharicum*, was effective against *An. gambiae s.s.* after a 4-year storage of its essential oil (Kweka *et al.*, 2008, 2009). Repellents are deployed to interrupt mosquitoes from the cues they perceive from hosts during blood feeding. *O. kilimandscharicum* blocks electrophysiological responses to olfactory sensory neurons attractive odours in *An. gambiae s.s.* (Syed and Leal, 2008). The major content of the oil is camphor and minor content, Linalool (Kweka *et al.*, 2008, 2009).

Similarly a species of the genus, *Eucalyptus*, recorded in this study, *Eu. maculate citriodon* was also found effective against the local malaria vector *Anopheles darlingi* in the Bolivian Amazon (Hill *et al.*, 2007) and, *An. gambiae* and *An. funestus* in Tanzania (Trigg, 1976). Other species recorded in this study have also been used as repellents in studies across the world. These include *A. indica*, effective against several anopheline and culicine species (Schumutterer, 2002) and *Lantana camara* in India and other south easter Asian countries (Dua *et al.*, 1996). The flora of Southeast Nigeria has a potential array of species that may serve as sources of plant-based repellents for mosquito control.

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Table 1. Plant species used as mosquito repellents in six states of in southeast Nigeria

Species	Family	Common Name	Parts of Plant Used	States
Sida acuta Burn. F.	Malvaceae	Wire weed	Fresh leaf or dry leaf ash	Rivers
Sida cordifolia Linn.	Malvaceae	Mosquito weed	Leaf, Flower, Fruit	Abia, Rivers
Azadirachta indica A. Juss	Meliaceae	Neem	Leaf, Flower, Seed oil	Rivers, Bayelsa
Carapa procera DC.	Meliaceae	Kunda oil tree	Burnt ash, seed oil	Bayelsa
Khaya senegalensis (Desr.) A. Juss	Meliaceae	Mahogany	Wood ash, seed oil	Cross River
Eucalyptus camadulensis Dehnh.	Myrtaceae	Gum tree	Oil extract	Cross River
Boerhaavia diffusa Linn.	Nyctaginaceae	Pig weed	Whole plant	Bayelsa
Ludwigia leptocarpa (Nutt.) Hara.	Onagraceae	Water primerose	Whole plant	Rivers, Bayelsa
Sesamum indicum Linn.	Pedaliaceae	Beniseed	Leaf, Sap, Oil	Enugu, Bayelsa
Piper guineense Schum. & Thonn.	Piperaceae	Ashanti pepper	Fruit	Enugu
Hensia crinita (Afzel.) G. Tayl.	Rubiaceae	Bush apple	Leaf, Bark	Rivers, Akwa-Ibom, Cross River
Citrus aurantifolia (Christen) Swingle	Rutaceae	Lime	Fruit , Juice	Rivers, Enugu
Stachytapheta cayennensis (LC. Rich) Schau.	Verbenaceae	Rat's tail verveine	Whole plant	Abia, Rivers, Bayelsa
Stachytapheta jameaicensis Vahl.	Verbenaceae	Brazilian tea	Whole plant	Abia, Rivers, Bayelsa
Duranta rapens Linn.	Verbenaceae	Mosquito plant / golden dewberry	Leafs, Fruit, seed oil	Rivers, Abia, Enugu, Bayelsa, Cross River, Akwa- Ibom
Duranta plumeri Linn.	Verbenaceae	Mosquito plant	Whole plant	Rivers, Abia, Enugu, Bayelsa, Cross River, Akwa- Ibom
Lantana camara Linn.	Verbenaceae	Mosquito plant / Bahama tea	Whole plant	Rivers, Enugu, Bayelsa, Cross River, Akwa- Ibom
Azolla pinnata R. Br. var. *africana*	Azollaceae	African Mosquito fern	Whole plant	Rivers, Bayelsa
Microsorium sp Link.	Polypodiaceae	Epiphytic fern	Whole plant	Rivers, Bayelsa
Paullina pinnata Linn.	Sapindaceae	Bread & cheese	Whole plant	Abia, River, Akwa - Ibom
Ocimum gratissimum Linn.	Labiatae	Scent Leaf / mosquito plant	Whole plant	Rivers, Abia, Enugu, Bayelsa, Cross River, Akwa- Ibom
Hyptis saveolens Poit.	Labiatae	Bush tea	Leaf, Fruit	Enugu, Cross River, Akwa- Ibom
Napoleonaea imperalis P. Beauv.	Lecythidaceae	Napoleonaea	Leaf	Cross River, Akwa-Ibom, Rivers.
Nerium oleander Linn.	Apocynaceae	Oleander	Leaf	Cross River, Akwa-Ibom, Rivers.
Azolla pinnata R. Br. var. *Africana*	Azollaceae	African Mosquito fern	Whole plant	Rivers, Bayelsa
Microsorium sp Link.	Polypodiaceae	Epiphytic fern	Whole plant	Rivers, Bayelsa

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Nsirim L. Edwin-Wosu[1], Samuel N. Okiwelu[2, 3*], and M. Aline E. Noutcha[2]

[1]Department of Plant Science and Biotechnology

[2]Department of Animal and Environmental Biology

[3]University of Port Harcourt, Port Harcourt, Nigeria

*Corresponding Author's E mail: okiwelu2003@yahoo.com