

Malaria is one of the major public health problems in tropical Africa. The existing vector control tools are not sufficient to reduce the already escalating burden of the disease. The main aims of this study were to search for simple and cost-effective plant-based repellents against the main malaria vectors in Africa, and compare existing and alternative methods of utilizing the plants. The repellency of the following plants suggested by the ethnobotanical survey and the literature was evaluated against *Anopheles gambiae sensu stricto* Giles in experimental huts within a screen-walled greenhouse: *Ocimum americanum* Linnaeus, *Ocimum kilimandscharicum* Guerke, *Ocimum suave* Willd., *Lantana camara* L, *Azadirachta indica* Adrien Jussieu, *Hyptis suaveolens* Poit, *Lippia ukambensis* Spreng and *Corymbia citriodora* Hook. Thermal expulsion, direct burning, and intact potted plants were tested as alternative application methods. When thermally expelled (from modified traditional stoves), only *H. suaveolens* failed to repel mosquitoes, whereas the leaves of *C. citriodora* (74.5% repellency,  $p < 0.0001$ ), leaves and seeds of *O. suave* (53.1% repellency,  $P < 0.0001$ ) and *O. kilimandscharicum* (52.0% repellency,  $P < 0.0001$ ) were the most effective. Leaves of *C. citriodora* also exhibited the highest repellency (51.3% repellency,  $P < 0.0001$ ) by direct burning. Intact potted plants of *O. americanum*, *L. camara*, and *L. ukambensis* repelled on average 39.7, 32.4 and 33.3% ( $P < 0.0001$ ) of the mosquitoes respectively in semi-field experimental system.

The effectiveness of live potted plants and thermal expulsion in repelling *An. gambiae s.l.* and *An. funestus* was also estimated in traditional houses in western Kenya. *Ocimum americanum*, *L. camara* and *L. ukambensis* were tested in potted form, and *C. citriodora*, *O. kilimandscharicum* and *O. suave* by thermal expulsion. All plant species showed significant repellency against *An. gambiae s.l.*, with the highest repellency by *C. citriodora* (48.71%  $P < 0.0001$ ) followed by an equal level of repellency of *O. kilimandscharicum* and *O. suave* (44.54%,  $P = 0.001$ ) during application of plants by thermal expulsion. All the three also showed residual effects against *An. gambiae s.l.* Similarly, potted plants of *O. americanum* and *L. camara* repelled *An. gambiae s.l.* significantly (37.91%,  $P = 0.004$  and 27.22%,  $P = 0.05$  respectively). Thermal expulsion of *O. kilimandscharicum* significantly repelled *An. funestus* Giles, although none of the potted plants repelled this species.

Volatile oils extracted by steam distillation of plants (*O. americanum*, *O. kilimandscharicum*, *O. suave* *H. suaveolens* and *L. camara*) were also evaluated against *An. gambiae s.s.* The essential oils from all candidate plants showed complete protection for less than an hour, but this was 4 hours for the standard DEET. Gas chromatographic analysis of the volatiles emitted by thermally expelled *C. citriodora* revealed that the major constituents are citronellal, citronelol and *iso*-pulegol, and that of *O. kilimandscharicum* and *O. suave* are camphor and *trans*-methyl *iso*-eugenol, respectively. The major constituent from potted plants of *O. americanum* is  $\alpha$ -terpineole. This study showed that modifications of traditional practices represented by thermal expulsion and intact potted plants can reduce domestic exposure to malaria vectors. As such, they may represent a sustainable and readily applicable malaria vector control tool for incorporation into integrated vector management programs