Ethnobotanical survey in 2 communities in western Kenya revealed that the most commonly known repellent plants were *Ocimum americanum* L. (64·1%), *Lantana camara* L. (17·9%), *Tagetes minuta* L. (11·3%) and *Azadirachta indica* A. Juss (8·7%) on Rusinga Island, and *Hyptis suaveolens* Poit. (49·2%), *L. camara* (30·9%) and *O. basilicum* L. (30·4%) in Rambira. Direct burning of plants is the most common method of application for *O. americanum* (68·8%), *L. camara* (100%) and *O. basilicum* (58·8%). Placing branches or whole plants inside houses is most common for *H. suaveolens* (33.3 and 57·8% for the respective locations), *A. indica* (66·7 and 100%), and *T. minuta* (54·8 and 56·0%). The repellency of plants suggested by the ethnobotanical survey and other empirical information was evaluated against the malaria vector *Anopheles gambiae s.s.* Giles in experimental huts within a screenwalled greenhouse. Thermal expulsion and direct burning were tested as alternative application methods for the selected plants *O. americanum*, *O. kilimandscharicum* Guerke, *O. suave* Willd., *L. camara*, *A. indica*, *H. suaveolens*, *Lippia uckambensis* Spreng and *Corymbia citriodora* Hook. When thermally expelled, only *H. suaveolens* failed to repel mosquitoes, whereas the leaves of *C. citriodora* (74·5%, $P < 0·0001$), leaves and seeds of *O. suave* (53·.1%, $P < 0·0001$) and *O. kilimandscharicum* (52·0%, $P < 0·0001$) were the most effective. Leaves of *C. citriodora* also exhibited the highest repellency (51·3%, $P < 0·0001$) by direct burning, followed by leaves of *L. uckambensis* (33·4%, $P = 0·0004$) and leaves and seeds of *O. suave* (28·0%, $P = 0·0255$). The combination of *O. kilimandscharicum* with *L. uckambensis* repelled 54·8% of mosquitoes ($P < 0·0001$) by thermal expulsion. No combination of plants increased repellency by either method. The semi-field system described appears a promising alternative to full-field trials for screening large numbers of candidate repellents without risk of malaria exposure.