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Plant extracts as a source of bio-insecticide for mosquito control, review

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Abstract

Mosquitoes are the vectors of the major infectious diseases of Public Health concern such as Malaria, Dengue, Lymphatic filariasis, Yellow fever, Chikungunya and Zika virus causing morbidity and mortality in tropical and subtropical Africa and the present practice of using synthetic chemical insecticides to control mosquito vectors have result in the development of serious resistance, persistent pollution and damaging the ecosystem. This work reviewed the adulticidal activities of some plants extracts and oils: Lemon grass (*Cymbopogon citratus*), Spear mint (*Mentha piperita*), Lemon basil (*Ocimum citriodorum*), Coffee senna (*Senna occidentalis*), Purple dead-nettle (*Lamium purpurium*), and Ginger (*Zingiber officinale*) leaves extracted with different solvents and were established as effective bio-insecticide against different genus and species of mosquitoes which can be used as an alternative means of controlling the population of mosquito vectors that would be environmentally safe and support the ecosystem. According to the established results reviewed in this work, different solvent extracts of Lemon grass (*Cymbopogon citratus*), Spear mint (*Mentha*) and Coffee senna (*Senna occidentalis*) were observed to possess high adulticidal activities against different species of mosquitoes. Therefore, we conclude that the activities of plant extract against mosquito species depend on the solvent used in extracting the phytochemicals responsible in the responses. We recommended the use of these plants extract as bio-insecticide against mosquito vectors.

Keywords: Plant, extracts, adulticidal, mosquito, public health

Introduction

Insecticides of plant origin have been tested to be specific in action against target insects and are non toxic on the ecosystem and man as compared to the chemical compounds (Jeyabalan *et al.*, 2003) [12]. The Plants Phytochemical compounds have the potentials to kill and repel insects and also serve as deterrents to other insects, this is also projected as next generation alternative of mosquito control and intervention programmes (Chalannavar *et al.*, 2013) [5]. Insecticidal activities of botanical extracts have been reported against various mosquito species: *Aedes*, *Anopheles* and *Culex* but their adulticide action on the total life cycle stages of mosquitoes is still not clearly understood (Kandaswamy *et al.*, 2012) [14].

Plants extracts from varieties of plants including species of *Ocimum* spp. (Tawatsin *et al.*, 2001) [34], *Lantana camara* and *Mentha* species (Ansari, 2000) [1] *Eucalyptus species* (Collins and Brady, 1993) [6], *Vitex rotundifolia* (Grayson, 2000) [8], *Palargo species* (Matsuda *et al.*, 1996) [17], *Curcuma* sp. (Pitasawat *et al.*, 2003), species of *Conyza*, species of *Tetradenia*, and species *Tarhchonathu* Lippia, species of *Plectranthus* (Omolo *et al.*, 2004) [20], have been demonstrated to exhibit good insecticidal and repellent activities against mosquitoes.

Larger number of human Population in this world of about 80% depends largely in plants for its health care control of infectious and non infectious diseases (Werka *et al.*, 2007) [36]. Therefore, plants extracts are gaining acceptance in providing alternative majors in vector control of diseases and arboviruses due to their non toxicity, specificity, and are safe to the environment and ecosystem and have lesser effects to the flora and fauna (Ormancey *et al.*, 2000) [21].

Lemons Grass *Cymbopogon citrates*. Spreng

Cymbopogon citratus (Lemon grass): The name *Cymbopogon* was originally derived from the ancient Greek words kymbe (boat) and pogon (beard), referring to the beautiful green flower with a spike arrangement (Plants, 2003) [28].

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Citrus means lemon with scent leaves. *C. citratus* is originally a native of southwest Asia and now grows rapidly and widely around the globe mainly in the Africa, sub-tropical, tropical and savannah regions (Gupta and Jain, 1978)^[9]. It is a grass that grows perennially with infusions in the leaves that are used in various purposes such as in medicine as antimicrobial, anti-inflammatory and as sedative as well (Negrelle and Gomes, 2007).

Adulticidal activities of lemon grass

Lemon grass has since been used in ancient period to protect, kill and repel blood feeding insects such as mosquitoes in the history of human home habitation and even now in many countries people use this plant parts for protection against mosquitoes, midges and other flying arthropods (Karunamoorthi *et al.*, 2008). Extract from *Cymbopogon* species (*C. citratus*, *C. martini*, *C. nardus*) were tested both in the field and laboratory to be very effective against *Culex quinquefasciatus* and *Anopheles* mosquitoes (Ansari and Razdan, 1995) *Cymbopogon* species was also found to inhibited some life cycle development phases of *Aedes aegypti* mosquito— an arboviruses vector of dengue and yellow (Osmani and Sighamony, 1980)^[22]. The citrus from the *C.* extract and oil was also found to be effective against *Musca domestica* L. (Rani and Osmani, 1980)^[31]. More recently in a study by Siriporn and Mayura (2011) reveals that *Cymbopogon citratus* reveals higher mortality rates of (100%) against *Cx. quinquefasciatus*, *An. dirus*. and *Ae. aegypti*.

Spear Mint *Mentha piperita* L.

Plants of this genus *Mentha* are members of the family Lamiaceae. They comprise about 19 different species and 13 various hybrids (Peeyush *et al.*, 2011)^[26]. They are commonly known with their mint name as pepper mint which distinguishes them from other plants and which gives them such an aromatic smell (Punit and Mello, 2004)^[29]. They grow faster and occupy a grater spaces in the surroundings and respond a adaptive to a variety of weather and climatic conditions.

Adulticidal activities of Spear mint *Mentha piperita*

Adulticidal activities of extracts of *Mentha piperita* against mosquito vectors of diseases such as malaria, dengue, yellow fever, and viral encephalitis have been reported by (Nerio *et al.*, 2010)^[19]. Rim and Jee, (2006)^[32] and Pavela, (2008)^[25] both studies reported that *Mentha piperita* extracts are most effective against adult stage of *C. quinquefasciatus* with over 97% adult mortality when applied on contact and topical toxicity bioassay in laboratory. Yang *et al.* (2005)^[37] found out that the adulticidal activity of *M. piperita* extract against *Culex quinquefasciatus* in a fumigation study in laboratory reveals 97% mortality after 24 hour exposure period. Moreover, in a study by Pavela (2008)^[25] reveals that the insecticidal activity of several extracts of *Mentha* species such as (*M. pulegium* L., *M. citrata* Ehrh, *M. spicata* L.) against *Musca domestica* in a laboratory fumigation conditions and in a topical application bioassay. *M. pulegium* extract reveals the LD₅₀-4.7 g/cm² and become the most effective extracts while the remaining *Mentha* species were found to be effective at moderate rate.

Lemon Basil *Ocimum sanctum* L.

Lemon Basil is a member of family Lamiaceae comprising a

number of species getting to about 65 (Paton *et al.*, 2005)^[24]. The leaves of the members of this family have a fragrance lemon scent; they are highly aromatic and economically important. *Ocimum citriodorum* is a hybrid of the *O. basilicum* L. *O. americanum* L. The essential oils and extracts composed of terpenoids (Padma *et al.*, 1999)^[23]. However, the presence of flavonoids has also been reported by other researchers. The scent of this plant makes it useful as culinary, cooking purpose and ornamental herb. Some species of *Ocimum* have been shown to have insecticidal and antioxidant and anti microbial properties (Juliani and Simon, 2002)^[13].

Adulticidal properties of lemon basil (*Ocimum Sanctum*)

The adulticidal activity of *Ocimum sactum* have also been reported to have caused morphogenetic aberration and growth regulation against 4th instar larvae of *An. stephensi*, Similarly, in the same study, the extracts of 200 mg of *Ocimum sactum* have also been reported to stopped the post embryonic development of the *An. stephensi* larvae. In this study also, the *O. basilicum* have been found to be more active and cause high mortality in low concentration than *O. sanctum*. The eugenol extracted from *O. sanctum* induces 100% mortality at the concentration of 0.003ml/43.0cm³ in 30-35 min while methylchavicol extracts of *O. basilicum* causes 100% mortality at the concentration of 0.003 ml/43.0cm³ *An. stephensi*, *Aedes aegypti* and *Cx. quinquefasciatus* in 10-20 mins (Bhatnagar *et al.*, 1993)^[13].

Coffee Senna *Senna occidentalis* L.

Coffee senna also called weed that stinks or some called it “fedegoso” a member of the family Caesalpinaceae and subfamily Caesalpinioideae. This plant has long been used the ayurvedic believes in India as it has a huge medicinal purposes and importance (Arya *et al.*, 2010)^[2]. Several species of *Senna* survives as an annual herb in temperate warm areas to annual shrub and that exhibits a short-lived perennial shrub nature (Holm *et al.*, 1997)^[10]. It usually matures at a height of about 0.5 to 2.0m. Coffee *senna* produces a hard, tap root with relatively few branches and penetrates down the soil (Stevens *et al.*, 2001)^[33].

Adulticidal properties of Coffee Senna *Senna occidentalis*

The adulticidal activities of *Senna occidentalis* have been mentioned in the work of many researchers. Malviya and Sharma (2013)^[16] mentioned the insecticidal potentials of *Senna occidentalis* among with several medicinal and pharmacological benefits of the plant. In another study by Deepak *et al.*, (2014)^[7] the results obtained in the larvicidal activity of *Senna occidentalis* leave extract of petroleum ether and N-butanol against the larvae of *Cx. quinquefasciatus* results in 100% mortality at the concentration of 200 and 300 ppm (parts per million) respectively.

Ginger *Zingiber officinale* L.

Ginger (*Zingiber officinale*) a member of the family Zingiberaceae and popular popular spices that is used in all countries of the world. This perennial and creeping plant exhibit a long and elaborate leaves, yellowish and much times green flowers and with thick and strong rhizome. The root is a storage type and posses a pungent like taste. Ginger has widely been accepted because of its long history of medicinal importance for a century. It has also been reported by several

studies to possess a wide spectrum of botanical activities (Iqbal *et al.*, 2006) [11].

Adulticidal activities of Ginger *Zingiber officinale*

Ginger has historically been reported as a medicinal plant but few works were reported for its insecticidal properties against adult mosquito vectors (Veena *et al.*, 2005) [35]. Ginger (*Zingiber officinale*; *Zingiberaceae*) and lemon grass (*Cymbopogon citratus*; *Poaceae*) were evaluated in a study by Pushpanathan *et al.* (2008) [30]. for their larvicidal activity against *Culex quinquefasciatus* and *Aedes albopictus* and found a moderate percentage mortality of 40% after 24hour exposure.

Conclusion

In conclusion, various plants extracts and essential oils have been established to cause mosquito mortality due to the presence of phytochemicals in the plants. This review found that the activity of the plant extracts is relative to the type of extracting solvent used which is responsible for the bioactivity of the extract against various species of *Anopheles*, *Aedes*, and *Culex* mosquitoes. All the reviewed plants show the bioactivity at different percentage of mortality and at different doses.

Recommendation

We recommended these plants extract and essential oils that should be used to formulate bio-insecticide against different species of mosquito vectors for effectiveness in control and intervention measures.

More plant species should be screened to identify a large number of plants that could be potentially useful in mosquito control in the attempt to avoid resistance in mosquitoes as it observed in the synthetic insecticides.

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