Entomology, Ornithology & Herpetology

Baskar et al., Entomol Ornithol Herpetol 2016, 5:1
DOI: 10.4172/2161-0983.1000172

Review Article Open Access

Meliaceae Plant Extracts as Potential Mosquitocides-A Review

Kathirvelu Baskar[1]*, Subramanian Mohankumar[1], Venkatesan Sudha[1], Rajan Maheswaran[2], Subramaniyan Vijayalakshmi[3] and Manikkam Jayakumar[4]

[1]*Department of Ecotoxicology and Entomology, Bioscience Research Foundation, Porur, Chennai-600116, India*
[2]*Department of Zoology, Periyar University, Salem 636 011, Tamil Nadu, India*
[3]*Department of Hotel and Catering Management, Vels University, Chennai, India*
[4]*Department of Zoology, University of Madras, Guindy Campus, Chennai-600 025, India*

Abstract

Mosquitoes are responsible for the transmission of dreadful diseases such as Malaria, Dengue, Chikungunya, Lymphatic filariasis. An ecofriendly approaches made to control mosquito larvae by using plant extracts is alternative to synthetic pesticides for avoid the environmental hazards. In order to achieve control, knowledge about the interactions between the pest population and plant products is very much important. Many plant species exhibited mosquitocidal activity, among them meliaceae having potential activity against mosquitoes. For example *Azadirachta indica, Dysoxylum malabaricum, Khaya senegalensis, Lansium domesticum, Melia volkensii Melia azedarach, Turraea abyssinica, Turraea wakefeldii, Turraea mombassana and Trichilia roka*, were showed potential larvicidal activity against vector mosquitoes. Hence, there is a need to know the feasibility of using these plant extracts for the control of mosquito larva in the field condition. Since this plant is readily available and widely distributed, can be used as a cheap alternative to the conventional larvicides.

Keywords: Lymphatic filariasis; Insecticides; Encephalitis

Introduction

Mosquitoes are found throughout the world excluding the places which are completely frozen. Three fourth (3/4) of the existing mosquito species were native to tropical and Subtropical region. Mosquitoes are likely to transmit disease to more than two fifth (2/5) of the world population [1]. The major dreadful diseases such as Malaria, Chikungunya, Dengue, Filariasis and Japanese encephalitis were transmitted by mosquito bites. In order to reduce the awful diseases, extensive research has been done on mosquitoes for few decades. Researchers have also carried out numerous experiments in various fields that deals with their Systemic morphology, biology, physiology, behavior, ecology, and disease epidemiology, etc.,. More recently the advancements in genetics and Molecular biology also contributed significantly to the mosquito control strategy [2].

Vector control techniques face serious threats because of the emergence of resistance to synthetic insecticides. There are several types of biological control measures including the introduction of parasites, pathogens, predators etc., are used to target mosquitoes. These bio control using pathogens are generally done with microbial pathogens Bacillus thuringiensis israelensis (Bti) and Bacillus spaericus [3]. The crystalline protein inclusions produced during the process of sporulation that showed significant mortality of larval. On the other hand aquatic predators such as larvivorous fish (Gambusia affinis), predator mosquito larvae from Toxorhynchites sp. and Cyclopoid copepod, especially Mesocyclops sp., copepod used as effective biocontrol agents [4]. Plants are rich sources of bioactive compounds and synthesize a number of secondary metabolites to serve as defensive chemical for control the insect pests. Plants offer an advantage over than synthetic pesticide, which used as an alternative to chemical insecticides. Several plant species have been reported for mosquitocidal properties [5]. Nevertheless, only few were tested in the field condition [6]. This study mainly focuses on usage of plant based insecticides against important vectors mosquito.

Azadirachta Indica

Azadirachta indica constitute various types of active compounds, including limonoids of azadirachtin, salannin, deacetylgedunin, gedunin, 17-hydroxyazadiradione and deacetylnimbinthe which were evaluated against malarial vector *Anopheles stephensi*. The entire compound exhibited more than 50% mortality against the mosquitoes. Among them azadirachtin showed maximum biological activity of 95% against 1, 2, 3, 4 and 5th instar larvae, pupae and adult at 0.1 ppm concentration by Nathan et al. [7] and also reported that increased larval-pupal durations and reduced the adult longevity. Alouani et al. [8] tested azadirachtin against fourth instar larvae of *Culex pipens* at different concentration. It exhibited more than 85% larvicidal activity against *Cx. pipens* at 1 ppm and the Lethal concentration for 50% mortality (LC50) value was less than 0.50 ppm; also extracts showed an increased larval duration up to 19 days when compared to control Methanolic seed kernel extract of *A. indica* and *Melia azedarach* were tested against *Aedes aegypti* at 0.0033 to 0.05% concentrations with 25 and 30°C. The *A. indica* exhibited LC50 value of 0.044-0.063 and 0.056-0.017% for fed and unfed mosquitoes at 25 and 30° C respectively. While, *M. azedarach* showed LC50 value of 0.166-0.152% for unfed and 0.034-0.038% for fed mosquitoes at 25 and 30° C respectively. The study clearly indicates that there was no effect in temperature for mortality of mosquito. Further, this study clearly indicated that *A. indica* was superior then *M. azedarach* [9]. Nour et al. [10] tested the acetone, chloroform and ethanolic extracts of bark, root, leaf and seed of *A. indica* against the larvae of *Ae. aegypti* at 50, 100, 500 and 1000 ppm concentrations. Among them, acetone leaf extract and chloroform root extract possess 100% mortality at 1000 ppm on 24 h and the LC50 values

***Corresponding author:** Kathirvelu Baskar, Department of Ecotoxicology and Entomology, Bioscience Research Foundation, Porur, Chennai-600116, India, Tel: +91-8110009641; E-mail: suribaskar@hotmail.com

Received December 11, 2015; **Accepted** December 25, 2015; **Published** January 19, 2016

Citation: Baskar K, Mohankumar S, Sudha V, Maheswaran R, Vijayalakshmi S, et al. (2016) Meliaceae Plant Extracts as Potential Mosquitocides-A Review. Entomol Ornithol Herpetol 5: 172. doi:10.4172/2161-0983.1000172

were 50 to 837.5 ppm. Petroleum ether extract of *A. indica*, was tested against the Culex sp. at different concentrations (40, 35, 25 and 20%). A 100% larvicidal activity was observed at 35 and 40% concentration with the LC50 values of 14.3 ppm [11]. Batabyal et al. [12] tested the petroleum ether, carbon tetra-chloride and methanol extracts from seed of *A. indica* against the larvae of *An. stephensi*. Among the three extracts, the methanolic extract of *A. indica* showed maximum activity with minimum LC50 value of 15.25 and 12.70 ppm for 24 and 48 h, respectively. Maragathavalli et al. [13] tested the methanol and ethanol leaf extracts of *A. indica* against *Ae. aegypti* and *Cx. quinquefasciatus*. Result revealed that the methanolic extract of *A. indica* showed 90 and 70% mortality at 200 mg/100 ml and 150 mg/100 ml concentration against the larvae of *Ae. aegypti* and *Cx. quinquefasciatus* respectively. On the other hand, the ethanolic extracts of *A. indica* shows 85 and 90% mortality at 200 mg/100 ml concentration against *Ae. aegypti* and *Cx. quinquefasciatus*, respectively. The neem products of suneem (1%), formulated neem oil and neem powder were tested against the dengue vector *Ae. aegypti* at five different concentrations (2, 4, 6, 8 and 10 mg/l) with control. Suneem showed 100% mortality after 24 h at 10 mg/l and the LC50 value was 2 mg/l and formulated neem oil (1%) showed 64.71% larvicidal activity at 10 mg/l with LC50 value of 8 mg/l after 24 h treatment. The neem powder 0.3% also showed 82% larvicidal activity at 15 mg/l concentration on 24 h exposure and the LC50 value was 3 mg/l for 120 h treatment. Thus, the study portrays that 1% Suneem showed more effect than other neem product against *Ae. aegypti* larvae [14]. Dua et al. [15] reported that neem (*A. indica*) formulation exhibited LC50 value of 1.6 ppm (*Ae. aegypti*), 1.8 ppm (*Cx. quinquefasciatus*) and 1.7 ppm (*An. stephensi*) for larvicidal activity. In the field condition, neem oil formulation exhibited more than 90% population reduction of mosquito species. The neem oil exhibited LC50 value of 1.7, 1.7 and 1.8 ppm against *Ae. aegypti* when it was stored at different temperature (24 ± 2° C, 40 and 45° C),thus it may conclude that temperature not affect the efficacy of oil. Howard et al. [16] reported that aqueous extracts of wood and bark of neem showed a growth inhibitory activity of increased larval period upto 3rd instar larvae. The inhibitory effect (IE50) values of 0.07, 0.11 and 0.18 g/l obtained for 1st, 2nd and 3rd instar respectively, in case of pupae, the IE50 value was 58.16 g/l. The aqueous extract of *A. indica* was tested for the larvicidal potential against *Cx. quinquefasciatus* at 1, 2, 3, 4 and 5 ppm concentrations. All the concentrations showed more than 60% larvicidal activity, the maximum larvicdal activity of 99% was noticed at 5 ppm concentration and the LC_{50} and LC_{90} values were 0.53 and 3.423 ppm [17]. Fresh and air dried leaves of *A. indica* water extracts showed larvicidal activity against Cx.pipiens fatigans [18]. Abiy et al [19] reported that *A. indica* oil exhibited repellent activity against An. Arabiensis. Neem cake extract exhibited larvicidal and pupicidal activities against *Ae. aegypti* and the LC_{50} values of 106.53 and 235.36 ppm for larva and pupa respectively [20]. Medani et al. [21]. The neem aqueous extract exhibited larvicidal activity of 13-87% against mosquito. *Melia azedarach.*

The methanolic leaves and seed extract of *M. azedarach* was tested for larvicidal, pupicidal, adulticidal, oviposition deterrent and repellent activity against the malarial vector *An. stephensi*. The seed and leaf extract of M. azedarach showed more than 70% of larvicidal, pupicidal, adulticidal and repellent activity at 2% concentration. The extracts also inhibit the adult duration and fecundity of *An. stephensi* and the larval and pupal duration was increased [22]. The ethanolic extract of *M. azedarach* was studied for their larvicidal potential against *Cx. quinquefasciatus* and the LC_{50} value was 1.035 and 0.754 mg/l at 24 h and 48 h respectively; also it exhibited the histopathological changes, midgut of microvilli, epithelial layer and lumen and the research inferred that the histopathological observation support the larvicidal activity of M. azedarach extract against *Cx. quinquefasciatus* [23]. Coria et al. [24] reported that the ethanolic extracts of leaves and ripe fruits from M. azedarach were tested against the *Ae. aegypti* at 0.50, 0.75 and 1.00 g/l concentrations. All the concentration showed larvicidal activity. All the treatments of fruit extracts significantly inhibit the growth of larval, pupal and adult developmental period at maximum concentration. And also these extracts exhibited oviposition deterrent activity against tested mosquitoes. Based on the result leaf extracts was more active then fruit extract of M. azedarach against dengue vector. Bhargava [25] reported that M. azedarach was studied for their repellent activity against *Ae. Aegypti*, it showed protection time of 26-236 minute with 0.16-3.33 mg/cm2. Leaves of M. azedarach derived 2, 7.bis [2-[diethylamino]-ethoxy]fluorence exhibited larvicidal activity against *Ae. aegypti* and *Cx. Quinquefasciatus* and it shows LC50 of 7.94 and 13.58 ppm respectively [26]. Abiy et al. [19] reported that M. azedarach oil exhibited repellent activity against *An. Arabiensis.*

Turraea sp., Melia volkensii and Trichilia roka Ndung'u et al. [27] reported that methanol and chloroform extracts from *M. volkensii, Turraea abyssinica, T. wakefeldii, T. mombassana, Trichilia roka* against *An. gambiae*. All the extracts exhibited notable larvicidal activity. Maximum activity and least LC_{50} values of 63 and 97 ppm were obtained from chloroform extract of *T. mombassana* and *M. volkensii* respectively. Owino et al. [28] reported that the methanol and chloroform extract from T. abyssinica and T. cornucopia showed more than 90% larvicidal activity against *An. gambiae* and the LC_{50} values of methanol extracts were 265 and 202 ppm. In this study methanol extracts were more active than chloroform extracts. The limonoids derivatives from the root bark of *T. wakefeldii* exhibited larvicidal activity against *An. gambiae* [29].

Dysoxylum sp.,

The methanolic extracts of leaves from *D. malabaricum* were tested for larvicidal, pupicidal, adulticidal and anti-ovipositional activity against *An. stephensi*. At 4% concentration methanolic extract exhibited more than 90% larval, pupicidal and adulticidal activity against *An. stephensi*. Also it inhibits the reproductive potential of treated adult mosquitoes [30]. Nathan et al. [31] tested 3β, 24, 25-trihydroxycycloartane and beddomeilactone from ethyl acetate extracts of *D. malabaricum* and *D. beddomei* for larvicidal, pupicidal, adulticidal activity against *An. stephensi*. At the 10 ppm concentration of 3β, 24, 25- trihydroxycycloartane and beddomeilactone exhibited 90% larval mortality and oviposition deterrent activity; also both compounds completely inhibit growth of test insect. The result clearly indicates that the secondary metabolites from the *D. malabaricum* and *D. beddomei* showed considerable effects in the life stages of *An. stephensi*. Masur et al. [32] reported that leaves and callus extracts from *D. binectariferum* exhibited 97.5 and 98.75% larvicidal activity at 18000 and 2000 ppm concentration of leaves and callus extracts respectively.

Khaya Senegalensis

Shaalan et al. [33] reported that the acetone, ethanol, hexane and methanol seed extracts of *K. senegalensis* exhibited 100% larval mortality at 100 mg/L concentration and the LC_{50} values of extract of ethanol 5.1, hexane 5.08, methanol 7.62 and acetone 12 mg/L concentration of *K. senegalensis* against *Cx. annulirostris*.

Lansium Domesticum

Monzon et al. [34] reported that aqueous extract of *L. domesticum* showed larvicidal activity against *Ae. aegypti* and *Cx. quinquefasciatus*.

Conclusion

Instant use of chemical pesticides to control or prevent by many methods such as larvicidal, pupicidal, adulticidal, ovicidal, oviposition deterrent, repellent and growth inhibitory activities are effectively controlling the mosquito population. In this purpose pesticide consumption is very high in developed and developing countries. Due to excessive use of synthetic chemicals, the mosquitoes were developed the resistance and also it affects the non-target organism from aquatic ecosystem as well as terrestrial. Many researchers were confirmed that Meliaceae family inflicted significant mosquitocidal activity, among them *Azadirachta indica* proved superior mosquitocidal activity in all the bioassay. Formulation derived from neem and other potential plant could play an important role in controlling these vector mosquitoes. The prepared formulation will be multimode of actions for all the bioefficacy. It is concluded that the extracts of *A. indica* from melicease showed significant mortality against all the vector mosquitoes and considering the wide distribution and availability of this plant species among the Indian Sub – Continent throughout the year, this would be a potential source of insecticide for the control medically important vectors.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. de Omena MC, Navarro DM, de Paula JE, Luna JS, Ferreira de Lima MR, et al. (2007) Larvicidal activities against *Aedes aegypti* of some Brazilian medicinal plants. Bioresour Technol 98: 2549-2556.
2. Dimopoulos G, Christophides GK, Meister S, Schultz J, White KP, et al. (2002) Genome expression analysis of *Anopheles gambiae*: responses to injury, bacterial challenge, and malaria infection. Proc Natl Acad Sci U S A 99: 8814-8819.
3. Tetreau G, Alessi M, Veyrenc S, Périgon S, David JP, et al. (2012) Fate of *Bacillus thuringiensis* subsp. israelensis in the field: evidence for spore recycling and differential persistence of toxins in leaf litter. Appl Environ Microbiol 78: 8362-8367.
4. Kanniga S, Ramanibai R (2008) Laboratory evaluation of *Mesocyclops aspericornis* as a biocontrol agent of Aedes aegypti. Dengue Bulletin 32: 207-210.
5. Sukumar K, Perich MJ, Boobar LR (1991) Botanical derivatives in mosquito control: a review. J Am Mosq Control Assoc 7: 210-237.
6. Chowdhury N, Ghosh A, Chandra G (2008) Mosquito larvicidal activities of *Solanum villosum* berry extract against the Dengue vector *Stegomyia aegypti*. BMC Complement Altern Med. 8: 10.
7. Nathan SS, Kalaivani K, Murugan K (2005) Effects of neem limonoids on the malaria vector *Anopheles stephensi* Liston (Diptera: Culicidae). Acta Trop 96: 47-55.
8. Alouani A, Rehimi N, Soltani N (2009) Larvicidal activity of a Neem tree extract (Azadirachtin) against mosquito larvae in the republic of Algeria. Jordan J Biological Sci 2: 15-22.
9. Wandscheer CB, Duque JE, da Silva MAN, Fukuyuma Y, Wohlke JL, et al (2004) Larvicidal action of ethanolic extracts from fruit endocarps of *Melia azedarach* and *Azadirachta indica* against the dengue mosquito *Aedes aegypti*. Toxicon 44: 829-835.
10. Nour AH, Jessinta S, Nour AH (2012) Larvicidal activity of extracts from different parts of neem (*Azadirachta indica*) against *Aedes aegypti* mosquitoes' larvae. Scientific Res Essays 7: 2810-2815.
11. Okigbo RN, Okeke JJ, Madu NC (2010) Larvicidal effects of *Azadirachta indica*, *Ocimum gratissimum* and *Hyptis suaveolens* against mosquito larvae. J Agric Technol 6: 703-719.
12. Batabyal L, Sharma P, Mohan L, Maurya P, Srivastava CN (2007) Larvicidal efficiency of certain seed extracts against *Anopheles stephensi*, with reference to *Azadirachta indica*. J Asia-Pacific Entomol 10: 251-255.
13. Maragathavalli S, Brindha S, Kaviyarasi NS, Annadurai B, Gangwar SK (2012) Mosquitoes larvicidal activity of leaf extracts of Neem (*Azadirachta indica*). International J Adv Biol Res 2: 138-142.
14. Ndione RD, Faye O, Ndiaye M, Dieye A, Afoutou JM (2007) Toxic effects of neem products (*Azadirachta indica A.Juss*) on *Aedes aegypti* Linnaeus 1762 larvae. African J Biotechnol 6: 2846-2854.
15. Dua VK, Pandey AC, Raghavendra K, Gupta A, Sharma T, et al. (2009) Larvicidal activity of neem oil (*Azadirachta indica*) formulation against mosquitoes. Malar J 8: 124.
16. Howard AF, Adongo EA, Hassanali A, Omlin FX, Wanjoya A, et al. (2009) Laboratory evaluation of the aqueous extract of *Azadirachta indica* (neem) wood chippings on Anopheles gambiae s.s. (Diptera: Culicidae) mosquitoes. J Med Entomol 46: 107-114.
17. Tandon P, Sirohi A (2010) Assessment of larvicidal properties of Aqueous extracts of four plants Against *Culex quinquefasciatus* Larvae. Jordan J Biological Sci 3: 1-6.
18. Rashid M, Ahmad A (2013) The effect of neem (Azedirachta indica) leaves extract of the ecdysis and mortality of immature stage of common house mosquito *Culex pipiens fatigans*. Biologia (Pakistan) 59: 213-219.
19. Abiy E, Gebre-Michael T, Balkew M, Medhin G (2015) Repellent efficacy of DEET, MyggA, neem (*Azedirachta indica*) oil and chinaberry (*Melia azedarach*) oil against *Anopheles arabiensis*, the principal malaria vector in Ethiopia. Malaria J 14:187.
20. Chandramohan B, Murugan K, Panneerselvam C, Madhiyazhagan P, Chandirasekar R, et al (2015) Characterization and mosquitocidal potential of neem cake-synthesized silver nanoparticles: genotoxicity and impact on predation efficiency of mosquito natural enemies. Parasitol Res.
21. Medani ME, Elkhidir ME, Satti AB (2015) Sensitivity of mosquito larvae to water extract of *Azadiracta indica* (Neem). J Sci. 5:147-150.
22. Nathan SS, Savitha G, George DK, Narmadha A, Suganya L, et al. (2006) Efficacy of Melia azedarach L. extract on the malarial vector *Anopheles stephensi* Liston (Diptera:Culicidae). Bioresource Technol 97: 1316-1323.
23. Al-Mehmadi RM, Al-Khalaf AA (2010) Larvicidal and histological effects of Melia azedarach extract of *Culex quinquefasciatus* Say larvae (Diptera:Culicidae). J King Saud Uni (Sci) 22: 77-85.
24. Coria C, Almiron W, Valladares G, Carpinella C, Luduena F, et al. (2008) Larvicide and oviposition deterrent effects of fruit and leaf extracts from *Melia azedarach* L. On *Aedes aegypti* (L.) (*Diptera: Culicidae*). Bioresource Technol 99: 3066-3070.
25. Bhargava S (2013) Phytochemical screening and evaluation of its repellent activity of *Melia azedarach* L. Indo Am J Pharmaceutical Res 3: 4310-4318.
26. Ramanibai R, Velayutham K2 (2015) Bioactive compound synthesis of Ag nanoparticles from leaves of *Melia azedarach* and its control for mosquito larvae. Res Vet Sci 98: 82-88.
27. Ndung'u M, Torto B, Knols BGJ, Hassanali A (2004) Laboratory evaluation of African Meliaceae as sources of larvicidal botanicals for *Anopheles gambiae*. International J Trop Insect Sci 24: 311-318.
28. Owino J, Hassanali A, Ndungu M (2014) Bio-Assay Guided Fractionation of Anti-Mosquito Limonoids from *Turraea abyssinica* and *Turraea cornucopia*. J Biofertilizer Biopest 5: 142.
29. Ndung'u M, Hassanali A, Hooper AM, Chhabra S, Miller TA, et al. (2003) Ring A-seco mosquito larvicidal limonoids from *Turraea wakefieldii*. Phytochemistry 64: 817-823.
30. Senthil Nathan S, Kalaivani K, Sehoon K (2006) Effects of *Dysoxylum malabaricum* Bedd. (Meliaceae) extract on the malarial vector *Anopheles stephensi* Liston (Diptera: Culicidae). Bioresour Technol 97: 2077-2083.
31. Nathan SS, Hisham A, Jayakumar G (2008) Larvicidal and growth inhibition of the malaria vector *Anopheles stephensi* by triterpenes from *Dysoxylum malabaricum* and *Dysoxylum beddomei*. Fitoterapia 79: 106-111.
32. Masur U, Kumar H, Kumar A (2014) Anti – larval effects of leaf and callus extract of *Dysoxylum binectariferum* against urban malaria vector, *Anopheles stephensi*. J Natural Prod 7: 147-154.

33. Shaalan EA, Canyon DV, Younes MW, Abdel-Wahab H, Mansour AH (2006) Efficacy of eight larvicidal botanical extracts from *Khaya senegalensis* and *Daucus carota* against *Culex annulirostris*. J Am Mosq Control Assoc 22: 433-436.

34. Monzon RB, Alvior JP, Luczon LL, Morales AS, Mutuc FE (1994) Larvicidal potential of five Philippine plants against *Aedes aegypti* (Linnaeus) and *Culex quinquefasciatus* (Say). Southeast Asian J Trop Med Public Health 25: 755-759.