Adulticidal activity of plant oil of *Lavandula latifolia* against the selected mosquito species

Kuppusamy Elumalai[1], Pappathi Thanigaimalai[1], Ezhilraj Ettiyappan[1], K.P. Sefeer[1], Jeganathan Pandiyan[2], Marimuthu Govindarajan[3and4], Govindaraju Chandru[2], Samidurai Jayakumar[2], Paramanandham Joothipillai[2], Kaliyamoorthy Krishnappa[2]

Article History
Received: 08-02-2020
Revised and Accepted : 14-08-2020
Published: 26-09-2020

https://doi.org/10.56343/STET.116.014.001.004

http://stetjournals.com

Abstract

Plant essential oils are emerging as competent mosquitocidal and repellent candidates and may act differently in different mosquito species. We studied the adulticidal efficacy of *Lavandula latifolia*L essential oil against three medically important mosquito species, *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus*. Under laboratory conditions, the LC_{50}values were 490.05ppm, 492.93ppm and 521.16ppm for *Ae. aegypti, An. stephensi* and *C. quinquefasciatus* respectively. The LC_{90}values were 923.45ppm,938.63ppm and 964.08ppm for for *Ae. aegypti, An. stephensi* and *C. quinquefasciatus* respectively. These findings elicited its possible role in combating with *Ae. aegypti, An. stephensi*and *C. quinquefasciatus*. Further studies on the application of such oil in the field are needed to pave the way for development of new green mosquitocide.

Key Words: *Ae. aegypti, An. Stephensi*and,*C. quinquefasciatus,. L.latifolia,* plant oil, ovicidal activity

INTRODUCTION

Mosquitoes are nuisance insect pests and disease vectors of dangerous human and animal diseases in Asia and other tropical and subtropical countries of the world (Nasci and Miller, 1996;). They act as a vector for malaria, yellow fever, dengue fever, chikungunya fever, filariasis, encephalitis, West Nile virus infection, *etc*., in the areas where mosquitoes are in prevalence (Molyneux et al., 2009; Bernhard et al., 2003).

Mosquito control to prevent the spreading of mosquito borne diseases and to improve quality of sustainable environment and the health status of public, mosquitocides such as organochlorine and organophosphate compounds were used as the major tool, earlier. During the last few decades, the indiscriminate application of several synthetic insecticides in mosquito control programme has been banned or limited mainly due to the insecticidal resistance pollution, and damaging effects on the ecosystems (WHO, 2010; Benedict *et al.,* 2007; Nirmala *et al.,* 2009). As a result, there is result in an urge to look for eco-friendly alternatives such as biological control has become the central focus of the control programme instead of the chemical insecticides (Mathivanan *et al.,* 2010; Krishnappa *et al.,* 2012a).

Plants and plant based secondary metabolites are explored under the biological control programme in mosquito control. Unlike conventional insecticides which are based on a single active ingredient, insecticides from plant's origin comprise a spectrum of chemical compounds. These compounds act concertedly in many processes by disturbing the insect's physiology or morphology. So, there is very less chance of developing resistance to such substances by the mosquitoes. For continued effective vector control management identifying bio-insecticides that are efficient, as well as being suitable and adaptive to ecological conditions, is imperative (Elumalai *et al.,* 2013; Krishnappa and Elumalai,2014; Elumalai and Krishnappa, 2014). More over, since the botanicals have broad spectrum of insecticidal properties, they could act as suitable alternative product in combating the mosquitoes. Hence, plant oil of the adulticidal

Kuppusamy Elumalai
email: *krishnappaprofessor@gmail.com*
[1]Department of Advanced Zoology and Biotechnology, Government Arts College (Autonomous), Chennai - 600 035, Tamil Nadu, India.

[2]Department of Zoology and Wildlife Biology, A.V.C. College (Autonomous), Mannampandal, Mayiladuthurai - 609 305, Tamil Nadu, India.

[3]Unit of Vector Control, Phytochemistry and Nanotechnology, Department of Zoology, Annamalai University, Annamalainagar - 608 002, Tamil Nadu, India.

[4]Department of Zoology, Government College for Women (Autonomous), Kumbakonam - 612 001, Tamil Nadu, India.

P - ISSN 0973 - 9157
E- ISSN 2393 - 9249

activity of *L. latifolia* was investigated on the adults of *Ae. aegypti, An. Stephensi* and *C. quinquefasciatus*.

MATERIALS AND METHODS

Preparation of the oil for the bioassay:

Plant oil, *L.latifolia,* was purchased from the distributor. 0.50mg, 0.100mg, 0.150mg, 0.200mg and 250mg oil was weighed and mixed with 250ml of double distilled water to obtain 200ppm, 400ppm, 600ppm, 800ppm and 1000ppm concentrations respectively with this 0.05ml of dimethyl sulphoxide (DMSO) was used as an emulsifier to blend the oil with water.

Adulticidal Bioassay:

The adulticidal activity of plant oil, *L.latifolia,* was determined by following the protocol given by World Health Organization (WHO, 1981). .Freshly moulted adult mosquitoes (0–24h old; sugar with multivitamin-fed, blood-starved mosquito) 30 nos. were collected from the insect rearing cage and gently transferred into a glass holding tube. The different concentrations (as mentioned earlier) of the plant oils were individually prepared in acetone and applied on filter papers (size 120×120mm). Acetone impregnated paper was used as control. The oils were impregnated on filter papers and the papers were left to dry at room temperature to evaporate off the acetone overnight. Impregnated papers were prepared fresh prior to testing. Adulticidal activity was conducted with two cylindrical glass tubes both measuring 100ml. One tube was used to expose the mosquitoes to the plant oil and another tube was used to hold the mosquitoes before and after the exposure periods. The impregnated papers were rolled and placed in the exposure tube. Each tube was closed at one end with a 12-mesh size cotton cloth. The selected experimental mosquitoes were released into the tube, and the mortality effects of the oils were observed every 15min for 3 h exposure period. At the end of exposure periods, the mosquitoes were placed in the holding tube. The above experiment was carried out in five replicates for each test concentration. Adulticidal activity was calculated by counting dead mosquito from the introduced mosquito.

$$\text{Mortality (\%)} = (\%A - \%B)/(100 - \%B) \times 100$$

Where, % A = % adult mortality in treatment and % B = % adult mortality in control. The LC_{50} and LC_{90} values were calculated using probit analysis (SPSS version 20, 2016).

Statistical analysis

Per cent mortality was corrected for control mortality using Abbott's formula (Abbotts, 1925). Results from all replicates for the oil were subjected to probit analysis using SPSS (v20.0) to determine $LC_{50}$and LC_{90}values and their 95 % confidence intervals (Sakuma, 1998). Samples for which the 95 % fiducial limits did not overlap were considered to be significantly different.

RESULTS

The adulticidal activity of *L. latifolia* oil was tested against the adult of *Ae. aegypti, An. stephensi*and *C. quinquefasciatus* with 200, 400, 600, 800 and 1000 ppm concentrations. The data pertaining to the experiment are shown in Tables and figures 1 to 3. It was observed that 22.4±1.4, 35.6±1.6, 65.6±1.6, 76.2±2.6 and 96.8±2.8.% adult mortality at 200, 400, 600, 800 and 1000 ppm concentrations, respectively, against the adults of *A. aegypti*. Similarly, 22.2±1.2, 35.6±1.6, 66.2±2.6, 75.4±2.8 and 95.6±2.8% adult mortality at 200, 400, 600, 800 and 1000 ppm concentrations, respectively, against the adults of *An. Stephensi*. Likewise, 18.4±1.6, 33.6±2.4, 63.8±2.8, 74.6±2.8 and 93.2±3.2% adult mortality at 200, 400, 600, 800 and 1000 ppm concentrations, respectively, against the adults of *C. quinquefasciatus*.

Moreover, the LC_{50} of 490.05ppm was recorded with the LCL and UCL of 444.24 and 532.45ppm, respectively, against the adults of *Ae. Aegypti.* In the same way, the LC_{90} of 923.45ppm was recorded with the LCL and UCL of 856.72 and 1011.84pm, respectively, against the adults of, *Ae. aegypti.* The LC_{50} of 492.93ppm was recorded with the LCL and UCL of 446.03 and 536.25 respectively was recorded against the adults of *An. stephensi.* In the same way, the LC_{90} of 938.63ppm was recorded with the LCL and UCL of 869.69 and 1030.45ppm, respectively, against the adults of *An. stephensi*. The LC_{50} of 521.16ppm was recorded with the LCL and UCL of 475.75 and 563.97ppm, respectively, was noted against the adults of *C. quinquefasciatus.* In the same way, the LC_{90} of 964.08ppm was recorded with the LCL and UCL of 894.47 and 1056.58ppm, respectively, against the adults of *C. quinquefasciatus.* At the same time, the probit responses showed by the *L. latifolia*oil tested on the adults of *Ae. Aegypti, An. stephensi and C. quinquefasciatus*were showed positive responses to the concentrations tested in the present experiment (Figures 4, 5 and 6).

DISCUSSION

In the present investigation, plant oil of *L. latifolia* oil showed statistically significant activity against adult mosquitoes of *Ae. aegypti, An. Stephensi* and *C. quinquefasciatus*. Our present findings go in hand in hand with the earlier findings of several authors. To quote few, Mahanta *et al.* (2019) evaluated the ovicidal, larvicidal, adulticidal and repellent activities of essential oil extracted from the leaves of *Lippia alba* against two medically important mosquito species,

Aedes aegypti and *Culex quinquefasciatus*, and indicated that the essential oil of *L. alba* has the potentiality to act more effectively as a repellent, followed by a larvicidal activity against mosquito and at the same time the results revealed differential vulnerability of different mosquito species and their life stages against a particular plant essential oil. .Cotchakaew *et al.* (2019). investigated the efficacies of 12 essential oil (EO) formulations from three *Zingebraceae* plants (*Alpinia galanga, Curcuma zedoaria,* and *Zingiber cassumunar*) individually and in combination with an augmenting *Eucalyptus globulus* EO against females of *Aedes albopictus* and *Anopheles minimus* and found that all formulations of Zingiberaceae plants EOs augmented with *E. globulus* and EOs were more effective in oviposition deterrent, ovicidal, and adulticidal activities against the two mosquito species. Abu Bakar *et al.* (2019) evaluated the *in vitro* activity of *Melaleuca cajuputi* essential oil leaf extract against *Aedes aegypt i*and *Aedes albopictus* and showed that *M. cajuputi* essential oil exhibited moderate toxicity effects against the larva and adults of *Aedes* species and proved that could be used as an alternative to chemical insecticide. Emmanuel *et al.* (2020) conducted a study to confirm the effectiveness and applicability of locally-

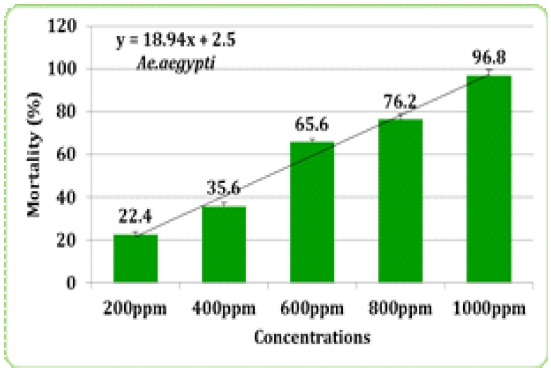

Fig. 1. Adulticidal activity of plant oil of *L. latifolia*tested against the larvae of *Ae. aegypti.*

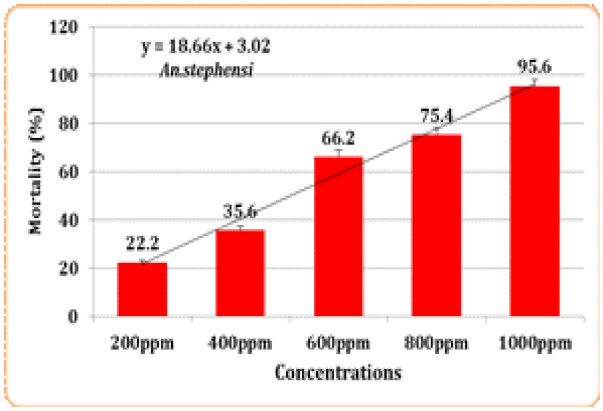

Fig. 2. Adulticidal activity of plant oil of *L. latifoli a* tested against *An. stephensi.*

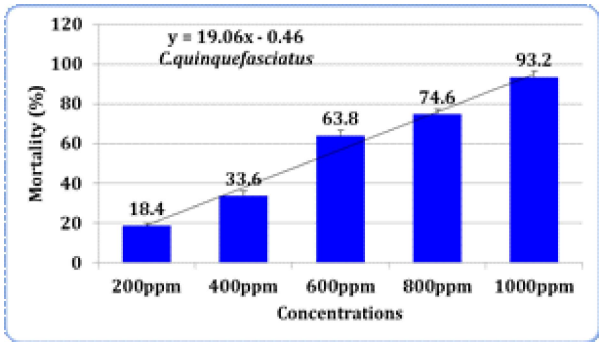

Fig. 3. Adulticidal activity of plant oil of *L. latifolia* tested against *C. quinquefasciatus*

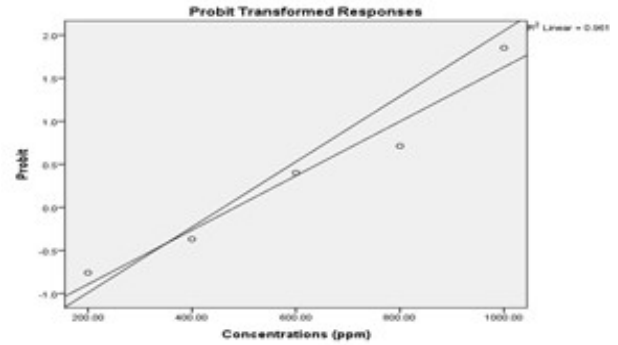

Fig. 4. Probit transformed responses observed on plant oil of *L. latifolia* tested against *Ae. aegypti.*

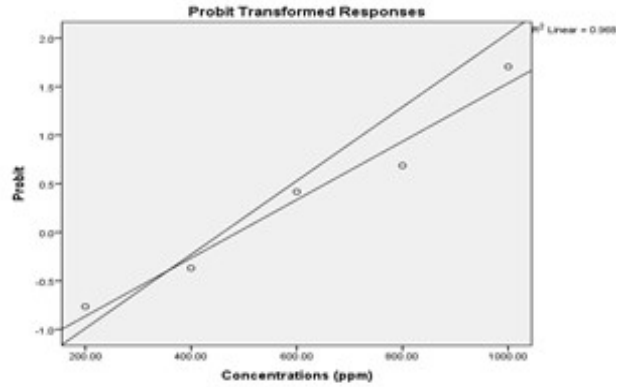

Fig. 5. Probit transformed responses observed on plant oil of *L. latifolia* tested against *An. stephensi.*

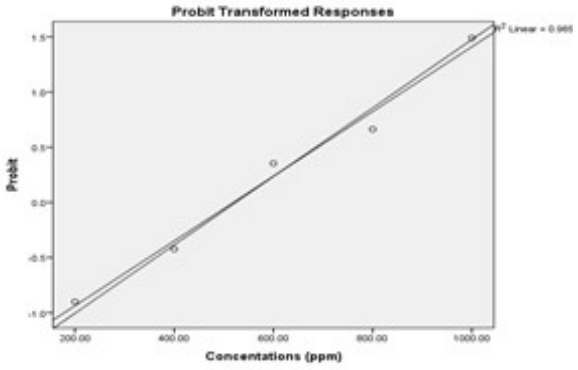

Fig. 6. Probit transformed responses observed on plant oil of *L. latifolia* tested against *C. quinquefasciatus*

Table 1. Adulticidal activity of *L. latifolia* tested against the selected mosquito species of *Ae. Aegypti, An. stephensi and C. quinquefasciatus*

Concentration (ppm)	Mortality* (%)	LC_{50} (LCL - UCL)	LC_{90} (LCL - UCL)
Aedesaegypti			
Control	1.6±0.8[a]	490.05 (444.24-532.45)	923.45 (856.72-1011.84)
200	22.4±1.4[b]		
400	35.6±1.6[c]		
600	65.6±1.6[d]		
800	76.2±2.6[e]		
1000	96.8±2.8[f]		
Anopheles stephensi			
Control	1.6±0.8[a]	492.93 (446.03-536.25)	938.63 (869.69-1030.45)
200	22.2±1.2[b]		
400	35.6±1.6[c]		
600	66.2±2.6[d]		
800	75.4± 2.8[e]		
1000	95.6±2.8[f]		
Culexquinquefasciatus			
Control	1.8±0.4[a]	521.16 (475.75-563.97)	964.08 (894.47-1056.58)
200	18.4±1.6[b]		
400	33.6±2.4[c]		
600	63.8±2.8[d]		
800	74.6±2.8[e]		
1000	93.2±3.2[f]		

Values expressed mean ± SD of five replications. Values with different alphabets in the column differs statistically (DMRT, p<0.005)

produced Lemon grass oil as a mosquito repellent and adulticidal agent for the prevention of mosquito-borne diseases in Nigeria and concluded that volatile oils of Lemon grass possess mosquito (*A. gambiae*and *An. funestus*) repellent and adulticidal effects, especially at higher concentrations and suggested its potential use to reduce human mosquito contacts and hence mosquito-borne diseases and irritation caused by their bites could be prevented.

Oladipupo *et al*. (2019) evaluated the response of *Anopheles gambiae* (larvae and adults) from spatially different populations to acetone extracts of two botanicals, *Piper guineense* and *Eugenia aromatic,* and demonstrated that any future use of botanicals as alternative eco friendly vector control chemicals needs to be closely monitored because they do not develop resistance. Cotchakaew et al. (2018) studied the efficacies of essential oils from the members of Llliciaceae and Zingiberaceae as oviposition deterrent, ovicidal, and adulticidal agents against females *Aedes albopictus*(Skuse) and *Anopheles minimus* (Theobald). Rijusarma *et al*. (2019) prepared twenty-eight combinations of plant essential oil-based terpene compounds and tested against larval and adult stages of *A. aegypti* and the result revealed that , the combination of Temephos and Diallyldisulfde and combination of Malathion and Eudesmol were the most efective combination. These effective combinations bear potential prospect to be used against *A. aegypti.*

CONCLUSION

Application of plant oil to control the mosquitos has proven to be the best strategy in integrated vector control program. As a part of it, the present investigation on the adulticidal activity of *L. latifolia* elicited its possible role to combat *Ae. aegypti, An. stephensi*and *C. quinquefasciatus*. Further studies regarding the application of such oil in the field will improve the way for development of new ecofriendly mosquitocide in the future.

ACKNOWLEDGEMENT

Authors are thankful to the Head, Department of Zoology and The Principal, Govt. Arts college for Men (Autonomous), Nandanam, Chennai for providing the laboratory facilities.

REFERENCES

Abbott, W.S. 1925. A method for computing the effectiveness of an insecticide. *J. Econ. Entomol.*,18: 265–267. https://doi.org/10.1093/jee/18.2.265a

AsmaMirza and AmtuzZehra. 2018. Bioefficacy of plant essential oils for the ovicidal, larvicidal and pupicidal activities against the Dengue vector *Ae. Aegypti. J. Entomol. Zool. Stud.*, 6(2): 1819-1823.

Benedict, M.Q., Levine, R.S., Hawley, W.A. and Lounibos, L.P. 2007. Spread of the tiger: global risk of invasion by the mosquito *Aedesalbopictus*. *Vect.Bor. and Zoonot. Dise.*, 7: 76-85. https://doi.org/10.1089/vbz.2006.0562

Bernhard, L., Bernhard, P. and Magnussen, P. 2003. Management of patientwithlymphoedema caused by filariasis in north-eastern Tanzania: alternative approaches. *Physio.* 89(12): 743-749. https://doi.org/10.1016/S0031-9406(05)60500-7

Cotchakaew, N. and Soonwera, M. 2018. Efficacies of essential oils from Lilliciaceae and zingiberaceae plants as oviposition deterrent, ovicidal, and adulticidal agents against females *Aedesalbopictus*(Skuse) and *Anopheles minimus* (Theobald). *Int. J. Agr. Tech.*, 14(5): 631 - 652.

Elumalai, K., Dhanasekaran, S. and Krishnappa, K. 2013. Larvicidal activity of Saponin isolated from *Gymnema sylvestre* R. Br. (Asclepiadaceae) against Japanese Encephalitis vector, *Culextritaeniorhynchus*Giles (Diptera: Culicidae). *Eur. Rev. Med. Pharmacol. Sci.*, 17: 1404-1410.

Finney, D.J.1971. *Probit analysis*. London: Cambridge University Press; P. 68–72.

FokoDadji Gisele Aurelie, BoboNgowe Manuela Pierre, NyegueMaximilienne Ascension and Tamesse Joseph Lebel, 2018. Chemical composition and biocide properties of *Clausenaanisata*(Rutaceae) essential oil against developmental stages of the malaria vector *Anopheles coluzzii. American Journal of Essential Oils and Natural Products*, 6 (1): 09-15.

Kaliyamoorthy Krishnappa, Kuppusamy Elumalai. 2014. Mosquitocidal activity of indigenenous plants of Western Ghats, *Achrassapota*Linn. (Sapotaceae) and *Cassia auriculata*L. (Fabaceae) against acommon malarial vector, *Anopheles stephensi* Liston (Culicidae: Diptera*). J. Coas. Life Med.*, 2(5): 402-410.

Krishnappa, K. and Elumalai, K. 2012a. *Abutilon indicum* and *Diplocyclospalmatus* botanical extracts against ovicidal,pupicidal and repellentactivities of *Aedesaegypti,Anopheles stephensi* and *Culexquinque fasciatus* (Diptera :Culicidae). *Asi. Pac. J. Trop. Biomed.*,1: 1-7.

Mahanta, S., Sarma, R. and Khanikor, B. 2019. The essential oil of Lippia alba Mill (Lamiales:Verbenaceae) as mosquitocidal and repellent agent against *Culexquinquefasciatus Say* (Diptera: Culicidae) and *Aedesaegypti* Linn (Diptera: Culicidae). *The Journal of Basic and Applied Zoology*, 80(1). doi:10.1186/s41936-019-0132-0. https://doi.org/10.1186/s41936-019-0132-0

Mathivanan, T., Govindarajan, M., Elumalai, K., Krishnappa, K. and Ananthan, A. 2010. Mosquito larvicidal and phytochemical properties of *Ervatamia coronaria* Stapf. (Family: Apocynaceae). *J. Vect. Bor. Dis.*, 47: 178–180.

Molyneux, D.H., Hotez, P.J., Fenwick, A., Newman, R.D., Greenwood, B. and Sachs, J. 2009. Nelected tropical diseases and the global funds.*Lancet*. 373: 296-7. https://doi.org/10.1016/S0140-6736(09)60089-1

Nasci, R.S. and Miller, B.R. 1996.Culicine mosquitoes and the agents they transmit. In: Beauty BJ, Marquardt WC. (Eds.), The Biology of Disease Vectors. Uni. Pre. Colo. 85–97.

Nirmala, A., Saroja, S., Vasanthi, H.R. and Lalitha, G. 2009. Hypoglycemic effect of *Basellarubra* in streptozotocin – induced diabetic albino rats. *J. Pharmaco. Phytothe.* 1: 025-030.

Oladipupo, S.O., Callaghan, A., Holloway, G.J. and Gbaye, O.A. 2019.Variation in the susceptibility of *Anopheles gambiae*to botanicals across a metropolitan region of Nigeria. PLoS ONE 14(1): e0210440. https://doi.org/10.1371/journal.pone.0210440

Rijusarma, Kamal Adhikari, Sudarshana Mahanta and Bulbuli Khanikor. 2019. Combinations of plant essential oil Based terpene Compounds as Larvicidal and Adulticidal Agent against Aedesaegypti (Diptera:Culicidae). Sci. Rep., 9(9471):1-1. https://doi.org/10.1038/s41598-019-45908-3

World Health Organization (2010). *Malaria*. Fact sheet No. 94. Geneva: World Health Organization. Available from: http://www.who.int/mediacentre/factsheets/fs094/en/.

World Health Organization, Guidelines for laboratory and fieldtesting of mosquito larvicides. Geneva: World Health Organization; [Online] Available from: http://apps.who.int/ iris / bitstream/10665/69101/1/WHO_CDS_WHOPES_GCDPP_2005.13, (2005)

https://doi.org/10.1093/jee/18.2.265a