MOSQUITO REPELLENT ACTION OF DURANTA PLUMIERI (VERBENACEAE) AGAINST CULEX QUINQUEFASCIATUS

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ABSTRACT

Objective: The objective of the study was to investigate the repellent activity of different extracts of Duranta plumieri against mosquito vector Culex quinquefasciatus.

Methods: Four different extracts (petroleum ether, chloroform, ethanol, and aqueous) of D. plumieri were evaluated for repellency test against mosquito vector C. quinquefasciatus Say (Diptera: Culicidae) in comparison with diethyltoluamide (DEET), which was used as a positive control.

Results: Results showed that chloroform extract was the most effective against mosquito vector even at a low dose. A direct relationship was observed with different concentrations of D. plumieri extract and the repellent activity. Moreover, all the extracts showed highly significant level of repellency as compared to DEET at 10% dosage till 5 h of exposure. Among all of these, chloroform extract showed significant repellency at 5% dosage till 4 h.

Conclusion: Chloroform extract of D. plumieri has the potential as an effective mosquito repellent and further studies are needed to isolate the marker compound responsible for this activity.

Keywords: Duranta plumieri, Culex quinquefasciatus, Mosquito repellent.
12 h (Light:Dark). Adult mosquitoes were fed with 10% sucrose. Adult mosquitoes were kept in mosquito cages and starved for overnight. Triplicates were prepared.

Repellent and control preparation
Repellent surface was prepared in a 6 cm diameter plastic bowl. Cotton was placed in adequate quantity in 250 ml plastic bowl. 10% solution of sugar was prepared in distilled water and cotton was soaked by pouring 230 ml of sugar solution into the plastic bowl. Top layer of cotton at the top was covered with a single layer of nylon net. In the remaining 20 ml, different concentrations of repellent were prepared. Different concentrations of extract, namely 2.5, 5, 10, and 10% were prepared by mixing 20 ml of sugar solution with the required quantity of extract and were poured evenly on the sugar soaked cotton in the above plastic bowl. In the same manner, 2% solution of DEET was prepared in 10% sugar soaked cotton for use as positive control and only 10% sugar soaked cotton was used as a negative control, respectively. Various test concentrations, namely 2.5, 5, 10, and 10% were prepared in distilled water using freshly made stock solution.

Repellency test
The repellency test was carried out in a room maintained at 27°C and 70% relative humidity. The mosquitoes along with cages were kept in the room. The plastic bowl containing cotton soaked in three different concentrations of extract of D. plumieri, namely 2.5, 5, 10, and 10% solution of sugar, DEET 2% (positive control) in 10% solution of sugar and 10% solution of sugar (negative control) were placed in four different corners and one in the center of the cage. Landing counts for 5 min were made at each hour for 6 h (0, 1, 2, 3, 4, 5, and 6 h). After observation of 5 min, the bowls were removed from the cage at each interval of time. To avoid evaporation, the bowl was covered and kept in the refrigerator. The position of bowls was interchanged for subsequent exposure.

Data analysis
Observations for mosquito cage studies were made with triplicates for the selected species of the mosquito. Rates of the mosquito landing on the treated bowls with different concentrations of the extract of D. plumieri 2.5, 5, 10, and 10%, DEET 2% and sugar (10%) were noted. Mean of the observations for was recorded for each. Results were expressed as average landing and percent repellency per exposure interval compared to control using the following formula [22].

\[ \% \text{ Repellency} = \frac{C - T}{C} \times 100 \]

Where, \( C \) = The mean number of landing on negative control (10% sugar solution); \( T \) = Mean number of landing on the repellents (DEET and extract of D. plumieri).

Statistical analysis
For evaluating the significant difference between the repellent activity of DEET and different extracts of D. plumieri at different concentrations, Student’s t-test was applied where \( p<0.05 \) was considered as the significant value.

**RESULTS**

The leaf extract of D. plumieri exhibited strong repellent activity against C. quinquefasciatus. There is a great difference between the mean number of mosquitoes landing on the control and the treated surface (Tables 1-4). The percent repellency of chloroform extract was maximum and varied from 90 to 69% against different concentrations at different observation periods (0 h, 1 h, 2 h, 3 h, 4 h, 5 h, and 6 h). The repellency rates at 0 h varied between 86 and 90% at different concentrations of D. plumieri extract. Petroleum ether, ethanol, and aqueous extracts also showed mosquito repellent activity but lesser than chloroform extract. Moreover, all the extracts showed a highly significant repellent activity.
significant level of repellency as compared to DEET at 10% dosage till 5 h of exposure. Among all of these, chloroform extract showed significant repellency at 5% dosage till 4 h.  

**DISCUSSION**

Chloroform leaf extract of *D. plumieri* showed up to 90% repellency against *C. quinquefasciatus* in laboratory bioassays. These results show that *D. plumieri* chloroform leaf extract is potentially an effective mosquito repellent. The efficacy of *D. plumieri* leaf extract is comparable with the currently used commercial repellent product DEET. Although DEET provided better and longer protection, it has certain health risks that should be considered while using it [23]. Nowadays, trend for the use of natural repellent products is gaining importance and several botanicals have been screened for mosquito repellent activity [24-27]. The petroleum ether extract of *justicia adhatoda* showed in vitro strong repellent action as it gave 100% protection against *C. quinquefasciatus* 180 min followed by *A. aegypti* for 210 min [28]. *Andrographis paniculata* ethanol extract proved mosquitocidal activity of 94.2% of mortality at 3.0 mg/cm² [29]. The methanol extract of *Eclipta alba* and *A. paniculata* produced maximum repellent activity against *Anopheles Stephensi* [30]. The maximum repellent activity was observed at 500 ppm in the methanol extracts of *Aegle marmelos, Acacia lineata,* and ethyl acetate extract of *Chamaecytisus hirsutus,* and the mean complete protection time ranged from 90 to 120 min against *Anopheles subpictus.* The hexane extract of *A. paniculata* showed a better mosquito repellent effect in comparison with *Acacia lineata* extract [31]. Neem oil showed 37.5% protection against *C. quinquefasciatus,* whereas, in the present study, the chloroform leaf extract of *D. plumieri* showed up to 90% repellency against the same species, but the efficacy declined after 2 h. Most of the plant-based repellents are shown to repel mosquitoes, but for short duration (few minutes to some hours). Most of the phytoconstituents are volatile; therefore, they provide repellent effect for a short duration after application and rapidly evaporate leaving the user unprotected [24]. Para-methane 3, 8 diol, a herbal repellent extracted from the leaves of lemon eucalyptus *Corymbia citriodora* (*Myrtaceae*) tree is an exception, which is less volatile than monoterpenes and provides effective repellency against a large number of insect vectors for several hours and it has been advised for use in disease-endemic areas by the Centers For Disease Control as it considered safe for human health [24]. More research is needed to develop new repellents from the substance of herbal origin that can provide effective mosquito control to reduce the indiscriminate use of DEET: *Diethyltoluamide.*

### Table 4: Percent repellency of the aqueous extract of leaf of *Duranta plumieri* against *Culex quinquefasciatus*

| Species                  | Doses (%) | Repellency in h (Mean±SEM) |
|--------------------------|-----------|----------------------------|
|                          |           | 0   | 1   | 2   | 3   | 4   | 5   | 6   |
| *Culex quinquefasciatus* | 2.5       | 75.6±1.76**  | 74.66±0.88  | 74.2±0.00  | 70.66±0.33  | 66.66±0.88  | 65.66±1.20  | 56.33±1.33  |
|                          | 5         | 77.3±1.20**  | 76.66±1.66** | 76.3±0.88  | 71±0.57    | 66.33±1.85** | 65.66±0.66  | 59.1±1.15   |
|                          | 10        | 81.6±0.88**  | 81.33±1.85** | 80.6±2.18** | 72.66±2.33**| 69.1±0.57**  | 68.0±0.57   | 63.33±1.20  |
| DEET                     | 95.6±0.33 | 97.33±0.33   | 97.33±0.33   | 98.33±1.20 | 93.66±0.88 | 92.66±0.33  | 90.3±0.33   |
| Sucrose                  | 9.6±1.85  | 6.3±1.85     | 8.66±0.33    | 7.3±1.33   | 7.3±1.33   | 8.3±0.88    | 8.3±2.02    |

*p=0.05 significant, **p=0.001 highly significant, SEM: Standard error of the mean, DEET: *Diethyltoluamide.*

**REFERENCES**

1. El-Hag EA, El-Nadi AH, Zaitoon AA. Toxic and growth retard ing effects of three plant extracts on *Culex pipiens* larvae (*Diptera: Culicidae*). Phyter Res 1999;13:385-92.
2. Barraud PJ. The Fauna of British India, Including Ceylon and Burma. Diptera. Vol. 5. Family *Culicidae.* Tribes Megarhinini and Culicini. London: Taylor and Francis, 1934. p. 1-463.
3. Hubble Z, Halouzka J. West nile fever a reemerging mosquito-borne viral disease in europe. Emerg Infect Dis 1999;5:643-50.
4. Service MW. Mosquitoes (*Culicidae*). London: Chapman and Hall; 1993.
5. Peterson C, Coats J. Insect repellents-past, present and future. Pestic Outlook 2001;12:154-8.
6. Mandal S. Repellent activity of *Eucalyptus and Azadirachta indica* seed oil against the filarial mosquito *Culex quinquefasciatus* Say (*Diptera: Culicidae*). India. Asian Pac J Trop Biomed 2011;1:109-12.
7. King WV. Chemicals Evaluated as Insecticides and Repellents at Orlando, Florida, Agricultural Handbook No. 69. Washington, D.C.: U.S. Department of Agriculture; 1954.
8. Jacobson M. Glossary of Plant Derived Insect Deterrents. Boca Raton: CRC press; 1990.
9. Sukukar M, Pheric MJ, Boober LR. Botanical derivatives in mosquito control: A review. J Am Mosq Control Assoc 1991;30:122-4.
10. Curtis CF, Lines JD, Lu B, Renz A. Natural and synthetic repellents. In: Curtis CF, editor. Appropriate Technology in Vector Control. Boca Raton, CRC Press; 1990. p. 75-92.
11. Hebbalkar DS, Hebbalkar GD, Sharma RN, Joshi VS, Bhat VS. Mosquito repellent activity of oils from *Vetiveri negro L.* Leaves. Indian J Med Res 1992;95:200-3.
12. White GB. The insect-repellent value of *Ocimum spp.* (Labiatabe): Traditional anti-mosquito plants. East Afr Med J 1973;50:248-52.
13. Trigg JK, Hill N. Laboratory evaluation of a eucalyptus based repellent against four biting arthropods. Phyther Res 1996;10:313-6.
14. Vinayagamoorthy P, Senthilkumar B, Patchiyappan KM, Kavitha R. Microencapsulated lemongrass oil for mosquito repellent finishing of knitted cotton wear. Asian J Pharm Clin Res 2017;10:303-7.
15. Ramar M, Ignacimuthu S, Manonmani P, Murugan K. Adul ticidal activity of botanical oils by impregnated paper assay against *Culex quinquefasciatus* Say. Int J Pharm Pharm Sci 2017;9:156-60.
16. El-Naggar ME, Mosallam SS. Insecticidal properties of some isolates from *Duranta repens.* J Egypt Soc Parasitol 1987;17:243-9.
17. Rathnasagar K, Thiyagaraj A. Larvicidal activity of *Lantana Indica* and *Vitex negundo* on *Culex quinquefasciatus.* Asian J Pharm Clin Res 2018;11:414-8.
18. Kekuda TR, Raghavendra HL, Shilpa M, Pushpavathi D, Peltar K, Siddiqua A. Antimicrobial, antiradical and insecticidal activity of *Gardenia gummifera* L. F. (*Rubiaceae*). Int J Pharm Pharm Sci 2017;9:265-7.
19. Castro O, Barrios M, Chinchilla M, Guerrero O. Chemical and biological evaluation of the effect of plant extracts against *Plasmodium berghei.* Rev Biol Trop 1996;44:361-7.
20. Patil VJ, Deshmukh MB, Maner ML. Antimicrobial and antifeedant activity of the extract of the plant *Duranta repens.* J Biotech Agric Ind Environ 2002;5:65-7.
21. Lobna MA, Naglal LN, Abdellatyy AS. Phytochemical investigation and antiviral activity of *Duranta repens.* J Appl Sci Res 2007;3:1426-33.
22. Ansari MA, Vasudevan P, Tandon M, Razdan RK. Larvicidal and mosquito repellent action of peppermint (*Mentha piperita*) oil.
23. Qiu H, Jun WM. Pharmacokinetic, formulation and safety of insect repellent N, N-diethyl-3-methylbenzamide (DEET): A review. J Am Mosq Control Assoc 1998;14:12-27.

24. Maia MF, Moore SJ. Plant-based insect repellents: A review of their efficacy, development and testing. Malar J 2011;10 Suppl 1:11.

25. Novak RJ, Gerberg EJ. Natural-based repellent products: Efficacy for military and general public users. J Am Mosq Control Assoc 2005;21:7-11.

26. Pålsson K, Jaenson TG. Plant products used as mosquito repellents in Guinea Bissau, West Africa. Acta Trop 1999;72:39-52.

27. Tuetun B, Choochote W, Rattanachanpichai E, Chaithong U, Jitpakdi A, Tippawangkosol P, et al. Mosquito repellency of the seeds of celery Apium graveolens L. Ann Trop Med Parasitol 2004;98:407-17.

28. Jayapriya G, Shoba FG. Larvicidal, ovicidal, adulticidal and repellent activity of Justicia adhatoda Linn (Acanthaceae) against Aedes aegypti Linn and Culex quinquefasciatus Say. Int J Rec Sci Res 2014;5:2321-7.

29. Kuppusamy C, Murugan K. Mosquitocidal effect of Andrographis paniculata Nees against the malarial vector, Anopheles stephensi Liston (Diptera: culicidae). Int J Integrative Biol 2009;5:75-81.

30. Govindarajan M, Sivakumar R. Mosquito adulticidal and repellent activities of botanical extracts against malarial vector, Anopheles stephensi Liston (Diptera: Culicidae). Asian Pac J Trop Med 2011;4:941-7.

31. Elango G, Rahuman AA, Bagavan A, Kamaraj C, Zahir AA, Rajakumar G, et al. Efficacy of botanical extracts against Japanese encephalitis vector Culex tritaeniorrhynchus. Parasitol Res 2010;106:481-92.