Journal of Agricultural Science; Vol. 6, No. 9; 2014
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Innovative Biocontrolling Method of Dengue Fever Vector, *Aedes aegypti* (Diptera: Culicidae)

Mohamed H. Madkour[1], Ahmed A. Zaitoun[2] & Fatma A. Singer[3]

[1] Environmental sciences Dept., Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz Univ., Jeddah, Saudi Arabia

[2] Arid Land Agriculture sciences Dept., Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz Univ., Jeddah, Saudi Arabia

[3] Deanship for Accommodation and Nutrition, Girls Section, King Abdulaziz Univ., Jeddah, Saudi Arabia

Correspondence: Mohamed H. Madkour, Environmental sciences Dept., Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz Univ., Jeddah, Saudi Arabia. Tel: 966-532-690-171. E-mail: madkour55@yahoo.com

Received: June 3, 2014 Accepted: July 3, 2014 Online Published: August 15, 2014

doi:10.5539/jas.v6n9p208 URL: http://dx.doi.org/10.5539/jas.v6n9p208

Abstract

The control of mosquitoes is an important public health concern around the world. The activity of petroleum ether extracts of *Dodonaea viscose*, *Lantana camara* and *Ruta chaliphenses* have been investigated towards larval development of *Aedes aegypti*. The plant extracts exhibits variable biological activity against *Ae. aegypti*. The greatest effect was observed with *Dodonaea viscose* and *Lantana* camara. They showed acute LC_{50} (2days) of 126.2, 136.9 and chronic LC_{50} (10 days) of 64.6 and 68.5 ppm, respectively. Larvae suffered chronic toxicities leading to 97.8% mortality using *Dodonaea viscose* and 95.6% using *Lantana* camara. Egg hatchability was significantly reduced in *Dodonaea viscose* and *Lantana* camara concentrations. All extracts concentrations of *Dodonaea viscose* and *Lantana camara* as well as higher extract concentration of *Ruta chaliphenses* caused significant high hindrance of subsequent larval development and consequently reduced both pupation and adult mergence. Drastic retardation of development was shown using *Dodonaea viscose* extracts (17.3, 7.4%) and *Lantana camara* extracts (19.3, 9.0%) from larval stage managed to pupal and adult stages, when reared in very low concentration (100 ppm) of the extracts. *Ruta chaliphense* was only more effective at higher concentrations. Hence, application of these extracts to *Ae. aegypti* mosquito breeding sites can be used as an innovative valuable alternative to the existing synthetic pesticides for the control of *Ae. aegypti*.

Keywords: petroleum ether extraction, toxicity, *Aedes aegypti*, *Dodonaea viscose*, *Lantana camara* and *Ruta chaliphenses*

1. Introduction

Insect transmitted diseases remain a major source of illness and death worldwide. Mosquitoes are still the world's number one vectors of human and animal diseases. These diseases including malaria, filariasis, yellow and dengue fever and Japanese encephalitis, contribute significantly to poverty and social debility in tropical countries (Jang, Kim, Ahn, & Lee, 2002; Rajkumar & Jebanesan, 2005). *Aedes aegypti*, the main carrier for viruses that cause dengue and dengue hemorrhagic and yellow fevers, is found majorly in the tropics and subtropics (Langat et al., 2012). There is no effective vaccine against dengue, and thus the only way of significantly lowering the incidence of this disease is through mosquito control (Malavige, Fernando, Fernando, & Seneviratne, 2004). The target of mosquito control is to prevent proliferation of mosquito borne diseases and to improve quality of environment and public health. Mosquitoes are conspicuous nuisance pests as well, even after massive efforts of eradication or control (El-Maghraby, Nawwar, Bakr, Helmy, & Kamel, 2012). The extensive use of chemical pesticides or insecticides resulted in inducing resistance by insect pests besides, residue contamination of human food, mammalian toxicity and environmental pollution (Domingues, Agra, Monaghan, Soares, & Nogueira, 2010). One alternative approach is the use of insecticides from natural origin, especially plant-derived products to resolve these problems (Elhag, Harraz, Zaitoun, & Salama, 1996). Several studies have emphasized the importance of research and development of herbal substances for controlling mosquitoes (Shaalan, Canyon, Younes, Abdel-Wahab, 2012). Sukumar, Perich, and Boobar (1991) listed and

discussed results of 344 plant species that only exhibited mosquitocidal activity. The phytochemicals derived plant recourses can act as larvicides, insect growth regulators, repellant and ovipositional attractant (Das, Baruah, Talukadar, & Das, 2003; Venkatachalam & Jebanesan, 2001). Extracts of onion, garlic, eucalyptus and tobacco are reported to control many plant pathogenic fungi and insects. The neem biopesticides is usually used for all biological materials and organisms, which can be formulated for use as pesticides for the control of pests (Praveena, Venkatasubbu, & Jegadeesan, 2012). Kumar, Dhamodaran, Nilani, and Balakrishnan (2012) found that the hole extracts of *Tephrosia purpurea* (L.) has larvicidal activity against the larvae of *Culex quinquefasiciatus*. The three plants of *Dodonea viscose*, *Lantana camara* and *Ruta chalepensis* are available in Saudi Arabia and used in folk medicine (Migahid, 1978). Mogahed and Gesraha (2005) found that the extract of *Dodonea viscosa* significantly reduced the infestation of cotton plant by many insect pests. Also, *Lantana camara* and *Ruta chalipenesis* were tested for their efficacy against parasitic bee mite, *Varroa destructor* and toxic effect against the mite (Zaitoun & Madkour, 2012).

Therefore, the main objective of the present study was to investigate the effect of petroleum ether extracts from three plant species: *Dodonea viscosa, Lantana camara* and *Ruta chalipensis* on egg hatchability and larval development in *Aedes aegypti* mosquitoes.

2. Materials and Methods

2.1 Insects

The mosquito *Ae. Aegypti*, larvae was collected from the natural sites located in Jeddah city, Saudi Arabia. Colonies were maintained in the laboratory. Mosquitoes were held at 27 ± 1 ^{o}C, 70 ± 5% RH, and photo regime of 14:10 h (light: dark). Adults were provided with a 10% sucrose solution as food source. Female mosquitoes were allowed to blood feed periodically from pigeon host. Larvae were reared in dechlorinated water under the same laboratory conditions and were fed with fish food. The experiments were carried out at the Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, Jeddah, Saudi Arabia.

2.2 Plant Collection and Extractions

Test materials, *Dodonaea viscose*, *Lantana camara* and *Ruta chaliphenses* were collected from different parts of Saudi Arabia, and were authenticated by a specialist from Faculty of Pharmacy, King Abdulaziz University, Saudi Arabia. Plant leafs were air dried in the laboratory, ground in a mortar and extracted with petroleum ether. One hundred grams of powder for each solvent separately were extracted three times with 300 ml of petroleum ether at room temperature. After 24 h, the supernatants were decanted, filtrated through filter paper and dried in a rotary evaporator to obtain a semi solid crude extract according to Chitra, Janardhan, Kameswara, and Nagaiah (1993). The dry extracts were kept in refrigerator until using for experiments.

2.3 Test Procedure

Stock solution of the three plant petroleum ether extracts were prepared by dissolving the dry extract in warm distilled H_2O (0.5 g/100 mL H_2O). Two drops of Tween. 80 as emulsifier were used to facilitate the dissolving of tested material in water. Different concentration of 100, 200, 300, 400 and 500 ppm were prepared from the stock solution. About 30 freshly laid eggs or 30 second instars larvae were transferred from the culture into plastic cups (8-cm diameter, 10 cm deep), each containing 30 ml of the desired concentration. Treatments were carried out in triplicate and control larvae received only 2 drop of Tween. 80 in distilled water. Larvae were fed *adlibitum* and kept under laboratory conditions. Larval mortalities were counted at 2, 4 and 10 days after treatment. Percentage of successful pupation and adult emergence were determined by monitoring on daily basis until all adults in the control have emerged.

Data were analyzed using maximum likelihood procedures and the effectiveness was expressed as LC_{50} values according to Finney (1971). Data were corrected for control mortality (Abbot, 1925). Egg hatchability data were analyzed by an analysis of variance. If significant differences ($p < 0.05$) occurred, means were separated by Duncan's multiple range test.

3. Results and Discussion

Data given in table (1) indicated the biological activity of petroleum ether extracts of *Dodonaea viscose*, *Lantana camara* and *Ruta chalepensis* against the 2rd instar larvae of *Ae. aegypti*. The mortality percentages of *Ae. aegypti* larvae, their LC_{50} values and 95% confidence limits at 2, 4, 10 days after treatment are shown in Table 1, 2. Data shows that 97.8 and 95.6% mortality of larvae reached after 10 days of exposure to 500 ppm of *D. viscose* and *L.camara* extracts, respectively. However, the lowest *D. viscose* concentration (100 ppm) caused 47.8% mortality after 2 days of treatment. *Ruta chalepensis* petroleum ether extract caused the lowest mortalities, whereas highest concentration (500 ppm) caused 84.4% mortality after 10 days of treatment compared to 3.3%

for the controls. Data of Table 2 showed significant differences. LC_{50} for second instars larvae were (126.18 and 64.56), (136.89 and 68.49) and (173.66 and 75.43) for *Dodonaea viscose*, *Lantana camara* and *Ruta chalepensis*, respectively after 2 and 10 days from exposure of larvae to plant extracts. *Dodonaea viscose* and *Lantana camara* were significantly more toxic at all exposure times than *Ruta chalepensis*.

Table 1. Effect of plant extract on the mortality percentages of larvae of *Aedes aegypti*

Plant Extract	Conc. (ppm)	% Mortality after		
		2nd day	4th day	10th day
Dodonaea viscosa	100	47.8	52.2	66.7
	200	56.7	67.8	77.8
	300	70.0	73.3	84.4
	400	81.1	85.6	92.2
	500	90.0	94.4	97.8
	control	00.0	00.0	03.33
Lantana camara	100	45.6	51.1	65.6
	200	54.7	68.9	74.4
	300	67.8	71.1	81.1
	400	80.0	83.4	91.1
	500	85.6	93.3	95.6
	Control	00.0	00.0	06.7
Ruta chalepensis	100	41.1	45.6	60.0
	200	46.7	62.2	66.7
	300	61.1	67.8	76.7
	400	71.1	75.8	81.3
	500	75.6	81.1	84.4
	Control	00.0	00.0	03.0

Table 2. LC_{50} values and 95% confidence limits of *Aedes aegypti* larvae in media containing petroleum ether plant extracts

Plant material	Assay time (days)	Slope	LC_{50} (95%CL)
Dodonaea viscosa	2	1.64	126.18 (96.55-164.68)
	4	1.83	104.25 (78.57-138.13)
	10	1.78	64.56 (41.84-99.30)
Lantana camara	2	1.66	136.89 (106.94-175.63)
	4	1.76	105.31 (78.70-140.69)
	10	1.62	68.49 (41.08-104.04)
Ruta chalepensis	2	1.37	173.66 (136.08-221.39)
	4	1.40	123.40 (89.67-169.52)
	10	1.19	75.43 (45.55-142.42)

Egg hatchability was significantly lower ($p<0.05$) in all extracts than control (Table 3). At 100 ppm concentration, *Dodonaea viscose* and *Lantana camara* had the most sever effect on egg hatching rate which were reduced by about 35% and 33.5% compared with 26% for *Ruta chalepensis*. At their highest concentration (500 ppm), the tree plant extract reduced egg hatchability percentages by about 90%, 87% and 69% for *Dodonaea*

viscose, *Lantana camara* and *Ruta chalepensis* respectively. In fact, about 90% of the emerging larvae died within the first 2 days in the *Dodonaea viscose* extract at this concentration.

Table 3. Egg hatchability percentages of *Aedes aegypti* in media containing plant extracts

Plant extract	Concentration(ppm)	Mean% Egg Hatchability*
Dodonaea viscosa	100	65.0 cd
	200	52.6 e
	300	45.7 f
	400	22.5 i
	500	10.3 j
Lantana camara	100	66.5 c
	200	54.9 e
	300	47.2 f
	400	26.7 i
	500	13.0 j
Ruta chalepensis	100	73.7 b
	200	61.3 d
	300	53.9 e
	400	40.6 g
	500	31.2 h
	Control	97.5 a

*Means followed by the same letter are not significantly different at 5% level, Duncan's multiple tests.

On the other hand all plant extracts had an evidence inhibitory effect even at their lowest concentrations (100 ppm), where the successful pupation were only 17.3, 19.3 and 39.3 for *Dodonaea viscose*, *Lantana camara* and *Ruta chalepensis*, respectively. Complete suppression of adult emerging was evident in the 500 ppm concentration of *Dodonaea viscose and Lantana camara*. The adult emerging percentages from the 100 ppm treatments were 7.4, 9.0 and 14.9 for *Dodonaea viscose*, *Lantana camara* and *Ruta chalepensis*, respectively (Table 4).

Table 4. Successful pupation and adult emergence of *Aedes aegypti* larvae reared in media containing plant extracts

Plant extract	Conc. (ppm)	% Successful pupation or adult emergence	
		Pupation	Adult emergence
Dodonaea viscosa	100	17.3	7.4
	200	12.2	3.7
	300	6.1	2.2
	400	1.1	0.0
	500	0.0	0.0
Lantana camara	100	19.3	9.0
	200	15.7	7.1
	300	8.4	5.3
	400	5.1	2.2
	500	0.0	0.0
Ruta chalepensis	100	39.3	14.9
	200	23.9	10.3
	300	14.3	7.5
	400	8.7	3.7
	500	2.1	0.0
	Control	96.7	93.2

Considerable biological activity related to toxicity and hindrance of growth and development of the larvae of *Ae. aegypti* has been observed with the petroleum ether extracts of the three plant materials investigated. Of the three plant extracts, *Dodonaea viscose* and *Lantana camara* were found to cause higher rate of mortality compared with *Ruta chalepensis*. Thus, the extract of *Dodonaea viscose* caused toxicity at 300 ppm concentration leading up to 70% larval mortality over a period of 48 hrours, and 84.4% mortality after exposure for 10 days. Praveena, Venkatasubbu and Jegadeesan (2012) found that *Dodonaea viscose* extract has antifeedant acivity against spotted bollworm. Also, Zaitoun and Madkour (2012) found that *L. camara* extract was very effective against *Varroa destructor*. Emam, Swelam, and Megally (2009) found that furocoumarin and quinolone alkaloid isolated from *Ruta chalepensis*, showed larvicidal and antifeedant activity against the cotton pest, *Spodoptera littoralis* larvae.

5. Conclusions

The results obtained in this study demonstrated the importance, the toxic, growth and development-retarding influence of the extracted plant materials, especially *Dodonaea viscose* and *Lantana camara* on *Ae. aegypti* mosquitoes. It is anticipated that such effects may be observable when these materials are applied in natural larval breeding habitats in rural as well as in urban localities. Moreover, application of these materials is not likely to leave harmful residues in the environment science they are naturally occurring among the local flora.

Acknowledgements

This project was funding by the Deanship of Scientific Research (DSR), King Abdulaziz University, Jeddah under grant no. 217-155-1433. The authors, therefore, acknowledge with thanks DSR technical and financial support.

References

Abbot, W. S. (1925). A method of computing the effectiveness of an insecticide. *J. Econ. Entomol., 18*, 265-267.

Chitra, K. C., Janardhan, R., Kameswara, R., & Nagaiah, K. (1993). Field evaluation of certain plant products in the control of brinial pest complex. *Indian J. Entoml., 55*(3), 237-240.

Das, N. G., Baruah, I., Talukadar, P. K., & Das, S. C. (2003). Evaluation of botanicals as repellents against mosquitoes. *J. Vec. Borne Dis., 40*(1-2), 49-53. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15119071

Domingues I, Agra, A. R., Monaghan, K., Soares, A. M., & Nogueira, A. J. (2010). Cholinesterase and glutathione-S-transferase activities in freshwater invertebrates as biomarkers to assess pesticide contamination. *Environ. Toxicol. Chem., 29*, 5-18. http://dx.doi.org/10.1002/etc.23

Elhag, E. A., Harraz, F. M., Zaitoun, A. A., & Salama, A. K. (1996). Evaluation of some wiled herb extracts for control of mosquitoes. *J. King Saud Univ., Agric. Sci., 8*, 135-1450.

El-Maghraby, S., Nawwar, G. A., Bakr, R. F. A., Helmy, N., & Kamel, O. M. (2012). Toxicological studies for some agricultural waste extracts on mosquito larvae and experimental animals. *Asian Paci. J. Trop. Biomed., 2*(7), 558-563. http://dx.doi.org/10.1016/S2221-1691(12)60097-5

Emam, A. M., Swelam, E. S., & Megally, N. Y. (2009). Furocoumarin and quinolone alkaloid with larvicidal and antifeedantActivities isolated from *Ruta chalepensis* Leaves. *J. Nat. Prod., 2*, 10-22.

Finney, D. J. (1971). *Probit analysis* (3rd edition). Cambridge: Cambridge University Pres.

Jang, Y. S., Kim, M. K., Ahn, Y. J., & Lee, H. S. (2002). Larvicidal activity of Brazilian plants against *Aedes aegypti* and *Culex pipiens* pallens (Diptera: Culicidae). *Agric. Chem. Biotechnol., 45*(3), 131-134.

Kumar, D., Dhamodaran, P., Nilani, P., & Balakrishnan, N. (2012). Larvicidal activity of *Tephrosia purpurea* (L.) against the larvae of *Culex quinquefasiciatus*. *J. Appl. Pharm. Sci., 2*(7), 219-221. http://dx.doi.org/10.7324/JAPS.2012.2735

Langat, B. K., Siele, D. K., Wainaina, C., Mwandawiro, C., Ondicho, J., Tonui, W. K., ... Mutai, C. K. (2012). Larvicidal effect of *Mundulea sericea (Leguminosaea)* plant extract against *Aedes aegypti* (L.) (Diptera: *Culicidae*). *Afr. J. Pharmacol. Ther., 1*(3), 106-109. Retrieved from http://www.uonbi.ac.ke/journals/kesobap/

Malavige, G. N., Fernando, S., Fernando, D. J., & Seneviratne, S. L. (2004). Dengue viral infections. *Postgrad. Med. J., 80*(948), 588-601. http://dx.doi.org/10.1136/pgmj.2004.019638

Migahid, A. M. (1978). *Flora of Saudi Arabia*. University Press, Riyadh, Saudi Arabia.

Mogahed, M. I., & Gesraha, M. A. (2005). Efficacy of *Dodonaea viscosa* plant extract on some insect pests

infesting cotton plants under field conditions. *Annals Agric. Sci. (Cairo), 50*(2), 739-747.

Praveena, R., Venkatasubbu, G. D., & Jegadeesan, M. (2012). Antifeedant activity of selected medicinal plants on *Earias vittella*. *J. Biopest., 5*(2), 96-99. Retrieved from http://www.jbiopest.com/users/LW8/efiles/Vol_5_2_96-99-12011.pdf

Rajkumar, S., & jebanesan, A. (2005). Oviposition deternt and skin repellent activities of *Solanum trilobatum* leaf extract against the malarial vector *Anopheles stephensi*. *J. Insect Sci., 5*, 1-3. http://dx.doi.org/10.1672/1536-2442(2005)005[0001:ODASRA]2.0.CO;2

Shaalan, E. A. S., Canyon, D. E., Younes, M. W. F., & Abdel-Wahab, H. (2012). Plant extracts as potential mosquito larvicides. *Indian J. Med Res., 135*(5), 581-598.

Sukumar, K, M., Perich, J., & Boobar, L. R. (1991). Botanical derivatives in mosquito control: a review. *J Am Mosq Control Assoc., 7*(2), 210-37.

Venkatachalam, M. R., & Jenbanesan, J. (2001). Larvicidal activity of *Hydrocotyle japonica* Thumb. (*Rutacae*) extract against *Culex quinquefasciatus*. *Journal Experimental Zoology, 4*(1), 99-101.

Zaitoun, A. A., & Madkour, M. H. (2012). Acaricidal activity of some plant extracts on parasitic bee mite, *Varroa destructor*. *J. Food. Agric. & Environ., 10*(3&4), 1153-1155. Retrieved from http://world-food.net/acaricidal-activity-of-some-plant-extracts-on-parasitic-bee-mite-varroa-destructor/