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Mosquito larvicidal potential of bark extracts of *Dalbergia* sp against *Culex* mosquito larvae

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Abstract
Mosquitoes are responsible for the transmission of various diseases like Malaria, Dengue, Chikungunya, Elephantiasis (Lymphatic Filariasis), Zika virus etc. To find an alternative to chemical larvicides which has developed resistance in mosquitoes, plant based extract as Bio-insecticide was tried here. Methanolic extracts of bark of *Dalbergia* sp. were tested against 4 th instar mosquito larvae of *Culex* sp. It was found that the methanolic extracts of bark of *Dalbergia* sp. were effective on mosquito larvae with a mortality of 88%. It can be concluded that plant based insecticides can be a great alternative for the mosquito control in near future.

Keywords: Mosquito larvae, larvicidal potential, larvicidal activity

Introduction
Mosquitoes have been an insect group which is infamous for their ability to transmit various diseases that can cause mild to serious health hazards not only to human beings but also to animals world-over [1] like malaria, dengue, chikungunya, Japanese Encephalitis, zika virus, yellow fever, Rift Valley fever (RVF) and Lymphatic Filariasis (Elephantiasis) by carrying pathogens inside them especially in the tropical countries [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]. Their ability to feed on one or more than one human host is helping the diseases getting spread at a large scale [11].
In the context of controlling mosquito population, chemical insecticides such as DDT, Malathion, Methoprene etc. were used in the business [12, 13, 14]. But with time, this approach proved to be problematic as it created insecticide resistance and also posed problems for human health. Hence, it was necessary to formulate nature friendly control measures of mosquitoes [15, 16, 17]. Plants can be considered as an alternative source of mosquito larviciding agents as they are supposed to be rich in bioactive compounds [18] and also they are naturally available, biodegradable and are least toxic to non-target organisms [19, 20]. This study is a similar attempt to identify mosquito larvicidal potency of bark of *Dalbergia* species against larvae of *Culex* species.

Materials and methods
Plant collection and extracts preparation
The *Dalbergia* bark samples were collected from Chikhaldara forest of Maharashtra, India during a Botanical study tour. The plant was later authenticated from Department of Botany, School of Life Sciences, SRTM University, Nanded. The bark was sun dried for six days after which it was powdered with the help of commercially available blender and then extracts were obtained through Soxhalet apparatus with methanol. By applying Whatman filter paper number 1, it was filtered through Buchner funnel. After complete evaporation, it was kept in refrigerator at 4 ˚C until further use. Stock solution was prepared by adding the extract in 1L of distilled water. After serial dilutions, various grades were prepared to be used against mosquito larvae.

Mosquito larval collection
The mosquito larvae were collected from nearby mosquito breeding grounds of Swami Ramanand Teerth Marathwada University, Nanded campus. They were washed using distilled water after which identification of the mosquito larvae was done up to genus level by following pictorial identification keys [28, 29, 30]. Only *Culex* larvae were selected for further investigation.

Mosquito larvicidal bio-assay
25 *Culex* larvae of third and fourth instar were introduced in test cups with 100 ml distilled water with the help of brush. It was followed by the addition of methanolic extracts of bark of *Dalbergia* species. The larvae were exposed for 24 h duration after which their mortality was checked and recorded [31].

Statistical analysis
The data obtained through this investigation was analyzed statistically by the following formula:

$$Mortality\ (\%) = X - Y \div X \times 100,$$

Where X = percentage survival in the untreated control and Y = percentage survival in the treated sample [31].

Results & discussion
Plant based mosquito larvicides are looked up as potent larviciding agents as they do not affect non-target organisms, they can be procured naturally and they are biodegradable as well. Through the present investigation, it was found that concentrated levels of methanolic extracts of bark of *Dalbergia* species exert negative effect on the growth of *Culex* species mosquitoes if added in considerable quantity i.e. high mortality in the mosquito larvae was recorded when moderately concentrated test extracts were added in test cups while in the control test cup, no larval mortality was found after 24 h exposure.. The results obtained here clearly show that least concentrated test extracts cause least mortality in the study.

Table 1

Concentrations (in %)	% mortality in quantity in ml			Mean of % mortality
	0.1 ml	0.5 ml	1ml	
0.00001	16	16	16	16
0.0001	16	20	24	20
0.001	24	24	32	26.66
0.01	32	40	48	40.66
0.1	48	52	64	54.66
1.0	64	68	88	73.33

In a study carried out in Morocco [32], high concentration yielded positive results in terms of larval mortality while some of the extracts did not give any mortality. In a similar approach by Abutaha *et al*. [33], chloroform extracts were found to be more effective compared to the other two extracts like methanolic and ethanolic extracts of xerophytic plants from Saudi Arabia. In New Delhi, in an experiment conducted by Kumar *et al*. [34], hexane extracts of leaf of Lantana camara were most effective whereas the least effective was that of the amla extracts. When R. communis extracts were tested for the larvicidal activity against *Aedes aegypti* and *Anopheles culicifacies*, the seed extracts showed promising results than that of the leaf extracts [35]. In another such study by Kamraj *et al* [36], bark methanolic extracts showed 100 % mortality against *An. subpictus* and *Cx. Tritaniorhynchus* but in the current study, though not complete, but methanolic extracts of bark of *Dalbergia* species has shown promising results against *Culex* species to be considered as an alternative.

Conclusion

Through the present study, it can be concluded that methanolic bark extracts of *Dalbergia* species has potential to be counted as another alternative to deal with the ever increasing population of mosquitoes. We also conclude that similar studies can be made to identify more potent bioactive compounds from plants.

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