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Larvicidal efficacy of four weed extracts against the filarial vector *Culex quinquefasciatus* Say (*Diptera: culicidae*) under laboratory conditions in, West Bengal, India

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Abstract
The growing need for sustainable mosquito control methods has led to increased interest in plant-derived larvicides. This study evaluated the larvicidal activity of extracts from four commonly found weed species—*Mikania micrantha*, *Anisomeles indica*, *Senna tora*, and *Lantana camara*—against *Culex* mosquito larvae. Plant materials were extracted using four different solvents: acetone, 70% ethanol, chloroform, and benzene. Larval mortality was observed after 24, 48, 72, and 96 hours of exposure at various concentrations (50, 100, 150, 200, 250, and 300 ppm). Among the tested plant species, *Senna tora* exhibited the most potent larvicidal effect, with LC_{50} values of 51.32, 49.65, 66.00, and 42.94 ppm at the respective time intervals. The results emphasize the importance of solvent polarity in extracting bioactive compounds responsible for larvicidal effects. This research supports the potential of locally available aquatic weeds as environmentally friendly alternatives to synthetic insecticides in vector control programs.

Keywords: Larvicidal effect, Weed extracts, *C. quinquefasciatus* larvae, Solvent extraction, Botanical mosquito control

Introduction
Mosquitoes are among the most important vectors of infectious diseases worldwide. They are responsible for transmitting a variety of illnesses, including malaria, dengue, chikungunya, yellow fever, tularemia, filariasis, and dirofilariasis. In particular, the *Culex* genus—commonly referred to as house mosquitoes—often breeds in stagnant water and is known to carry diseases such as the West Nile virus [1]

Interrupting the mosquito life cycle at the aquatic stage, especially during the larval phase, is one of the most effective methods for limiting both mosquito populations and the spread of disease. Traditionally, larvicidal control has depended on the use of synthetic chemical insecticides such as pyrethroids, organophosphates, and carbamates. However, overreliance on these chemicals has led to serious issues such as environmental pollution, bioaccumulation, and the emergence of insecticide resistance in mosquito populations [2]

Mosquito-borne diseases remain a significant public health challenge, especially in tropical and subtropical areas. According to the World Health Organization, these diseases result in over a million deaths each year. Consequently, there is growing interest in developing larvicidal agents that are both effective and environmentally sustainable [8].

In this context, plant-based products have emerged as promising alternatives. Various studies have shown that plant extracts—whether in the form of crude extracts, essential oils, or powders—possess notable larvicidal activity. The effectiveness of these botanical compounds is largely due to the presence of natural bioactive chemicals such as flavonoids, alkaloids, glycosides, and terpenoids. These compounds disrupt larval development and physiological processes, often through mechanisms different from those of synthetic insecticides, thereby reducing the likelihood of resistance development [7]

Given their ecological safety and novel modes of action, plant-derived larvicides represent a sustainable alternative for vector control. The current study focuses on evaluating the larvicidal activity of extracts from five commonly found weed species—*Mikania micrantha*, *Anisomeles indica*, *Senna tora*, *and Lantana camara*—against larvae of *Culex quinquefasciatus*. The extracts were prepared using four different solvents: acetone, 70% ethanol, chloroform, and benzene, to assess variations in activity based on solvent polarity

Materials and Methods

Experimental Location

This experiment was conducted in the entomology laboratory of Vidyasagar College, Salt Lake Campus, Kolkata under ambient laboratory conditions of 30±2 °C temperature, 75 + 5% relative humidity.

Collection of Test Mosquitoes Larvae

The larvae of *Culex quinquefasciatus* were collected from drains surrounding the areas of Vidyasagar College campus and were brought into the laboratory. The *C. quinquefasciatus* larvae were identified by their morphological characters. Larvae of *C. quinquefasciatus* mosquito were kept in separately in an aquarium using optimum conditions.

Collection of Plants

The leaves of *Mikania micrantha, Anesomeles indica, Senna tora, and Lantana camara leaves* were collected locally.

Preparation of Plant Extracts

The leaves were collected and then allowed to sun dried for 1 week. Then the leaves were finely grounded to powder using an electrical blender. After grinding the powdered leaves were transferred to the conical flasks. Then the 4 suitable solvents acetone, 70% ethanol, chloroform and benzene were used to homogenize the solution. These solutions were kept for 3 days in room temperature in the laboratory. The conical flasks were stirred gently for 3 time each day. After 3 days the top layer extract was isolated and kept in petri dish and then supernatant was discarded. The mixture collected in petri dish was dried in incubator for 2-3 days. Then after 2-3days the dried extract was obtained.

Larvicidal bioassay

Different concentration of the crude extracts was prepared by dissolving 0.2gms of crude extract in suitable milliliters of distilled water. The concentrations prepared were 50ppm, 100ppm, 150ppm, 200ppm, 250ppm, 300ppm. The concentrations were transferred to suitable cups. For each concentration 3 cups were prepared (labeled R1, R2 and R3). About 10 larvae were transferred using dropper, and were placed in large trays. The trays were then covered with newspaper filled with some holes for proper ventilation. The cups were observed after 24, 48, 72 and 96hrs. The number of dead larvae were counted after 24, 48, 72 and 96hrs and noted down respectively.

Statistical analysis

Statistical analysis of the experimental data was performed by using MS Excel 2020 and antilog calculator to calculate LC50 lethal concentration, regession analysis, co-efficient value, mean larval mortality, standard error etc. Profit analysis was done following Finney, 1952.

Results

During the present experiment 5 most common and locally available plant species leaf extracts were applied on the 4th instars larvae of *C. quinquefasciatus* at different time intervals. Mosquito larvae also show different morphological changes after exposure with different concentrations of five plants at different time. The results were presented in the following tables 1, 2, 3 and 4

Persentage mortality of *C. quinquefasciatus* larvae when exposed to different concentration of *Mikania micrantha* leaves extracts in 4 different solvents

It was revealed from Table: 1 that percentage mortality of *Culex quinquefasciatus* larvae when exposed to different concentrations of *Mikania micranatha* extracts in acetone after 24hrs of treatment was 30,33.33, 36.67,40, 46.67, and 50%. After 48hrs of treatment was 50, 53. 33, 56. 67, 60, 66.67 and 73.33%. After 72 hrs of treatment was70, 73.33, 76.67,80, 86.67, 90%. After 96 hrs of treatment was 86.67,90, 93.33, 96.67, 100 and 100%. Similarly, in ethanol after 24hrs of treatment was23.33, 36.67, 40, 46.67, 53.33, and 56.67%. After 48hrs of treatment was43.33, 56.67, 60, 70, 73.33 and 80%. After 72 hrs of treatment was 63.33, 76.67, 80, 83.33, 90 and 96.67%. After 96hrs of treatment was 80% 90% 90% 93.33% 96.67% 100% Similarly in chloroform after 24hrs of treatment was 10, 23.33, 30, 33.33, 53.33 and 56.67%. After 48hrs of treatment was 30, 50, 53.33, 60, 73.33 and 876.67%. After 72hrs of treatment was 60, 73.33, 80, 96.67, 100 and 100%. After 96hrs of treatment was 80, 90, 93.33, 100, 100 and 100%. Similarly, in benzene after 24hrs of treatment was 30, 40, 46.67, 56.67, 700 and 76.67%. After 48hrs of treatment was 60, 63.33, 70, 76.67, 90 and 96.67%. After 72hrs of treatment was 80, 83.33, 86.67, 90, 96.67 and 100%. After 96hrs of treatment was 93.33, 96.67, 100, 100, 100 and 100% in the same concentrations of 50, 100, 150, 200, 250 and 300ppm respectively (Table1).

Persentage mortality of *C. quinquefasciatus* larvae when exposed to different concentration of *Anesomeles indica* leaves extracts in 4 different solvents

It was revealed from Table: 2 that percentage mortality of *Culex quinquefasciatus* larvae when exposed to different concentrations of *Anesomeles indica* extracts in acetone after 24hrs of treatment was 20,23.33, 26.67, 30, 33.33 and 56.67%. After 48hrs of treatment was 36.67, 43.33, 46.67, 50, 53.33 and 73.33%. After 72hrs of treatment was 56.67, 60, 66.67, 70, 73.33 and 93.33%. After 96hrs of treatment was 76.67, 80, 86.67, 90, 100 and 100%. Similarly, in ethanol after 24 hrs of treatment was 10, 16.67, 20, 23.33, 43.33 and 46.67%. After 48 hrs of treatment was 36.67, 43.33, 50, 53.33, 60, and 70%. After 72 hrs of treatment was 60, 63.33, 70, 73.33, 80 and 90%. After 96hrs of treatment was 80, 83.33, 86.67, 90, 96.67, and 100%. Similarly, in chloroform after 24hrs of treatment was 3.33, 26.67, 36.67, 43.33, 63.33 and 73.33%. After 48 hrs of treatment was 43.33, 53.33, 60, 63.33, 83.33 and 93.33%. After 72hrs of treatment was 66.67, 73.33, 76.67, 80, 96.67 and 100%. After 96hrs of treatment was 76.67, 80, 83.33, 100, 100 and 100%. Similarly, in benzene after 24hrs of treatment was 26.67, 36.67, 50, 70, 73.33 and 80%. After 48hrs of treatment was 53.33, 56.67, 70, 76.67, 93.33 and 96.67%. After 72 hrs of treatment was 63.33, 76.67, 80, 83.33, 96.67 and 100%. After 96hrs of treatment was 83.33, 86.67, 90, 100, 100 and 100% in the same concentrations of 50, 100, 150, 200, 250 and 300ppm respectively (Table1).

Persentage mortality of *C. quinquefasciatus* larvae when exposed to different concentration of *Senna tora* leaves extracts in 4 different solvents

It was revealed from Table: 3 that percentage mortality of *Culex quinquefasciatus* larvae when exposed to different

concentrations of *Senna tora* extracts in acetone after 24hrs of treatment was 6.67,13.33, 23.33, 30, 43.33 and 50%. After 48hrs of treatment was 26.67, 33.33, 36.67, 46.67, 63.33 and 70%. After 72hrs of treatment was 56.67, 60, 63.33, 66.67, 83.33 and 93.33%. After 96hrs of treatment was 76.67, 80, 83.33, 86.67, 100 and 100%. Similarly, in ethanol after 24hrs of treatment was 3.33,20, 26.67, 33.33, 46.67 and 56.67%. After 48hrs of treatment was 26.67,40, 43.33, 53.33, 66.67 and 76.67%. After 72hrs of treatment was 56.67, 63.33, 66.67, 66, 70, 86.67 and 96.67%. After 96hrs of treatment was 76.67, 80, 86.67, 100, 100, and 100%. Similarly, in chloroform after 24hrs of treatment was 26.67, 36.67, 43.33, 63.33,70 and 76.67%. After 48hrs of treatment was 50, 56.67, 63.33, 80, 90 and 93.33%. After 72hrs of treatment was 56.67, 73.33, 80, 83.33, 100 and 100%. After 96hrs of treatment was 76.67,80, 93.33,100, 100 and 100%. Similarly, in benzene after 24hrs of treatment was 16.67, 20, 23.33, 30, 50 and 56.67%. After 48hrs of treatment was 36.67, 46.67, 53.33, 56.67, 66.67 and 76.67%. After 72hrs of treatment was 63.33,70, 73.33, 76.67, 83.33 and 100%. After 96hrs of treatment was 83.33, 86.67, 90, 100, 100 and 100% in the same concentrations of 50, 100, 150, 200, 250 and 300ppm respectively (Table2).

Persentage mortality of *C. quinquefasciatus* larvae when exposed to different concentration of *Lantana camara* leaves extracts in 4 different solvents

It was revealed from Table: 4 that percentage mortality of *Culex quinquefasciatus* larvae when exposed to different concentrations of *Lantana camara* extracts in acetone after 24hrs of treatment was 6.67, 13.33, 16.67,20, 30 and 40%. After 48hrs of treatment was 26.66,30, 33.33, 36.67, 46.67 and 60%. After 72hrs of treatment was 43.33, 56.67, 60, 66.67, 70 and 80%. After 96hrs of treatment was 73.33, 76.67, 96.67, 100 and 100%. Similarly, in ethanol after 24hrs of treatment was 10, 16.67, 20, 23.33, 30 and 43.33%. After 48hrs of treatment was 30, 40, 46.67, 50, 53.33 and 60%. After 72hrs of treatment was 56.67,60, 66.67, 70, 76.67 and 80%. After 96hrs of treatment was 76.67, 83.33, 86.67, 90, 100, and 100%. Similarly, in chloroform after 24hrs of treatment was 13.33, 23.33, 33.33, 53.33, 56.67, and 66.67%. After 48hrs of treatment was 33.33, 36.67, 60, 66.67, 73.33 and 83.33%. After 72hrs of treatment was 56.67, 60, 80, 90, 96.67 and 100%. After 96hrs of treatment was 76.67, 80, 100, 100, 100 and 100%. Similarly, in benzene after 24hrs of treatment was 10, 23.33, 36.67, 43.33, 60 and 70%. After 48hrs of treatment was 33.33, 43.33, 53.33, 60, 76.67 and 83.33%. After 72hrs of treatment was 50, 60, 66.67, 90, 100 and 100%. After 96hrs of treatment was 70, 83.33, 96.67, 100, 100 and 100% in the same concentrations of 50, 100, 150, 200, 250 and 300ppm respectively (Table2).

Table 1: Percentage mortality ± SE of C. quinquefasciatus larvae when exposed to different concentration of *Mikania micrantha* and *Anisomeles indica* extracts with 4 solvents and different time interval.

solvent	Concentration (ppm)	Mortality rate							
		Mikania micrantha				*Anisomeles indica*			
		24 hrs.	48 hrs.	72 hrs	96 hrs	24 hrs	48 hrs	72 hrs	96 hrs.
Acetone	50	3±0	5±0	7±0.33	8.66±0.33	2±0	3.66±0.33	5.66±0.33	7.66±0.33
	100	3.33±O.33	5.33±0.33	7.33±O.33	9±0.33	2.33±0.33	4.33±0.66	6±0.57	8±0.57
	150	3.36±0.88	5.66±0.88	7.66±0.57	9.33±0.57	2.66±0.33	4.66±0.33	6.66±0.33	8.66±0.33
	200	4±0.57	6±0.57	8±0.33	9.66±0.33	3±0.57	5±0	7±0.57	9±0.57
	250	4.66±0.57	6.66±0.66	9±0	10±0	3.33±033	5.33±0.57	7.33±0.33	10±0
	300	5±0	7.33±0.33	9.66±0.33	10±0	5.55±0.33	7.33±0.33	9.33±0.33	10±0
Ethanol	50	2.33±0.33	4.33±0.33	6.33±0.33	8±0.33	1±0	3.66±0.33	6±0	8±0
	100	3.66±0.33	5.66±0.33	7.66±0.33	9±0.33	1.66±0.66	4.33±0.33	6.33±0.33	8.33±0.33
	150	4±0.57	6±0.57	8±0.57	9±0.57	2±0	5±0.57	7±0.57	8.66±0.33
	200	4.66±0.33	7±0.33	8.33±0.33	9.33±0.33	2.33±0.33	5.33±0.33	7.33±0.33	9±0
	250	5.33±0.33	7.33±0.33	9±0	9.66±0.33	4.33±0.33	6±0	8±0	9.66±0.33
	300	5.66±0.33	8±0.33	9.66±0.33	10±0	4.66±0.88	7±0	9±0	10±0
Chloroform	50	1±0.57	3±0.57	6±0.57	8±0.57	0.33±0.66	4.33±0.33	6.66±0.33	7.66±0.33
	100	2.33±0.33	5±0.57	7.33±0.57	9±O.57	2.66±0.33	5.33±0.33	7.33±0.33	8±0.33
	150	3±0.57	5.33±0.33	8±0	9.33±0.33	3.66±1	6±0	7.66±0.33	8.33±0.33
	200	3.33±0.88	6±0.57	9.66±0.33	10±0	4.33±0.33	6.33±0.88	8±0	10±0
	250	5.33±0.56	7.33±0.66	10±0	10±0	6.33±0.33	8.33±0.33	9.66±0.66	10±0
	300	5.66±0.33	7.66±0.33	10±0	10±0	7.33±0.57	9.33±0.33	10±0	10±0
Benzene	50	3±0	6±0	8±0	9.33±0.66	2.66±0.33	5.33±0.57	6.33±0.33	8.33±0.88
	100	4±0	6.33±0.66	8.33±0.66	9.66±0.33	3.66±0.33	5.66±0.33	7.66±0.66	8.66±0.57
	150	4.66±1	7±1	8.66±0.88	10±0	5±0	7±0	8±0.57	9±0
	200	5.66±0.66	7.66±0.66	9±0.57	10±0	7±0	7.66±0.33	8.33±0.33	10±0
	250	7±0	9±0	9.66±0.33	10±0	7.33±0.33	9.33±0.33	7.66±0.33	10±0
	300	7.66±0.33	9.66±0.33	10±0	10±0	8±0	9.66±0.33	10±0	10±0

Table 2: Percentage mortality ± SE of C. quinquefasciatus larvae when exposed to different concentration of *Senna tora* and *Lantana camara* extracts with 4 solvents and different time interval.

Sample	Concentration (ppm)	Mortality rate							
		Senna tora				*Lantana camara*			
		24 hrs	48 hrs	72 hrs	96 hrs	24 hrs	48 hrs	72 hrs	96 hrs
Acetone	50	0.66±0.33	2.66±0.33	5.66±0.33	7.66±0.33	6.66±0.33	2.66±	4.33±0.66	7.33±0.33
	100	1.33±0.66	3.33±0.88	6±0	8±0	1.33±0.33	3±0	5.66±0.33	7.66±0.33
	150	2.33±0.33	3.66±0.33	6.33±0.66	8.33±0.33	1.66±0.33	3.33±0.33	6±0	9±0
	200	3±0	4.66±0.57	6.66±0.33	8.66±0.33	2±0	3.66±0.33	6.66±0.33	9.66±0.33
	250	4.33±0.33	6.33±0.33	8.33±0.33	10±0	3±0	4.66±0.33	7±0	10±0
	300	5±0	7±0	9.33±0.33	10±0	4±0	6±0	8±0	10±0
Ethanol	50	1±0.33	2.66±0.33	5.66±0.33	7.66±0.57	1±0	3±0	5.66±0.33	7.66±0.33
	100	2±0	4±0	6.33±0.33	8±0	1.66±0.33	4±0	6±0	8.33±0.33
	150	2.66±0.33	4.33±0.33	6.66±0.66	8.66±0.88	2±0	4.66±	6.66±0.33	8.66±0.33
	200	3.33±0.88	5.33±0.33	7±0	10±0	2.33±0.33	5±0	7±0	9±0
	250	4.66±0.57	6.66±0.33	8.66±0.88	10±0	3±0	5.33±	7.66±0.33	10±0
	300	5.66±0.33	7.66±0.33	9.66±0.33	10±0	4.33±0.33	6±0	8±0	10±0
Chloroform	50	2.66±0.33	5±0	5.66±0.33	7.66±0.33	1.33±0.33	3.33±0.33	5.66±0.33	7.66±0.66
	100	3.66±0.88	5.66±0.33	7.33±0.33	8±0	2.33±0.33	3.66±0.33	6±0	8±0
	150	4.33±0.33	6.33±0.33	8±0	9.33±0.33	3.33±0.33	6±0	8±0	10±0
	200	6.33±0.33	8±0	8.33±0.33	10±0	5.33±0.33	6.66±0.33	9±0	10±0
	250	7±0	9±0	10±0	10±0	5.66±0.33	7.33±0.33	9.66±0.33	10±0
	300	7.66±0.33	9.33±0.33	10±0	10±0	6±0	8.33±0.33	10±0	10±0
Benzene	50	1.66±0.33	3.56±0.33	6.33±0.33	8.33±0.56	1±0	3.33±0.33	5±0	7±0
	100	2±0	4.66±0.57	7±0	8.66±0.33	2.33±0.33	4.33±0.33	6±0	8.33±0.33
	150	2.33±0.33	5.33±0.33	7.33±0.33	9±0	3.66±0.66	5.33±0.33	6.66±0.33	10±0
	200	3±0	5.66±0.33	7.66±0.33	10±0	4.33±0.66	6±0	9±0	10±0
	250	5±0	5.66±0.33	8.33±0.66	10±0	6±0	7.66±0.33	10±0	10±0
	300	5.66±0.33	7.66±0.33	10±0	10±0	7±0	8.33±0.33	10±0	10±0

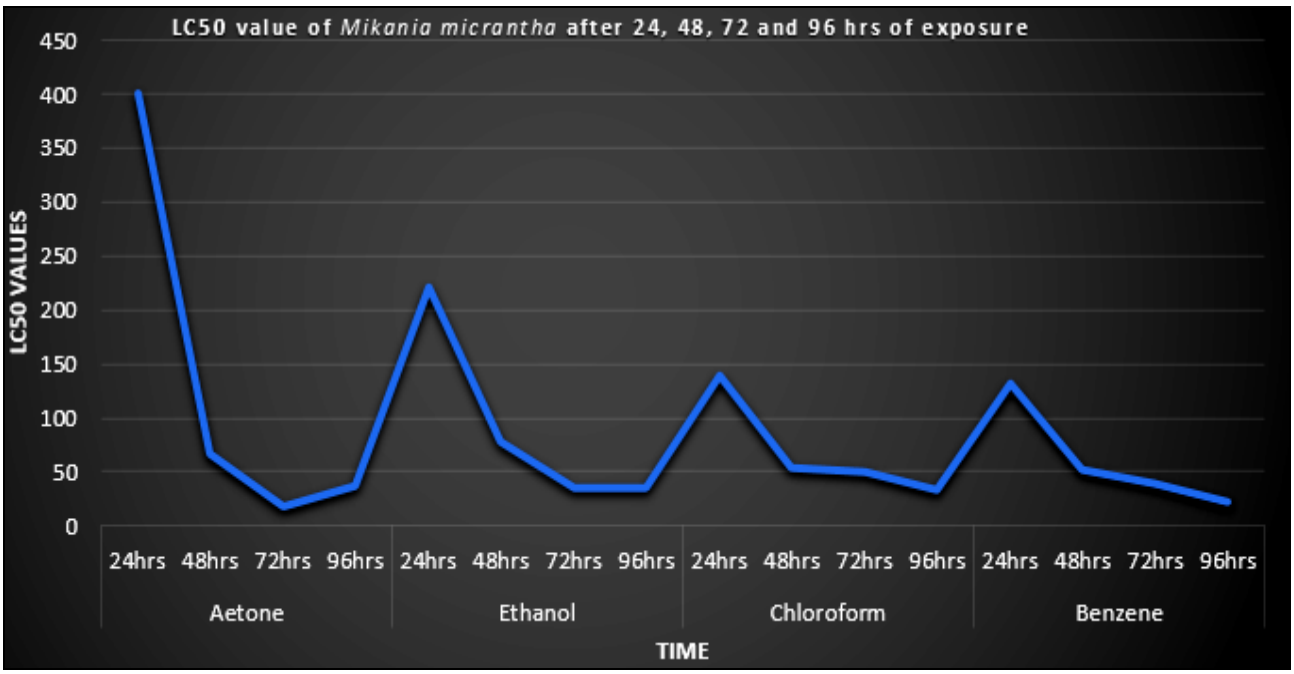

Fig 1: Graph showing LC50 values of Mikania Micranthes extract with 4 different solvents.

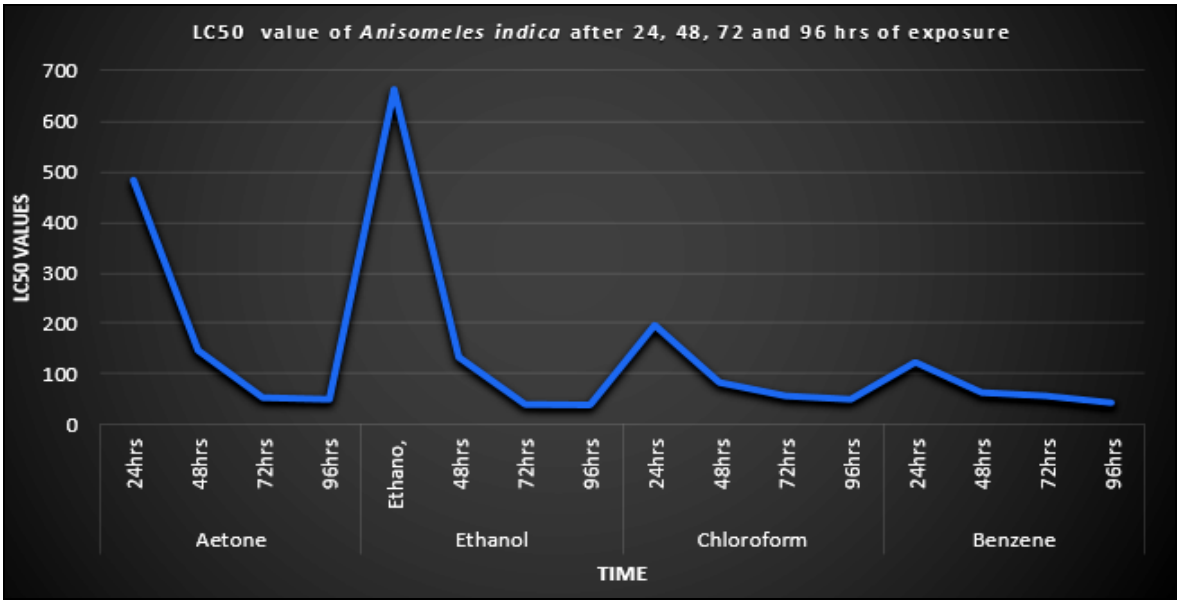

Fig 2: Graph showing LC50 values of Aneusomies indica extract with 4 different solvents.

Fig 3: Graph showing LC50 values of *Senna tora* extract with 4 different solvents.

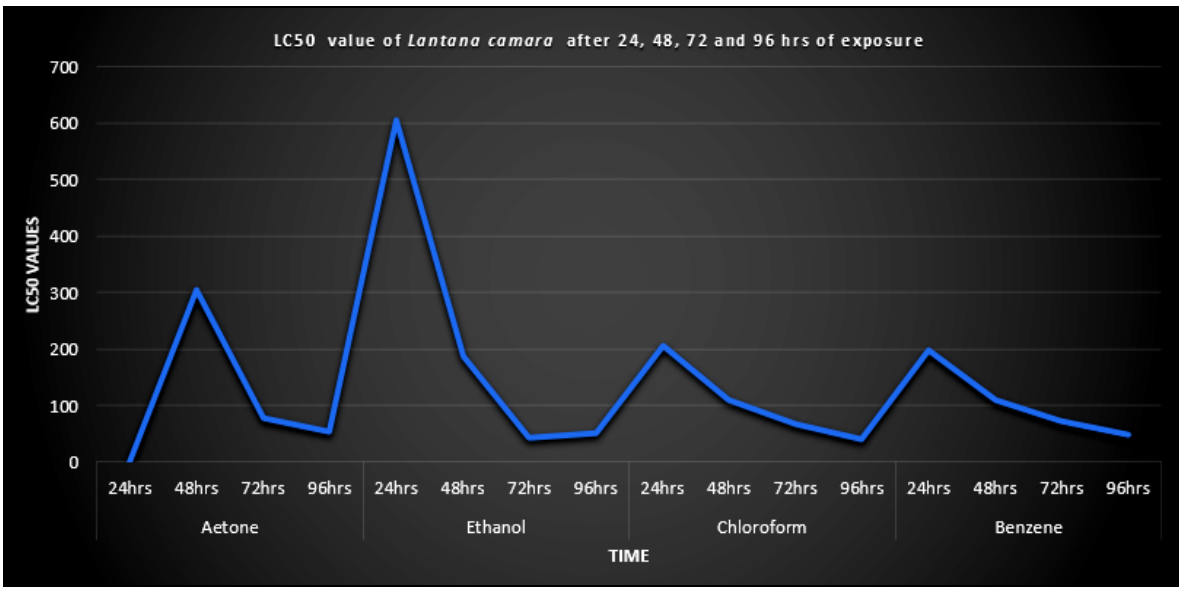

Fig 4: Graph showing LC50 values of *Lantana camara* extract with 4 different solvents.

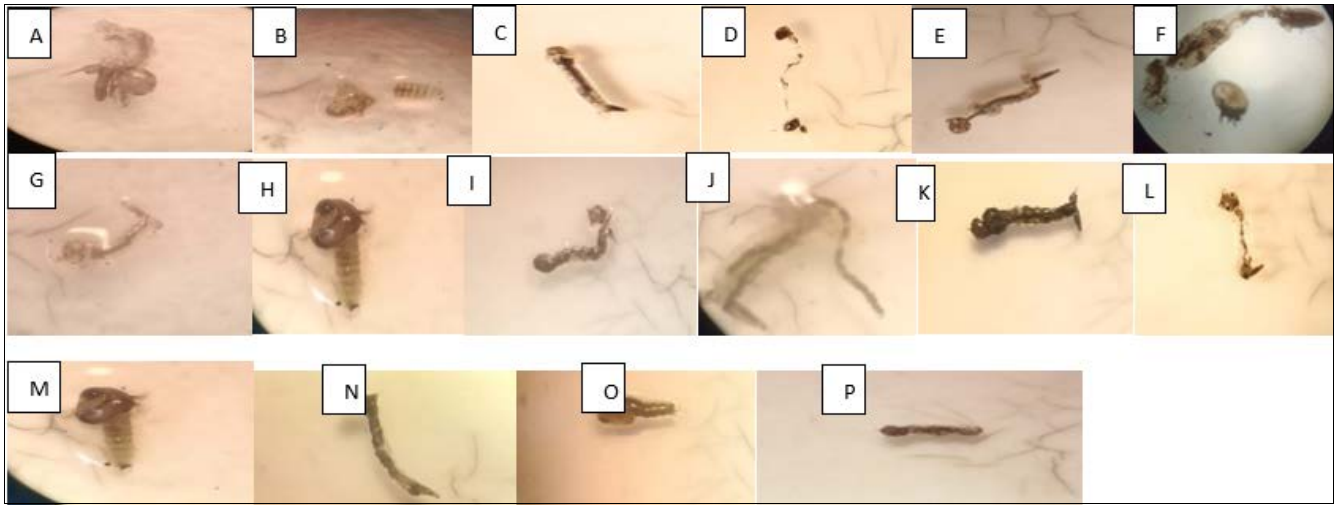

Fig 5: Larvae after treated with *Mikania micrantha* A) acetone, B) alcohol, C) chloroform, D) benzene. After treated with *Anesomeles indica* E) acetone, F) alcohol, G) chloroform, H) benzene. After treated with *Senna tora* I) acetone, J) alcohol, K) chloroform, L) benzene. After treated with *Lantana camara* M) acetone, N) alcohol, O) chloroform, P) benzene.

Discussion

The present study recorded the use of *Mikania micrantha*, Anesomeles indica, *Senna tora* and *Lantana camara* and extracts in: acetone, ethanol, chloroform and benzene at 6 different concentrations of 50ppm, 100ppm, 150ppm, 200ppm, 250ppm and 300ppm. Among them *Senna tora* showed highest larvicidal activity after 96hrs of exposure and the LC50 values of the *Senna tora* extract after 96 hrs of exposure in acetone, ethanol, chloroform and benzene respectively 51.31755, 49.65293,66.00358 and 42.93601. In case of Anesomeles indica extract it was 51.19726, 39.64094, 50.146 and 42.93601. In case of *Mikania micrantha* extracts it was 37.73612, 34.50376, 32.50091, 21.58833. In case of *Lantana camara* it was 53.13359, 50.11044, 39.98202 and 49.32093.

Among various plant-based larvicidal agents, the ethanol leaf extract of Cadaba indica demonstrated the highest larval mortality against Aedes aegypti, with an LC_{50} value of 143.75 ppm, outperforming extracts prepared with hexane, chloroform, and petroleum ether [3]. In contrast, another study on Leucas aspera revealed that its hexane extract exhibited superior larvicidal activity against A. aegypti and C. quinquefasciatus, followed by chloroform and ethanol extracts [5]. Complementing these findings, research on Acalypha alnifolia confirmed strong larvicidal and pupicidal effects against all instar stages and pupae of C. quinquefasciatus, with LC_{50} values ranging from 5.388% in first instar larvae to 10.073% in pupae [6]. Similarly, extracts of Euodia ridleyi showed promising larvicidal potential against C. quinquefasciatus, reinforcing the efficacy of botanical compounds in mosquito control strategies [4].

Conclusion

The present study investigated the larvicidal activity of *Mikania micrantha*, Anesomeles indica, *Senna tora*, and *Lantana camara* extracts in: acetone, 70% ethanol, chloroform and benzene at 6 different concentrations of 50ppm, 100ppm, 150ppm, 200ppm, 250ppm and 300ppm against C. quinquefasciatus larvae. In conclusion the study revealed that weed extracts, often considered agricultural nuisances, have shown remarkable efficacy in controlling mosquito larvae, offering a cost-effective and environmentally benign approach to vector management.

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