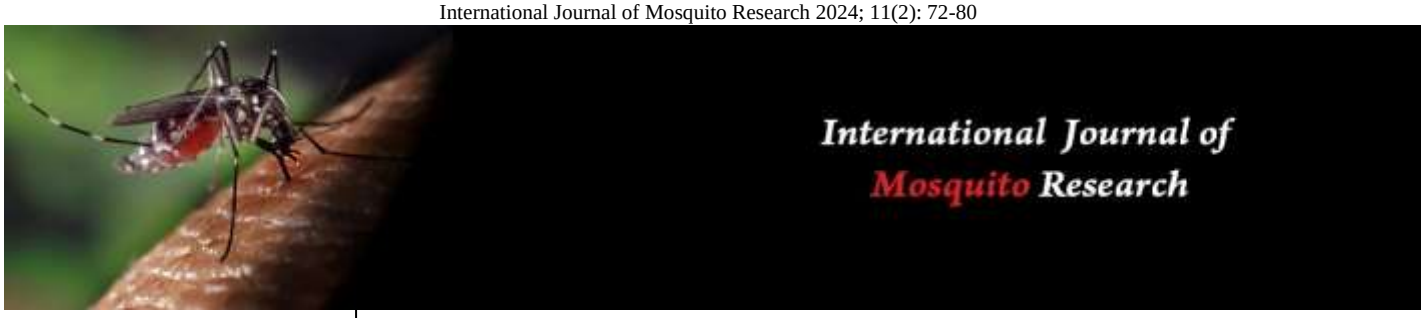


ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2024; 11(2): 72-80
© 2024 IJMR
https://www.dipterajournal.com
Received: 02-01-2024
Accepted: 07-02-2024

Raja S
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Kavya T
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Gayathri RP
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Premalatha P
Department of Zoology, Sri Vidya Mandir Arts & Science College, Katteri, Uthangarai, Krishnagiri District, Tamil Nadu, India

Vasanthakumar D
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Satheeshkumar
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Jayaprakash S
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Dr. Karuppannan P
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Corresponding Author:
Dr. Karuppannan P
PG and Research, Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India

Assessment of larvicidal and pupicidal activity of *Manihot esculenta* (Cassava) on dengue transmitting vector *Aedes aegypti*

Raja S, Kavya T, Gayathri RP, Premalatha P, Vasanthakumar D, Satheeshkumar, Jayaprakash S and Dr. Karuppannan P

DOI: https://doi.org/10.22271/23487941.2024.v11.i2a.770

Abstract
Control of vector mosquitoes naturally by using plants is very crucial for the prevention of the environmental toxicity that caused by insecticides. Hence, present work was focussed to evaluate the toxic nature of leaves extracts of *Manihot esculenta* (Cassava) against larvae and pupae of denuge transmitting vector *Aedes aegypti*. The fourth instars larvae of *A. aegypti* were used for larvicidal activity and kept a plastic container with 249 ml of distilled water and 1ml of known concentration of plant extracts and incubated for 48 hours. The mortality rate of larvae was observed frequently and recorded. Pupae of *A. aegypti* were put in a plastic container with 249 ml of distilled water and 1ml of desired concentration of plant extracts and incubated for 48 hours. The pupicidal activity of plant extracts was observed frequently and recorded. Different extracts of *Manihot esculenta* (Cassava) showed potential toxic to the larvae and pupae of the denuge transmitting vector *Aedes aegypti*. It was due to the presences of phytocompouds such as tannis, saponnin etc. Thus the medicinal plant *Manihot esculenta* (Cassava) was might be useful for control of mosquitoes after the details experiments.

Keywords: Vector borne diseases, Dengue, *A. aegypti*, *Manihot esculenta*, Phytochemicals, Larvicidal and pupicidal

1. Introduction
Mosquitoes are the important bloodsucking arthropods that can transmit serious communicable diseases with many socioeconomic consequences. They are belonging to genera *Culex*, *Anopheles* and *Aedes* are acting as vectors for many diseases like Malaria, Filariasis, Japanese Encephalitis, Dengue fever, Yellow fever etc. When compared to the arthropods, mosquitoes affect millions of people throughout the world by transmitting various communicable diseases. Thus, WHO has declared that the mosquitoes are the number one public enemy [1]. Over the 70 million people in 100 countries around the world were affected by vector borne diseases every year and 10.4 million of the Indian population. Mosquito borne diseases are spread globally, causing huge number of mortality and thereby acting as factors impedimenting the economic development of most of the developing countries across the world [2].

Dengue: Dengue is the important deadly viral disease that transmitted by vector *Aedes aegypti* and symptoms are mild fever to a severe and potentially life threatening hemorrhagic disease [3, 4]. About two-fifth of the world's population is risk with dengue and only way to prevent is to combat the disease-carrying mosquitoes. In 2010, a total of 28,292 cases and 110 deaths were reported in India because of dengue [5, 6].
At present days, there is no effective medicines available for dengue [7, 8]. Pesticides are substances of chemical or biological that used to kill or repel targeted organisms. In many cases pesticides are designed to affect the immune, reproductive, or nervous system of insects. Concerns exist over the safety of present day pesticides. For the purpose of this report, the focus is on health effects of pesticides that are currently used for controlling mosquito populations.

Synthetic insecticides are being widely used as larvicides to control mosquitoes [9, 10]. These insecticides are generally chlorinated hydrocarbon like DDT, dieldrin, endosulfan; Factors that influence malaria prevention and treatment practice are cost, religion, ethnicity, educational status [12]. organophosphates like diazinon, ben solice and carbamates like adizarb, carbofuron [11]. Genetic resistance was developed by the mosquitoes against these synthetic insecticides and even to biopesticides such as *Bacillus sphaericus*. Secondary metabolites from the plants are tha alternative source for mosquito control. Recent research has proved that effectiveness of plant derived compounds, such as saponine, steroids, isoflavonoids, essential oils, alkaloids and tannins has potential mosquito larvicides. These bioactive chemical may act as larvicides, insecticides, antifeedants, moulting hormones, oviposition deterrents, repellents, juvenile hormone mimics, growth inhibitors, antimoulting hormones as well as attractants [11, 12]. Thus the present study was made an attempt to evaluate the larvicidal and pupicidal activity of leaf extract of *M. Esculenta*

2. Materials and Methods

2.1 Collection of plant materials and preparation of extracts

The leaves of the *Manihot esculenta* (Cassava) were collected from local village, cut in to a small pieces and it dried under the shadow condition. Then the plant material was powdered using electrial grinder. The plant extraction was prepared by Soxhlet extraction method using ethanol and chloroform as solvents.

2.2 Phytochemical Screening

The primary phytochemical screening was evaluated to know the presence of phytochemical constituents in the leaves extracts of *M. Esculenta* [13-17].

2.3 Collection and maintenance of *Aedes aegypty* Larva

Larvae of *Aedes aegypti* were procured in ICMR Vector Control Research Centre, Madurai. They were brought to laboratory and transformed to plastic container and until the experiment. The larva was fed with powdered biscuits and yeast with ratio of 60:40. The feeding was continued till the larvae transformed into the pupal stage.

2.4 Preparation of test extracts concentration

1 g of plant extract was dissolved in 100ml of distilled water (stock solution). From this stock solution different concentration were prepared by diluting the stock solution proper direction.

2.5 Larvicidal activity test of plant extract

Six number of fourth instar larva of *Aedes aegypti* was kept in 500ml beaker filled with 249 ml of distilled water and 1ml of known concentration of plant extracts and incubated for 48 hours. The mortality of larva was observed for every 3 hours and recorded.

$$\text{Corrected mortality} = \frac{\text{Observed mortality in treatment} - \text{Observed Mortality in control}}{\text{100 - Control in mortality}} * 100$$

$$\text{Percentage mortality} = \frac{\text{Number of dead larva}}{\text{Number of tested larvae}} * 100$$

2.6 Pupicidal activity

Five numbers of freshly emerged pupae were kept in 500 ml glass beaker filled with 249ml of distilled water and 1ml of desired concentrations of plant extracts. Control was set up by mixing 1ml of desired solvent respectively with 249ml of dechlorinized water. Mortalities were observed and recorded. Mortality rate was corrected by Abbott's formula (Abbott's 1925).

$$\text{Corrected mortality} = \frac{\text{Observed mortality in treatment-observed Mortality in control}}{\text{100-Control in mortality}} * 100$$

$$\text{Percentage mortality} = \frac{\text{Number of dead pupae}}{\text{Number of tested pupae}} * 100$$

2.7 Statistical analysis

All data were expressed as mean ± SD. Hypothesis testing methods include One Way Analysis of Variance (ANOVA). LC_{50} was calculated by probit analysis. All the data were analyzed with SPSS software.

3. Results

3.1 Phytochemcial study

Phytochemcial results of leaf ethanol extract of *M. esculenta* showed the presence of alkaloids, flavonoids, carbohydrates, phenol proteins etc. The chloroform extract showed that presence of flavonoids, alkaloids, phenols etc. The phytochemcial screening results revealed that the presence of phytocompound in leaf of *M. esculenta* and these phyto constituents might be useful for the pharmacological and vector control activity.

3.2 Larvicidal activity of ethanolic leaf extract of *Manihot esculenta*

The larvicidal activity of different concentration of leaves ethanol extract of *M. esculenta* is shown in table 2-4 and Fig. 1.

To evaluate the larvicidal activity of leaf of *M. esculenta*, the larvae of *Aedes aegypti* was taken as a study animal. There was no mortality of larvae of *A. aegypti* observed in 10 ppm concentration up to 24 hours experimental period. Highest mortality rate (80.0 ± 5.78) was recorded in 45 hours. In 100 ppm concentration maximum mortality against dengue transmitting vector was observed in 48 hours (93.3 ± 3.33) of experimental period. The highest mortality (80.0 ± 3.33) was observed in 45 hours experimental period at 1000 ppm concentration. The one way ANOVA test result showed that there was a no significant different among the all concentration of ethanol extract of leaf of *M. esculenta* (p>0.05).

3.4 Larvicidal activity of chloroform extract of root of *M. esculenta*

In 10 ppm concentration the maximum mortality rate (70.0 ± 5.78) of chloroform extract of leaf of *M. esculenta* was observed at 45hrs. The mortality of larvae of *A. aegypti* was

observed in 27 hours onwards in 100 ppm concentration and highest mortality rate such as 60.0 ± 5.78 was observed in at 42 hours of experimental period.23.3 ± 3.33 mortality rate was observed in 27 hours of experimental period in 1000 ppm concentration and highest mortality of *A. aegypti* larvae (96.7± 3.33) was observed in 48 hours of experimental period. The one way ANOVA test result showed that there was no significant different among the all three concentrations at 0.05 level (p>0.05).

3.5 Pupicidal activity of ethanol leaf extract of *M. esculenta*

The larvicidal activity of different concentration of leaves ethanol extract of *M. esculenta* is shown in table 6-8 and Fig. 2.

Pupae of *A. aegypti* were taken to evaluate the pupicidal activity of leaf of *M. esculenta.* The highest rate of mortality (93.3 ± 3.33) was observed in 48 hours in 10 ppm concentration. In 100 ppm concentration the mortality was started at 24 hrs experimental period and observed mortality was 13.3 ± 3.33 and maximum mortality (96.7 ± 3.33) was recorded at 48 hours of experimental period. Moreover, highest mortality of *A. aegypti* was observed at 48 hours of experimental periods. The highest mortality (93.3 ± 3.33) of pupae of *A. aegypti* was observed in 48 hrs. of 1000 ppm concentration. Result of one way ANOVA test showed that there was no significant different among the all concentration of ethanol of root extract of *M. esculenta*.

3.6 Pupicidal activity of root chloroform extract of *M. esculenta*:

Pupae of *A. aegypti* were taken to evaluate the pupicidal activity of leaf of *M. esculenta.* The highest rate of mortality (80.0 ± 5.78) was observed in 45 hours in 10 ppm concentration. In 100 ppm concentration the mortality was started at 24 hrs experimental period and observed mortality was 13.3 ± 3.33 and maximum mortality (86.7 ± 3.33) was recorded at 48 hours of experimental period. Moreover, highest mortality of *A. aegypti* was observed at 48 hours of experimental periods. The highest mortality (93.3 ± 3.33) of pupae of *A. aegypti* was observed in 48 hrs. of 1000 ppm concentration. Result of one way ANOVA test showed that there was no significant different among the all concentration of ethanol of root extract of *M. esculenta*.

3.7 LC_{50} of larvae of *A. aegypti* treated with different extracts of *M. esculenta*

The LC_{50} value of ethanol extract was 12002.91 ppm and LC_{90} was 22425.73 ppm and chi square value was 131.40. LC_{50} value of chloroform extract was 7983.49 ppm and LC_{90} value was 13984.07 ppm and chi square value was 41.33 (Table 1).

3.8 LC_{50} of Pupae of *A. aegypti* treated with different extracts of *M. esculenta*

The LC_{50} value of ethanol extract was 7840.39 ppm and LC_{90} was 14500.00 ppm and chi square value was 180.08. LC_{50} value of chloroform extract was 9510.85 ppm and LC_{90} value was 17181.25 ppm and chi square value was 195.15 (Table 5).

Table 1: LC_{50} and LC_{90} values of *M. esculenta* extracts for larvicidal activity of Dengue transmitting vector *A. aegypti*

Extracts	LC_{50}			LC_{90}			Chi Square value
	Residual	Lower	Upper	Residual	Lower	Upper	
Ethanol	12002.91	10768.47	14643.36	22425.73	20789.74	24679.65	131.40
Chloroform	7983.49	5510.33	9050.83	13984.07	11337.79	16766.92	41.33

Table 2: Mortality rate of larvae of *A. aegypti* at 10 ppm concentration treatment of leaf extract of *M. esculenta*

Concentration (ppm)	Hours	Mortality Rate (%)	
		Ethanol	Chloroform
10	3	0.0 ± 0.00	0.0 ± 0.00
	6	0.0 ± 0.00	0.0 ± 0.00
	9	0.0 ± 0.00	0.0 ± 0.00
	12	0.0 ± 0.00	0.0 ± 0.00
	15	0.0 ± 0.00	0.0 ± 0.00
	18	0.0 ± 0.00	0.0 ± 0.00
	21	0.0 ± 0.00	0.0 ± 0.00
	24	0.0 ± 0.00	0.0 ± 0.00
	27	16.7 ± 3.33	0.0 ± 0.00
	30	26.7 ± 3.33	30.0 ± 5.78
	33	0.0 ± 0.00	40.0 ± 5.78
	36	40.0 ± 5.78	0.0 ± 0.00
	39	0.0 ± 0.00	56.7 ± 3.33
	42	50.0 ± 5.78	70.0 ± 5.78
	45	80.0 ± 5.78	70.0 ± 5.78
	48	0.0 ± 0.00	0.0 ± 0.00

Table 3: Mortality rate of larvae of *A. aegypti* at 100 ppm concentration treatment of leaf extract of *M. esculenta*

Concentration (ppm)	Hours	Mortality Rate (%)	
		Ethanol	Chloroform
100	3	0.0 ± 0.00	0.0 ± 0.00
	6	0.0 ± 0.00	0.0 ± 0.00
	9	0.0 ± 0.00	0.0 ± 0.00
	12	0.0 ± 0.00	0.0 ± 0.00
	15	0.0 ± 0.00	0.0 ± 0.00

	18	0.0 ± 0.00	0.0 ± 0.00
	21	0.0 ± 0.00	0.0 ± 0.00
	24	0.0 ± 0.00	0.0 ± 0.00
	27	30.0 ± 5.78	20.0 ± 5.78
	30	40.0 ± 5.78	0.0 ± 0.00
	33	0.0 ± 0.00	40.0 ± 5.78
	36	45.4 ± 3.33	50.0 ± 5.78
	39	60.0 ± 5.78	0.0 ± 0.00
	42	63.3 ± 8.82	60.0 ± 5.78
	45	86.7 ± 3.33	0.0 ± 0.00
	48	93.3 ± 3.33	0.0 ± 0.00

Table 4: Mortality rate of larvae of *A. aegypti* at 1000 ppm concentration treatment of leaf extract of *M. esculenta*

Concentration (ppm)	Hours	Mortality Rate (%)	
		Ethanol	Chloroform
1000	3	0.0 ± 0.00	0.0 ± 0.00
	6	0.0 ± 0.00	0.0 ± 0.00
	9	0.0 ± 0.00	0.0 ± 0.00
	12	0.0 ± 0.00	0.0 ± 0.00
	15	0.0 ± 0.00	0.0 ± 0.00
	18	0.0 ± 0.00	0.0 ± 0.00
	21	0.0 ± 0.00	0.0 ± 0.00
	24	0.0 ± 0.00	0.0 ± 0.00
	27	16.7 ± 3.33	23.3 ± 3.33
	30	0.0 ± 0.00	40.0 ± 5.78
	33	36.7 ± 3.33	0.0 ± 0.00
	36	0.0 ± 0.00	56.7 ± 3.33
	39	56.7 ± 3.33	60.0 ± 5.78
	42	0.0 ± 0.00	0.0 ± 0.00
	45	70.0 ± 5.78	80.0 ± 5.78
	48	80.0 ± 3.33	96.7 ± 3.33

Table 5: LC_{50} and LC_{90} values of *M. esculenta* extracts for pupicidal activity of Dengue transmitting vector *A. aegypti*

Extracts	LC_{50}			LC_{90}			Chi Square value
	Residual	Lower	Upper	Residual	Lower	Upper	
Ethanol	7840.39	7510.33	8050.83	14500.00	13367.79	16766.92	180.08
Chloroform	9510.85	7650.45	11056.08	17181.25	15179.76	19789.12	a. 195.15

Table 6: Mortality rate of pupae of *A. aegypti* at 10 ppm concentration treatment of leaf extract of *M. esculenta*

Concentration (ppm)	Hours	Mortality Rate (%)	
		Ethanol	Chloroform
10	3	0.0 ± 0.00	0.0 ± 0.00
	6	0.0 ± 0.00	0.0 ± 0.00
	9	0.0 ± 0.00	0.0 ± 0.00
	12	0.0 ± 0.00	0.0 ± 0.00
	15	0.0 ± 0.00	0.0 ± 0.00
	18	0.0 ± 0.00	0.0 ± 0.00
	21	0.0 ± 0.00	0.0 ± 0.00
	24	23.3 ± 3.33	16.7 ± 3.33
	27	33.3 ± 3.33	0.0 ± 0.00
	30	0.0 ± 0.00	26.7 ± 3.33
	33	36.7 ± 3.33	0.0 ± 0.00
	36	56.8 ± 3.33	50.0 ± 5.78
	39	66.7 ± 3.33	0.0 ± 0.00
	42	80.0 ± 5.78	66.7 ± 3.33
	45	0.0 ± 0.00	80.0 ± 5.78
	48	93.3 ± 3.33	0.0 ± 0.00

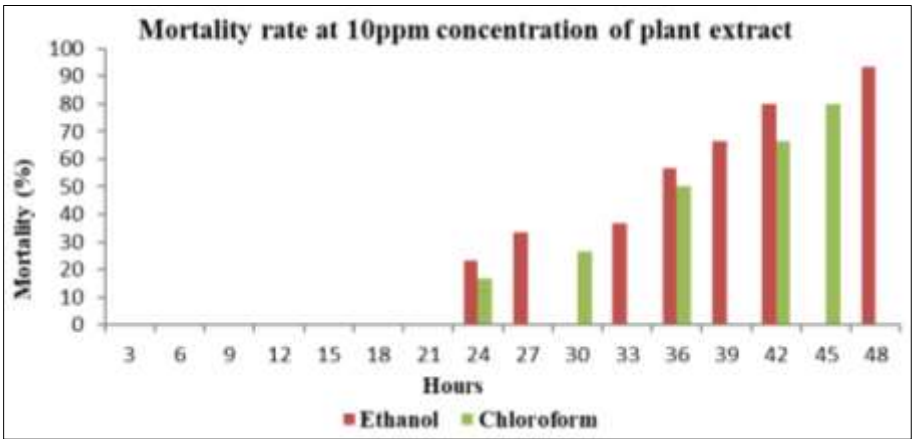
Table 7: Mortality rate of pupae of *A. aegypti* at 100 ppm concentration treatment of leaf extract of *M. esculenta*

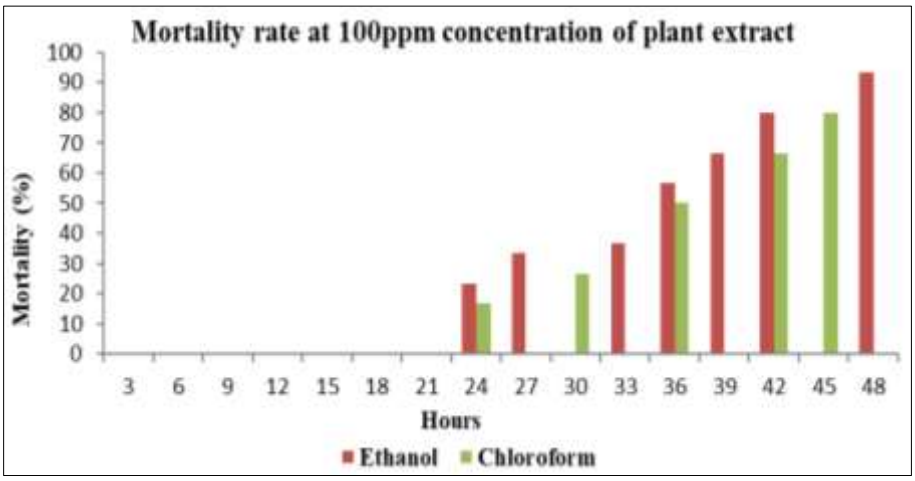
Concentration (ppm)	Hours	Mortality Rate (%)	
		Ethanol	Chloroform
100	3	0.0 ± 0.00	0.0 ± 0.00
	6	0.0 ± 0.00	0.0 ± 0.00
	9	0.0 ± 0.00	0.0 ± 0.00
	12	0.0 ± 0.00	0.0 ± 0.00

	15	0.0 ± 0.00	0.0 ± 0.00
	18	0.0 ± 0.00	0.0 ± 0.00
	21	0.0 ± 0.00	23.3 ± 3.33
	24	13.3 ± 3.33	30.0 ± 5.78
	27	0.0 ± 0.00	0.0 ± 0.00
	30	36.7 ± 3.33	33.3 ± 3.33
	33	50.0 ± 5.78	46.7 ± 3.33
	36	0.0 ± 0.00	60.0 ± 5.78
	39	56.7 ± 3.33	76.7 ± 3.33
	42	76.7 ± 3.33	0.0 ± 0.00
	45	83.7 ± 3.33	0.0 ± 0.00
	48	96.7 ± 3.33	86.7 ± 3.33

Table 8: Mortality rate of pupae of *A. aegypti* at 1000 ppm concentration treatment of leaf extract of *M. esculenta*

Concentration (ppm)	Hours	Mortality Rate (%)	
		Ethanol	Chloroform
1000	3	0.0 ± 0.00	0.0 ± 0.00
	6	0.0 ± 0.00	0.0 ± 0.00
	9	0.0 ± 0.00	0.0 ± 0.00
	12	0.0 ± 0.00	0.0 ± 0.00
	15	0.0 ± 0.00	0.0 ± 0.00
	18	0.0 ± 0.00	0.0 ± 0.00
	21	16.7 ± 3.33	0.0 ± 0.00
	24	26.7 ± 3.33	26.7 ± 3.33
	27	40.0 ± 5.78	40.0 ± 5.78
	30	0.0 ± 0.00	0.0 ± 0.00
	33	66.7 ± 3.33	60.0 ± 5.78
	36	0.0 ± 0.00	0.0 ± 0.00
	39	73.3 ± 3.33	70.0 ± 5.78
	42	86.7 ± 3.33	76.7 ± 3.33
	45	0.0 ± 0.00	0.0 ± 0.00
	48	93.3 ± 3.33	93.3 ± 3.33





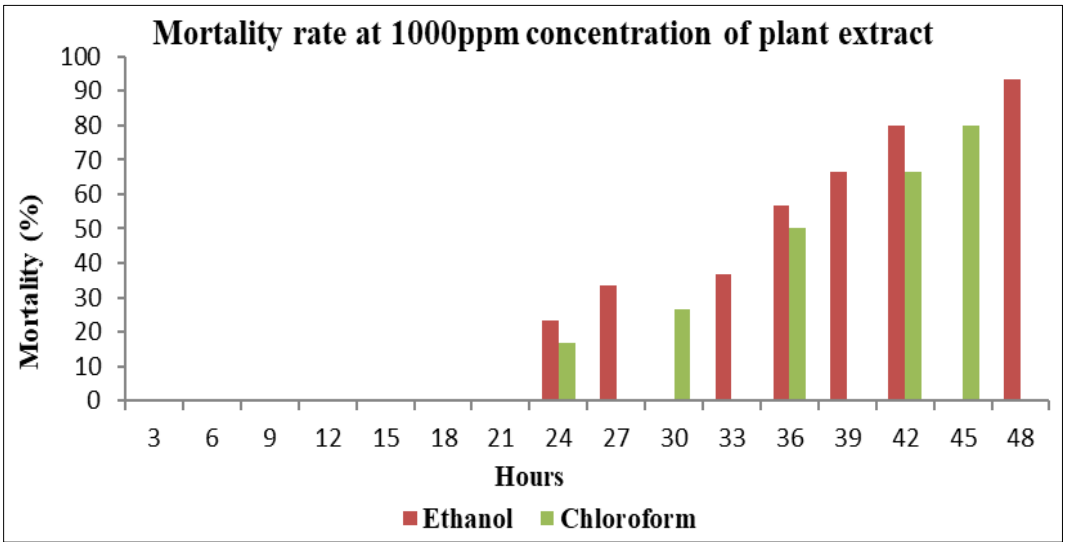
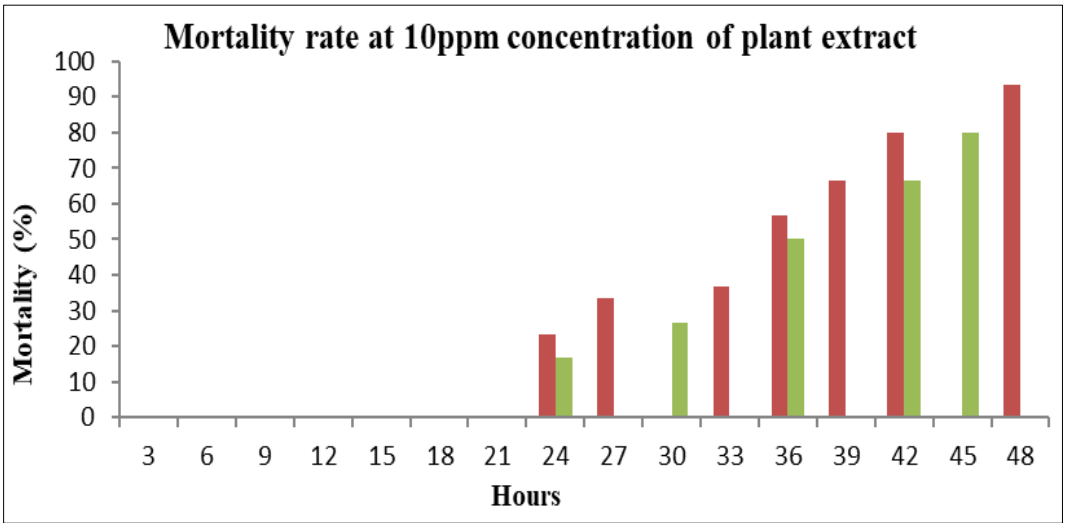
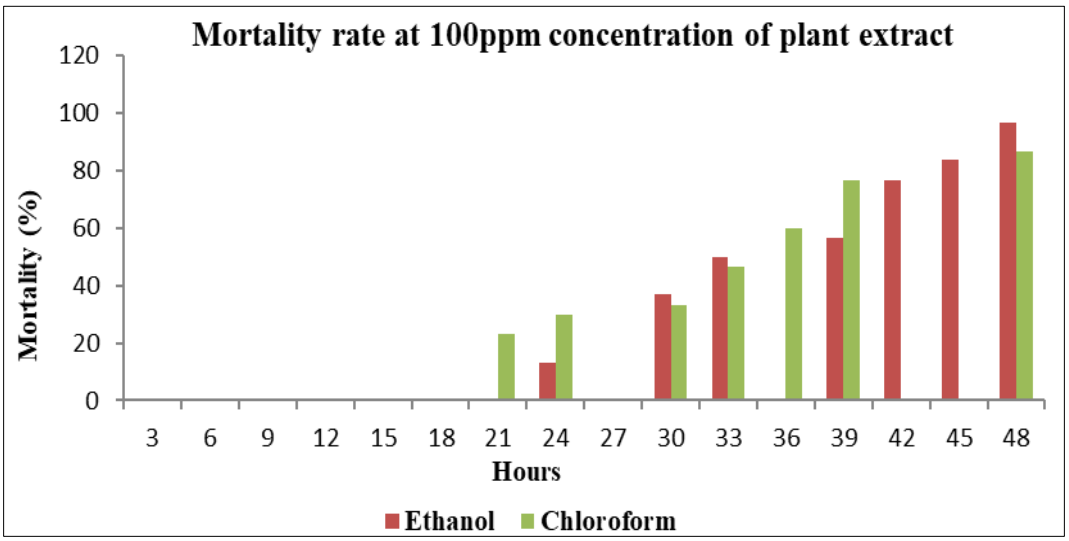


Fig 1: Larvicidal activity of leaf extracts of *M. esculenta* against dengue transmitting vector *A. aegypti*





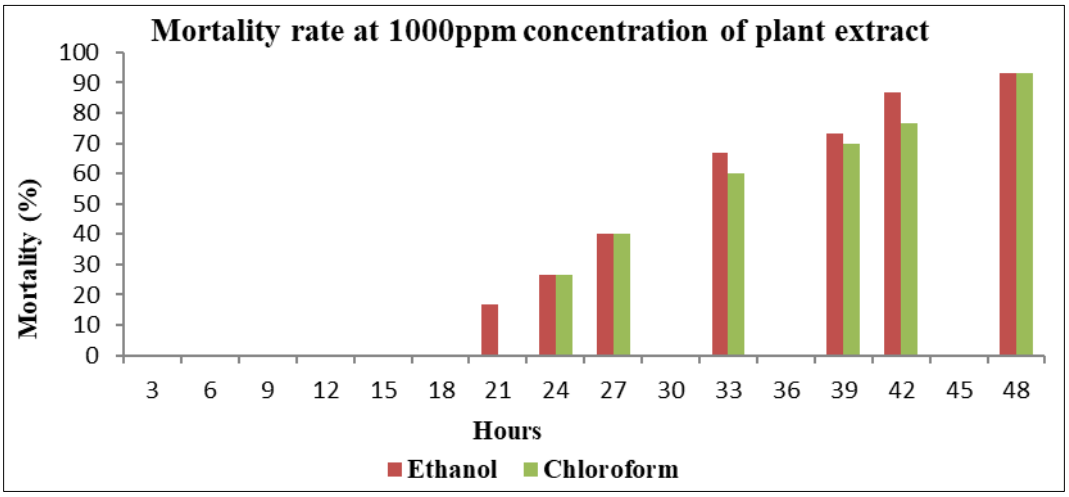


Fig 2: Pupicidal activity of leaf extracts of *M. esculenta* against dengue transmitting vector *A. aegypti*

4. Discussion

Mosquitoes are the belonging to the phylum arthropods that affect millions of people throughout the world compared to other arthropods. WHO has announced that the mosquitoes are the "number on public enemy" [1]. Globally, over 700,000,000 people were infected by mosquito borne diseases across the world and 40,000,000 of the Indian population. Mosquitoes are act as vector for life threatening diseases like yellow fever, dengue fever, chikungunya, malaria, filariasis, West Nile virus infection, encephalitis, *etc.*, in almost all tropical and subtropical countries and many other parts of the world. Mosquito control is essential for prevention of mosquito borne diseases and to improve the quality of environment and public health.

4.1 Chemical control of vector Mosquito

Most of the synthetic insecticides *viz.*, organochlorine and organophosphate compounds are widely used for the control of mosquito. But it is not been very successful due to human, operational, technical, ecological and economic factors, due to the lack of novelty of insecticides and high cost concern environmental sustainability, harmful to the human health, and other non-target populations and increasing insecticide resistance on a global scale [18-20]. These factors have resulted in an urge to focus for cost-effective, eco-friendly, biodegradable and target specific insecticides against mosquito species.

4.2 Biological control of Mosquitoes

Use of floral diversity and insecticides from plants are the simple and sustainable method of mosquito control. Plant derived insecticides comprise botanical blends of chemical compounds which act concertedly on both behavioural and physiological processes. Several phytochemicals groups such as alkaloids, steroids, terpenoids, essential oils and phenolics from medicinal plants have been reported previously for their insecticidal activities [21].

It is clearly indicated that crude or partially purified plant extracts are less expensive and highly efficacious for the control of mosquitoes rather than the purified compounds or extracts [22, 23, 24, 25]. Many plant extracts and essential oils showed repellent activity against different mosquito species. Sharma *et al.* [26] reported that the using of neem oils effectively prevent the different types of mosquitoes such as *Anopheles sp.*, *Culex sp.* and *Aedes. sp*. Kim *et al*. [27] reported that fruit ethanol extract of *Foeniculum vulgarea* prevent the biting of *A. aegypti*. Yang *et al.* [28] used methanol extracts of 23 aromatic medicinal plant species against female blood - starved *Ae. aegypti*, Choochote *et al*. [29] reported that repellent activity of selected essential oils from ten plant species against *A. aegypti*. Chio and Yang [30] proved repellent activity of neem tree (*Azadirachta indica*) oil against the Asian tiger mosquito (*A. albopictus*). Govnidarajan and Sivakumar [31] studied that repellent activities of crude extracts of *Eclipta alba* and *Andrographis paniculata* at three different concentrations of 1.0, 2.5, and 5.0 mg/cm^2 against important vector mosquito *A. aegypti* and reported that leaf solvent plant extracts have the potential to be used as an ideal ecofriendly approach for the control of mosquitoes.

Singhi *et al*. [32] have reported the *C. procera* latex showed larvicidal effect against all three important vector species such as *A. aegypti, A. stephensi* and *C. quinquefasciatus*. Patil *et al*. [33] evaluated larvicidal activity of extracts of medicinal plants *Plumbago zeylanica* and *Cestrum nocturnum* against *A. Aegypti*. From this study they concluded that LC_{50} values of both the plants were less than 50 ppm and effectively destroy the larvae vector mosquito. The ethanolic extract of whole plant *Leucas aspera* showed larvicicdal and pupicidal activity against first to fourth instar larvae and pupae and showed LC_{50} value for I instar was 9.695%, II instar was 10.272%, III instar was 10.823%and IV instar was 11.303%, and pupae was 12.732%, respectively against *A. stephensi* [34] (Kovendan *et al.*, 2012a). Yadav *et al.* [35] have reported the methanol, chloroform and ether extracts of *Euphorbia tirucalli* latex and stem bark were evaluated for larvicidal activity against laboratory-reared larvae of *C. quinquefasciatus*. Sharma *et al*. [36] suggested that the acetone extract of *Nerium indicum* and *Thuja oriertelis* showed LC_{50} values of 200.87, 127.53, 209.00 and 155.97 ppm against III instar larvae of *A. stephensi* and *C. quinquefasciatus*, respectively. Leaf methanol extract of *Clitoria ternatea* showed dose-dependent larvicidal activity against *A. stephensi* and 50% of mortality was showed at 555.6 (24 h) and 867.3 (48 h) ppm respectively. 50% of mortality was observed at 116.8, 195 ppm) after 24h and 154.5 ppm after 48h with treatment of seed extract against *A. stephensi* and *A. aegypti*, respectively. Larvicidal activity of flower methanol extract showed LC_{50} values 233 and 302.5 ppm against *A. stephensi* and *A. aegypti*, respectively, after 48 h treatment. Our result was coincided with above mentioned research work. In this research leaves

ethanol and chloroform extract of *M. Esculenta* showed effective larvicidal and pupicidal activity against dengue transmitting mosquito *A.* aegypti [37]. Plant as potential larvicides is considered as viable and preferred alternative in the control of the mosquito species at the community level. Phytochemicals derived from plants act as general toxicants against adult as well as against larval stages of mosquitoes, while some act as growth inhibitors or as chemosterilant or act as repellant or attractants [38]. Phytochemicals from plant sources act as larvicides, ovicidal, pupicidal, insect growth regulators, repellent, ovipositor attractant and have different activities which have been observed by many researchers [39]. Triterpenoids are generally credited with mosquito larvicidal activities [40]. The potent larvicidal activity of *L. aspera* could be attributed to the strong presences of terpenoids, triterpenoids and alkaloids. In our phytochemical result was proved that the presence of alkaloids, flavonoids, triterpenoids etc.

5. Conclusion

From the study it is concluded that the ethanol and chloroform extracts of leaf of *M. esculenta* possessed larvicidal and pupicidal activity against dengue transmitting vector *A. aegypti*. Moreover, the plant *M. esculenta* was might be useful for the biological control of dengue transmitting vector *A. aegypti*.

6. Acknowledgement

The authors thanks to The Management, The Principal and Head of the Department of Zoology, Vivekanandha College of Arts and Sciences for Women (Autonomous), Elayampalayam, Tiruchengode, Namakkal District, Tamil Nadu for providing necessary facilities to do the research work. The authors are also thanks to Department of Science and Technology for providing funding to the department in the name of DST - FIST.

7. References

1. World Health Organization. National malaria eradication programme, Directorate General of Health Services. Epidemiology and Control of Malaria in India. World Health Organization: New Delhi, India; c1996. p. 251.
2. Borah R, Kalita MC, Goswami RCH, Talukdarm AK. Larvicidal Efficacy of Crude Seed Extracts of Six Important Oil Yielding Plants of North East India against the Mosquitoes *Aedes aegypti* and *Culex quinquefasciatus*. Journal of Biofertilizers and Biopesticides. 2012;3:116.
3. Hahn CS, French OG, Foley P, Martin EN, Taylor RP. Bispecific Monoclonal Antibodies Mediate Binding of Dengue Virus to Erythrocytes in a Monkey Model of Passive Viremia. Journal of Immunology. 2001;66(2):1057-1065.
4. Invest JF, Lucas JR. Pyroproxyfen as a Mosquito Larvicide. Proceedings of the Sixth International Conference on Urban Pests; c2008.
5. World Health Organization. Global programme to eliminate lymphatic filariasis. Weekly Epidemiological Record. 2009;84:437-44.
6. National Vector Borne Disease Control Programme (NVBDCP). Dengue Cases and Deaths in the Country Since 2007. Available at: http://nvbdcp.gov.in/den-cd.html [accessed November 23, 2011]; c2011.
7. Malavige GN, Fernando S, Fernando DJ, Seneviratne SL. Dengue viral infections. Postgraduate Medical Journal. 2004;80:588–601.
8. Ghosh A, Chowdhury N, Chandra G. Plant extracts as potential mosquito larvicides. Indian Journal of Medical Research. 2012;135:581-598.
9. Brown AW. Laboratory Studies on the Behaviouristic Resistance of *Anopheles albimanus* in Panama. Bulletin of the World Health Organization. 1958;19:1053–1061.
10. Indian Council of Medical Research. Chemical insecticides in malaria vector control in India. ICMR Bulletin. 2002;32:0377-4910.
11. Indian Council of Medical Research. Prospects of using herbal products in the control of mosquito vectors. ICMR Bulletin. 2003;33:1-12.
12. Rattan RS. Mechanism of action of insecticidal secondary metabolites of plant origin. Crop Protection. 2010;29:913-920.
13. Brain KR, Turner TD. The practical evaluation of phytopharmaceuticals. Wright-Science Technical. 1975, 144.
14. Kokate CK, Purohit AP, Gokhale SB. Pharmacognosy. Nirali Prakashan, Pune, India; c1997.
15. Harborne JB. Phytochemical methods: A guide of modern techniques of plant analysis. Chapman and Hall Ltd., London; c1998.
16. Kokate CK, Purohit AP, Gokhale SB. Pharmacognosy. Nirali Prakashan, Pune; c2005.
17. Raman N. Phytochemical technique. New Indian Publishing Agencies, New Delhi; c2006.
18. Brown AW. Insecticide resistance in mosquitoes: a pragmatic review. Journal of the American Mosquito Control Association. 1986;2:123-140.
19. Russell TL, Kay BH, Skilleter GA. Environmental effects of mosquito insecticides on saltmarsh invertebrate fauna. Aquatic Biology. 2009;6:77-90.
20. Bhatt RP, Khanal SN. Environmental impact assessment system in Nepal - an overview of policy, legal instruments and process. Kathmandu University Journal of Science Engineering and Technology. 2009;5:60-70.
21. Shaalan EAS, Canyonb D, Younesc MWF, Abdel-Wahaba H, Mansoura AH. A review of botanical phytochemicals with mosquitocidal potential. Environmental International. 2005;3:1149-1166.
22. Jang YS, Baek BR, Yang YC, Kim MK, Lee HS. Larvicidal activity of leguminous seeds and grains against *Ae. aegypti* and *C. pipiens pallens*. Journal of the American Mosquito Control Association. 2002;18(3):210-213.
23. Cavalcanti ES, Morais SM, Lima MA, Santana EW. Larvicidal activity of essential oils from Brazilian plants against *Ae. aegypti* L. Memórias do Instituto Oswaldo Cruz. 2004;99(5):541-544.
24. Maurya P, Sharma P, Mohan L, Batabyal L, Srivastava CN. Evaluation of the toxicity of different phytoextracts of *Ocimum basilicum* against *Anopheles stephensi* and *Culex quinquefasciatus*. Journal of Asia-Pacific Entomology. 2009;12:113-115.
25. Kovendan K, Murugan K, Vincent S, Barnard DR. Mosquito larvicidal properties of *Orthosiphon thymiflorus* (Roth) Sleesen. (Family: Labiatae) against mosquito vectors, *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* (Diptera: Culicidae).

Asian Pacific Journal of Tropical Medicine. 2012;5(4):299–305.
26. Sharma SK, Dua VK, Sharma VP. Field studies on the mosquito repellent action of neem oil. Indian Journal of Malariology. 1985;32:99-103.
27. Kim DH, Kim SI, Chang KS, Ahn YJ. Repellent activity of constituents identified in *Foeniculum vulgare* fruit against *Ae. aegypti* (Diptera: Culicidae). Journal of Agricultural and Food Chemistry. 2002;50(24):6993-6996.
28. Yang YC, Lee EH, Lee HS, Lee DK, Ahn YG. Repellency of aromatic medicinal plant extracts and a steam distillate to *Ae. aegypti*. Journal of the American Mosquito Control Association. 2004;20(2):146-149.
29. Choochote W, Chaithong U, Kamsuk K, Jitpakdi A, Tippawangkosol P, Tuetun B, Champakaew D, Pitasawat B. Repellent activity of selected essential oils against *Aedes aegypti*. Fitoterapia. 2007;78:359–364.
30. Chio E.H, Yang E.C. A bioassay for natural insect repellents. Journal of Asia-Pacific Entomology. 2008;11:225–227.
31. Govnidarajan M, Sivakumar R. Adulticidal and repellent properties of indigenous plant extracts against *Culex quinquefasciatus* and *Aedes aegypti* (Diptera: Culicidae). Parasitology Research. 2011;109(2):353-367.
32. Singhi M, Joshi V, Dam PK. Studies on *Calotropis procera* as larvicidal and repellent plant against vectors of dengue and DHF in Rajasthan, India. Annual Report 2005-06. Desert Medicine Research Center, Jodhpur; c2006. p 24–28.
33. Patil CD, Patil SV, Salunke BK, Salunkhe RB. Bioefficacy of *Plumbago zeylanica* (Plumbaginaceae) and *Cestrum nocturnum* (Solanaceae) plant Extracts against *Aedes aegypti* (Diptera: Culicide) and *Poecilia reticulata*. Parasitology Research. 2011;108(5):1253-1263.
34. Kovendan K, Murugan K, Vincent S, Barnard DR. Studies on larvicidal and pupicidal activity of *Leucas aspera* Willd. (Lamiaceae) and bacterial insecticide, *Bacillus sphaericus* against malarial vector, *Anopheles stephensi* Liston. (Diptera: Culicidae). Parasitology Research. 2012;110:195–203.
35. Yadav R, Srivastava VK, Chandra R, Singh A. Larvicidal activity of latex and stem bark of *Euphorbia tirucalli* plant on the mosquito *Culex quinquefasciatus*. Journal of Communicable Diseases. 2002;34(4):264–269.
36. Sharma P, Mohan L, Srivastava CN. Larvicidal potential of *Nerium indicum* and *Thuja orientalis* extracts against malaria and Japanese encephalitis vector. Journal of Environmental Biology. 2005;26(4):657–660.
37. Kabaru JM, Gichia L. Insecticidal activity of extracts derived from different parts of the mangrove tree *Rhizophora mucronata* (Rhizophoraceae) Lam. Against three arthropods. African Journal of Science and Technology. 2001;2:44–49.
38. Venketachalam MR, Jebasan A. Larvicidal activity of *Hydrocotyle javanica* thumb (Apjaceal) extract against *Culex quinquefasciatus*. Journal of Experimental Zoology, India. 2010;4:99–101.
39. Gbolade A. Plant derived insecticides in the control of malaria vector. In: Adewunmi CO, Adesina SK, eds. Phytomedicines in Malaria and Sexually Transmitted Diseases: Challenges for new Millennium, Drug research and Production Unit, Faculty of Pharmacy. Obafemi, Awolowo University, lle-fe, Nigeria; c2000. p. 48-50.