INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 17, No. 4, p. 46-59, 2020

RESEARCH PAPER OPEN ACCESS

Biocontrol of larvae of dengue vector *Aedes aegypti* (L.) using fresh seed extract of some selected indigenous plants

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Key words: *Aedes aegypti,* dengue vector, fresh seed, larvicidal, mosquito.

http://dx.doi.org/10.12692/ijb/17.4.46-59 Article published on October 10, 2020

Abstract

Present study was conducted to control dengue vector mosquito, *Aedes aegypti* using environmentally safe biological materials, the seeds of some selected indigenous plants under laboratory condition. Here test plants were *Anacardium occidentale, Azadirachta indica, Corchorus capsularis, Momordica charantia, Swietenia mahagoni and Terminalia catappa*. For this late 3rd instar larvae of *Aedes aegypti* (L.) were exposed to different concentrations (5%, 4%, 3%, 2% and 1%) of aquatic extract of fresh seeds of 6 selected plants. After 24 hours of exposure highest mortality (95%) observed in crude seed extract of *Corchorus capsularis* followed by 90% mortality in crude extract of *Anacardium occidentale* and *Swietenia mahagoni*, 75% in *Azadirachta indica*, 60% in *Terminalia catappa* respectively. Lowest mortality observed in *Momordica charantia* killing 50% larvae after 24 hours of exposure. Among all the test plants minimum LC_{50} value was recorded in fresh seed extract of *Corchorus capsularis* (1.020) followed by *Anacardium occidentale* (1.44), *Azadiracta indica* (2.44), *Swietenia mahagoni* (3.11), *Terminalia catappa* (3.78) *and Momordica charantia* (5.47) after 24 hours of exposure. Among all the test plants crude seed extract of *Corchorus capsularis* was observed most toxic against late 3rd instar larvae of *Aedes aegypti* having LC_{50} (1.02, 0.78 and 0.59), Lc_{90} (4.74, 3.30 and 2.27) and LC_{95} (5.96, 4.47 and 3.32) values after 24, 48 and 72 hours of exposure respectively. From the above study, it can be said that plant seeds might contain certain phytochemicals that can be used in controlling *Aedes* mosquitoe larvae is an ideal environmental healthy approach.

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Introduction

Mosquitoes are the most important group of insects in terms of public health importance, which transmit a number of diseases, such as dengue, malaria, filaria, Japanese encephalitis and so on, causing millions of deaths every year (Das *et al.*, 2007). Currently, dengue is the most important viral disease transmitted by mosquitoes afflicting humans in a world context. Clinical symptoms range from mild fevers to a severe and potentially life threatening hemorrhagic disease. Dengue is transmitted to humans by the *Aedes aegypti* or more rarely the *Aedes albopictus* mosquito, both of which feed exclusively during daylight hours (Gubler, 1997). The primary vector of dengue fever is *Aedes aegypti* (L.) and the secondary vector is *Aedes albopictus* Skuse. *A. aegypti* (L.) is widely distributed within the limits of 40° N and 40° S latitude, but it is highly susceptible to temperature extremes and does not thrive in dry hot climates.

In Bangladesh Dhaka seems doomed to be hit by dengue during the rainy seasons every year. Moreover, the disease is no more Dhaka centered as it had been for the earlier time but it spreading to fur flung corners of the country. In 2002, dengue has claimed 30 lives and got around, 2674 people hospitalized (Chowdhury *et al.*, 2002). In order to prevent this mosquito borne disease and to improve public health it is necessary to control mosquitoes. As there is no specific drug to cure dengue or vaccine to prevent it, measures are usually taken against the vector mosquitoes, which breed in containers both artificial and natural and stagnant rotten water. The key measure that is being applied to prevent the spread of dengue/DHF is the elimination of such mosquito breeding places (Weekly Epidemiological Record, 2000).

Various methods are used all over the world to prevent mosquito such as chemical method, cultural method, ecological method, physical method and biological method. The major existing means of control of mosquito all over the world is the employment of synthetic insecticides (Burdick *et al.*, 1964). A large number of insecticides have been used in different countries to control mosquitoes. The most commonly used ones include chlorinated hydrocarbons viz. (D.D.T), dieldrin, lindane, chlordane and heptachlor, the organophosphorus compounds viz. malathion, diazinon, parathion, diclorvos, abate, and carbaryl (sevin) among carbamates (Khan, 1999).

Development of resistance to insecticides, widespread environmental pollution including soil degradation, destruction of beneficial flora and fauna including non-target organisms like insect parasitoids and predators, ozone depletion which contribute to the greenhouse effect, etc. necessitate a continued search for alternative pest control as well as vector control strategies (Cottam, 1965; Croft and Brown,1975; Freedman *et al.*, 1979; Metcalf, 1980; Ahmed *et al.*, 1981; Minjas and Sarda, 1986; Kalra and Chawla, 1986; Moses, 1991; Pimental *et al.*, 1992; Dinham, 1993; Heckman, 1993; Mulrennan, 1995). Botanicals, i.e., phytochemicals, derived from plants are promising alternatives to synthetic insecticides for the control of medically and agriculturally important insects because these products are biodegradable, they do not leave residue or byproducts to contaminate the environment, they are non-toxic to non-target organisms and are specific in their action (Marini-Bettello, 1977; Desmarchelier, 1979; Freedman *et al.*, 1979; Koul, 1982; Gerrits and Van Latum, 1988; Grainge and Ahmed, 1988). They can serve as ideal tools of integrated pest management. Moreover thay are easily produced by farmers and small-scale industries, and are potentially less expensive than chemical insecticides and the available information on pyrethrins, rotenone, ryanodine, azadirachtin, etc. shows that these products are comparatively safer to higher animals, including mammals. In addition, botanicals come from locally available plants which are easy to grow, preferably on poor quality land so that they do not compete with food or cash crops (Monzon *et al.*, 1994).

Bangladesh has rich plant diversity. Plant species having pesticidal and medicinal properties have long

been known to the people of this region. As many as 54 plant species have been evaluated for their bio-efficacy against different insect pest, pathogen and weeds. An intensive study on economic plants of Bengal with insecticidal properties were mentioned by Prain (1963). In 1998 Scott and Kaushik observed *Azadirachta indica* of 20-30 mg/L caused growth inhibitory effect in *Culex sp*. *Azadirachta indica, A. juss and Vitex negundo* L were effective against the larvae of *Culex quinquefasciatus* (Hossain, 1995). The insecticidal properties of an indigenous plant, *Cannabis sativa* (L), against the larval stages of *Anopheles stephensi, Culex quinquefasciatus* and *Aedes aegypti* were studied by Jalees *et al.* (1993).

As a part of the searching for insecticidal potential of the indigenous plants, the present study was undertaken to test the toxicity of 6 plants of Jahangrinagar University campus and surrounding areas against late 3rd instar larvae of *Aedes aegypti* (L.). Fresh extract of plant seeds were used. Here the main plants examined were *Anacardium occidentale, Azadirachta indica, Corchorus capsularis, Momordica charantia, Swietenia mehagoni* and *Terminalia catappa*. The plants were selected for their bitter taste.

Materials and methods

This experiment was conducted to evaluate larvicidal activity of aqueous fresh seed extracts of 6 indigenous plants against late 3rd instar larvae of Dengue vector mosquito *Aedes aegypti* (L.) under laboratory conditions (air temperature 27°-35°C, water temperature 26°-34°C and relative humidity 68%-88%) from June 2009 to May 2010 in the Medical Entomology Laboratory, Department of Zoology Jahangirnagar University, Savar, Dhaka.

Required materials

To conduct this research work required equipments and other materials were-rearing cage, sweeping net with iron frame, ovitrap, earthen bowl, petri dish, dropper, brush, mosquito net, plastic cup, pipette, cotton, glucose tube, tap water, test plants, Cerelac® Baby Food, yeast powder, glucose, pigeon (for blood feeding the adult female mosquitoes), glass beaker, dropper, measuring cylinder, petri dish, thermometer, hygrometer, magnifying glass, plastic cup, funnel, filter paper, conical flask, mortar-pestle etc.

Rearing of Aedes aegypti (L.)

Egg collection

For the rearing of *Aedes aegypti* wild eggs were collected by placing ovitrap in different areas of Jahangirnagar University campus. Ovitraps were made by inserting a long strip of filter paper wrapped inside a black colored glass jar. A little amount of water was kept in the bottom of glass jar so that some portion of the filter paper became wetted and moistened. *Aedes* mosquito laid eggs on the moist surface of the filter paper. After collecting the eggs, the egg strips were dried in the air for 1-2 days. Then the egg strip was placed in normal tap water for hatching.

Larvae rearing

The hatched larvae were reared in normal laboratory condition. They were kept in an earthen jar and provided Cerelac® baby food and yeast granules as larval food daily. In order to prevent egg laying by other mosquito species the bowl were kept in mosquito rearing cage.

Pupae rearing

Pupation takes place after 4th larval molt and the larvae become pupae. Pupae were separated from the larvae by using dropper and kept in a previously water filled plastic bowl. The pupae were then kept in a mosquito rearing cages for the emergence of adult mosquito.

Adult rearing

Adult mosquitoes emerged from the pupae within the mosquito-rearing cage. As adult food, 10 % glucose solution was supplied daily. The male mosquitoes took only the glucose feed throughout the life time. For the first two or three days of emergence the female also took only the sugar feed. From the third day of emergence, the female took blood meal along

with the glucose meal, throughout her life. The pigeon blood meals were supplied to the females for the anautogenous development. The pigeon was kept tight on the roof of the cage for about half an hour to one hour which allowed the females to suck blood to their full content. The females oviposited two to three days after a blood meal. *Aedes aegypti* prefer clean water for laying eggs. After oviposition, the egg rafts were transferred to an earthen bowl filled with water for hatching and then the bowl was kept within a mosquito rearing cage. The experiment was done from the continuous supplies of larvae from the colony. The experimental larvae were lab reared F_1 generation.

Extraction procedure

The plant seeds were collected from Jahangirnagar University campus and surrounding areas. Fresh seeds were crushed and powdered with the help of mortar pestle, grinder and blender. Then the powdered seeds were weighted with the help of electric balance for different concentrations (5%, 4%, 3%, 2%, 1%). Fresh seed extract was prepared by mixing the powdered seeds (weighed 100gm) in a beaker filled with 1900ml of distilled water. Then the total amount of solution was 2000 ml and it was left for 24 hours for extraction to settle down. After a successful extraction the solution was filtered by filter paper. This is the stock solution (concentration 5%).

Dose preparation

The stock solution was 5% concentrated. Then the solution was diluted to various concentrations (4%, 3%, 2%, and 1%). For 4% concentration, 400 ml of stock solution was mixed with 100ml of distilled water. For 3% concentration, 300 ml of stock solution was mixed with 200ml of distilled water. For 2% concentration, 200 ml of stock solution was mixed with 300ml of distilled water. For 1% concentration, 100 ml of stock solution was mixed with 400ml of distilled water.

Bioassay

Bioassay of 6 experimental plants *Anacardium occidentale, Azadirachta indica, Corchorus capsularis, Momordica charantia, Swietenia mehagoni* and *Terminalia catappa* was carried out in the laboratory against late 3rd instar larvae of mosquito *Aedes aegypti* (L.). For each test plant fresh seeds were used in five different concentrations (5%, 4%, 3%, 2% and 1%) and 5 replications were maintained for each concentration. Five replications were also maintained for control. For each replication 100 ml solution were taken in a plastic cup and 20 larvae were exposed in it. The plastic cups were covered with fine mosquito net to prevent contamination, and then the cups were kept undisturbed. Mortality of the larvae was recorded after 0, 24, 48 and 72 hours of exposure. The percentage of mortality was calculated by using the following formula.

$$\text{Percentage of mortality} = \frac{\text{Number of dead larvae}}{\text{Number of larvae introduced}} \times 100$$

Statistical analysis

The dose response data were analyzed by using Probit Analysis Program Version 1.5 developed by the 'Ecological Monitoring Research Division', Environmental Monitoring Systems Laboratory, U. S. Environmental Protection Agency (EPA), Cincinnati, Ohio 45268. The program is used to determine LC_{50}, LC_{90} and LC_{95} values. LC values were determined to compare the larvicidal effects of various seed extract. For multiple group comparisons, differences of means among groups were compared using one way analysis of variance (ANOVA). DMRT (Duncan Multiple Range Test) was done using SPSS (Statistical Package for Social Science) program (version 12). Graphical representations were done using Microsoft Office Excel 2007.

Results and discussion

Toxic effect of fresh seed extract of Anacardium occidentale

The fresh seed extract of *Anacardium occidentale* was very effective against late 3rd instar larvae of *Aedes aegypti* (L.). After 24 hours of exposure, maximum percentage of mortality (90%) was observed at 5% concentration, which followed by 75%, 70%, 60% and 40% at 4%, 3%, 2% and 1% concentration

respectively. After 48 hours of exposure maximum percentage of mortality (95%) was observed at 5% concentration, at 4% concentration percent mortality was 80%, which followed by 75%, 70% and 45% at 3%, 2% and 1% concentration respectively. Maximum mortality of all the concentrations occurred after 72 hours of exposure in which 100% larvae killed at 5% concentration. At 4%, 3%, 2% and 1% concentration mortality was 90%, 80%, 75% and 50% respectively (Figure 01).

Table 1. Comparative LC values of different fresh seed extract at 5% concentration with a 95% confidence limit.

Name of Plants	LC values after different time of exposure								
	24 hours			48 Hours			72 Hours		
	LC_{50}	LC_{90}	LC_{95}	LC_{50}	LC_{90}	LC_{95}	LC_{50}	LC_{90}	LC_{95}
Anacardium occidentale	1.44	6.96	10.87	1.18	5.25	8.01	1.06	3.59	5.06
Azadirachta indica	2.44	13.05	20.98	1.68	7.95	12.34	1.13	5.05	7.74
Corchorus capsularis	1.02	4.74	5.96	0.78	3.30	4.47	0.59	2.27	3.32
Momordica charantia	5.47	19.27	27.52	3.89	16.84	25.52	2.47	9.82	14.52
Swietenia mahagoni	3.11	6.06	7.13	2.45	5.65	7.13	1.75	4.72	6.26
Terminalia catappa	3.78	16.90	25.83	2.63	12.02	18.50	1.89	8.51	13.06

Probit analysis revealed the LC_{50}, LC_{90} and LC_{95} values of the fresh seed extract of *Anacardium occidentale* with 95% confidence limit. LC_{50} value after 24 hours of exposure was 1.44, where after 48 and 72 hours it was 1.181 and 1.062 respectively. LC_{90} value after 24 hours of exposure was 6.961, where after 48 and 72 hours it was 5.249 and 3.584 respectively. LC_{95} value after 24 hours of exposure was 10.872, where after 48 and 72 hours it was 8.012 and 5.059 respectively (Figure 02).

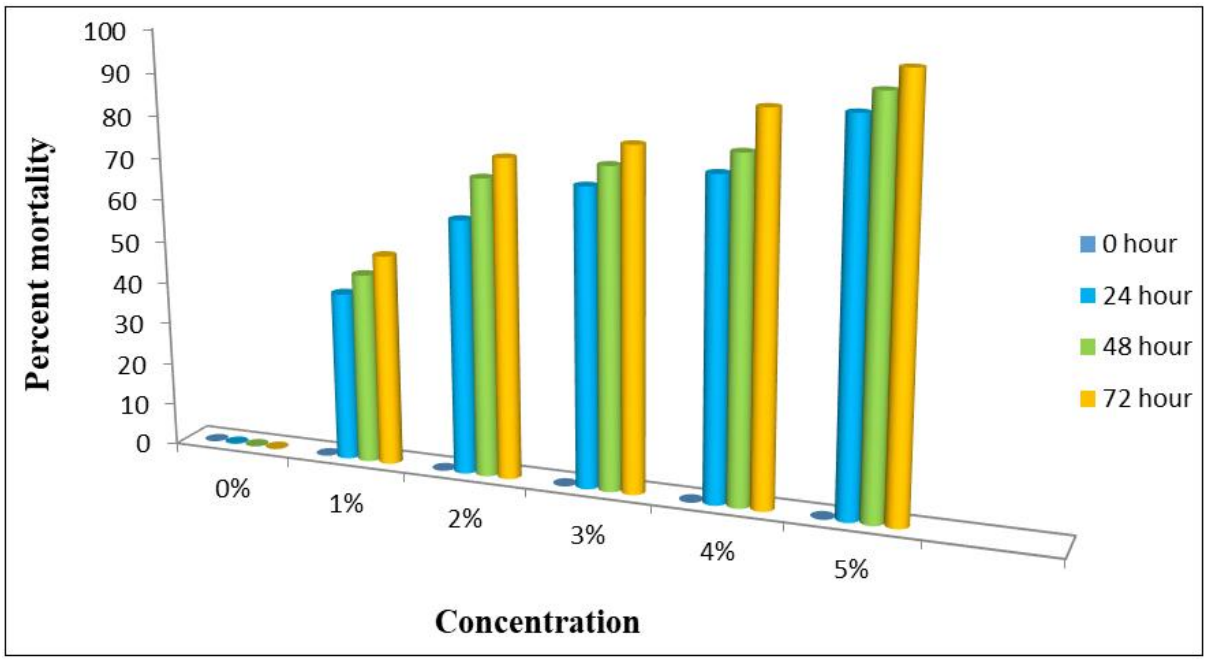

Fig. 1. Toxic effect of different concentration of fresh seed extract of *Anacardium occidentale* on larvae of *Aedes aegypti* (L.) at different time period.

Toxic effect of fresh seed extract of Azadirachta indica

The fresh seed extract of *Azadirachta indica* was effective against late 3rd instar larvae of *Aedes aegypti* (L.). After 24 hours of exposure, maximum percentage of mortality (75%) was observed at 5% concentration, which followed by 60%, 55%, 45% and 25% at 4%, 3%, 2% and 1% concentration respectively. After 48 hours of exposure maximum percent of mortality (85%) was observed at 5% concentration, at 4% concentration percent mortality was 75%, which followed by 65%, 55% and 35% at 3%,

2% and 1% concentration respectively. Maximum mortality of all the concentrations occurred after 72 hours of exposure, in which 95% larvae killed at 5% concentration. At 4%, 3%, 2% and 1% concentration percentage of mortality was 85%, 75%, 65% and 50% respectively (Figure 03). Probit analysis revealed the LC_{50}, LC_{90} and LC_{95} values of the fresh seed extract of *Azadirachta indica* with 95% confidence limit. LC_{50} value after 24 hours of exposure was 2.448, where after 48 and 72 hours it was 1.683 and 1.127 respectively. After 24 hours of exposure LC_{90} value was 13.052, where after 48 and 72 hours it was 7.947 and 5.059 respectively. After 24 hours of exposure LC_{95} value was 20.976, where after 48 and 72 hours it was 12.341 and 7.744 respectively (Figure 04).

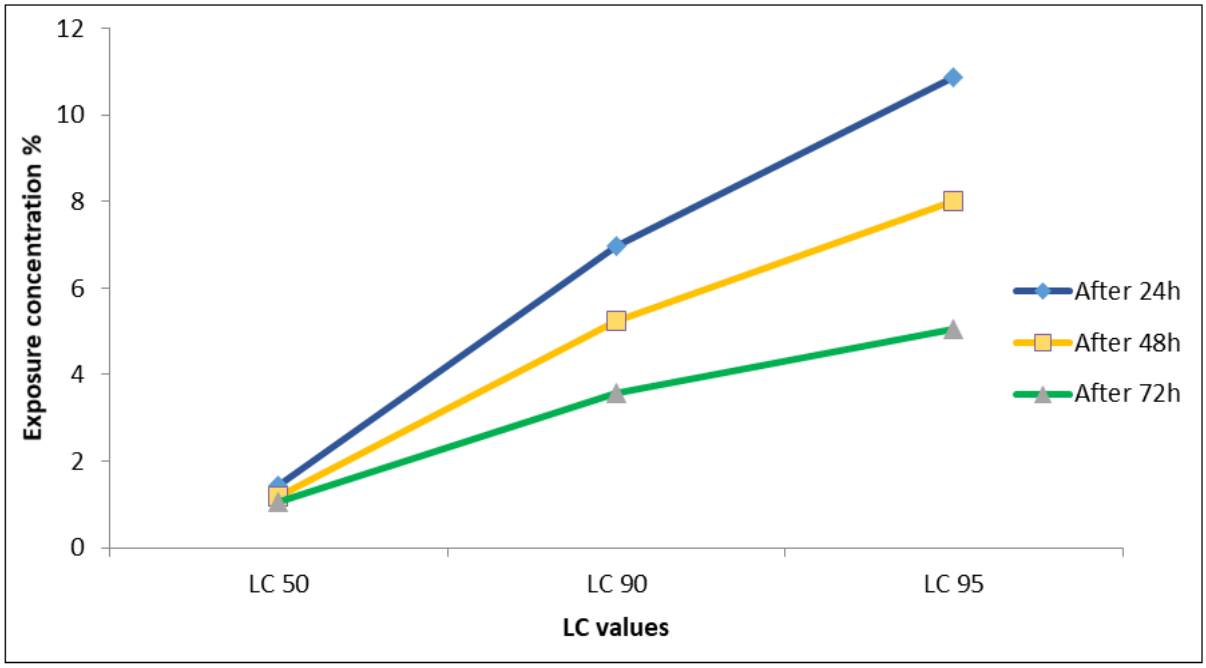

Fig. 2. The estimated LC values of fresh seed extract of *Anacardium occidentale* after different time period.

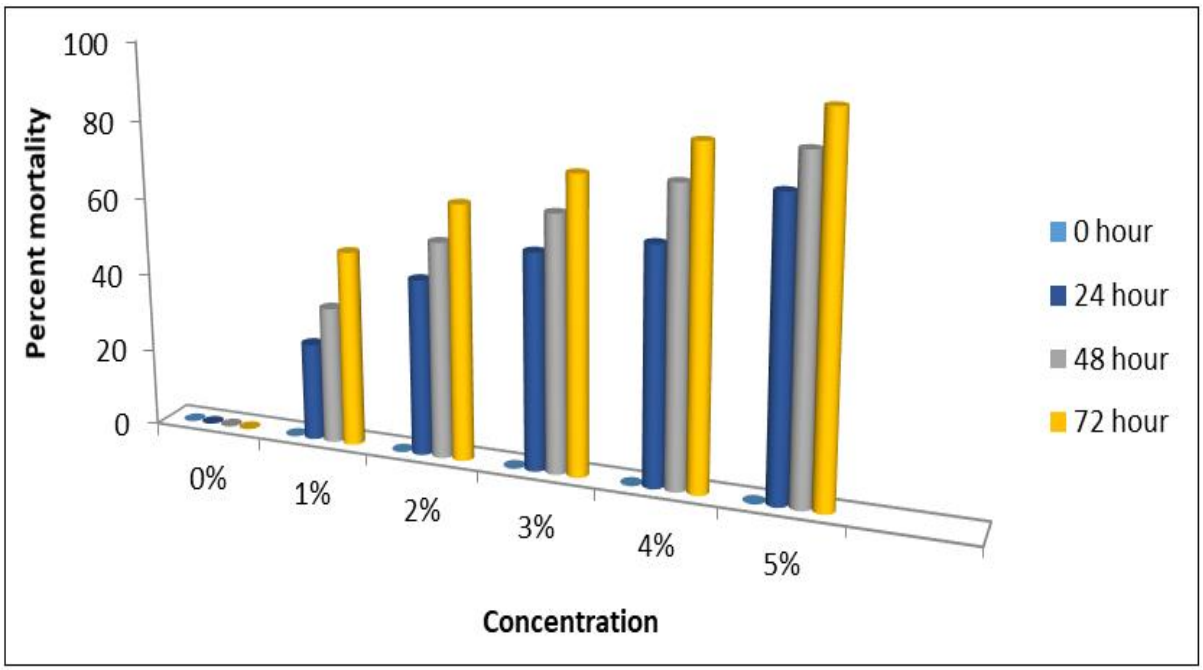

Fig. 3. Toxic effect of different concentration of fresh seed extract of *Azadirachta indica* on larvae of *Aedes aegypti* (L.) at different time period.

Toxic effect of fresh seed extract of Corchorus capsularis

The fresh seed extract of *Corchorus capsularis* was effective against late 3rd instar larvae of *Aedes aegypti* (L.) After 24 hours of exposure, maximum percentage of mortality (95%) observed at 5% concentration, which followed by 90%, 75%, 65% and 55% at 4%, 3%, 2% and 1% concentration respectively. After 48 hours of exposure maximum percentage of mortality (100%) observed at 5% concentration, at 4% concentration percent mortality was 95%, which followed by 85%, 75% and 65% at 3%, 2% and 1% concentration respectively. Maximum mortality of all the concentrations occurred after 72 hours of exposure, in which 100% larvae killed at 5% concentration.

At 4%, 3%, 2% and 1% concentration, percent mortality was 100%, 90%, 80% and 75%.

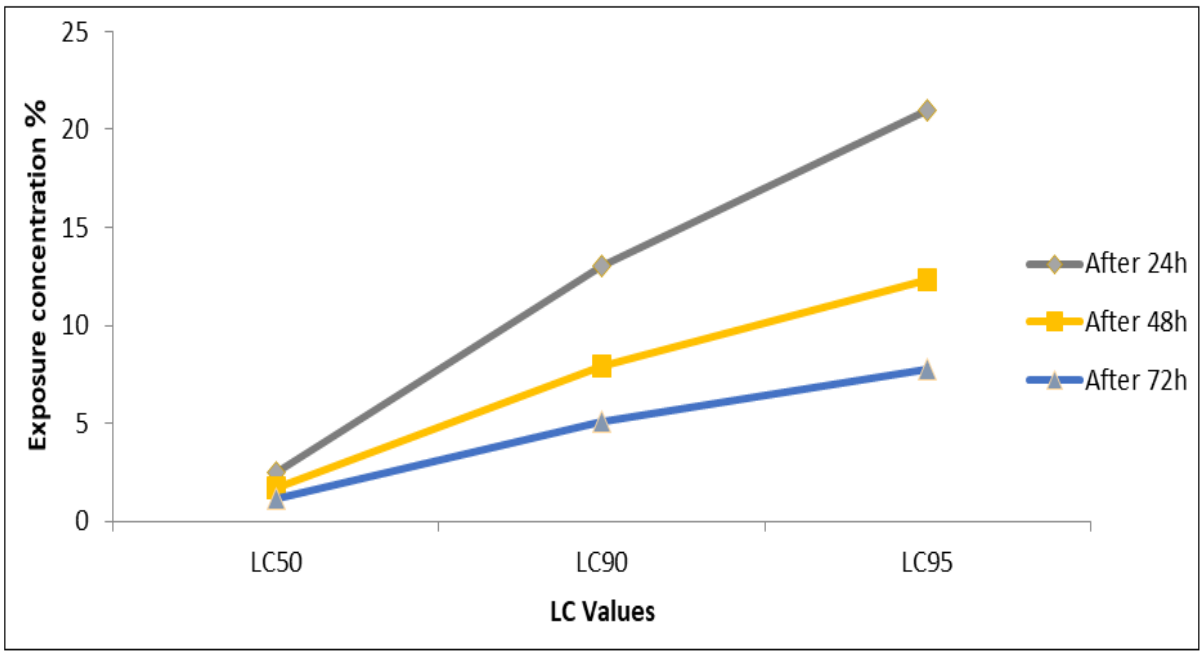

Fig. 4. The estimated LC values of fresh seed extract of *Azadirachta indica* at different time period.

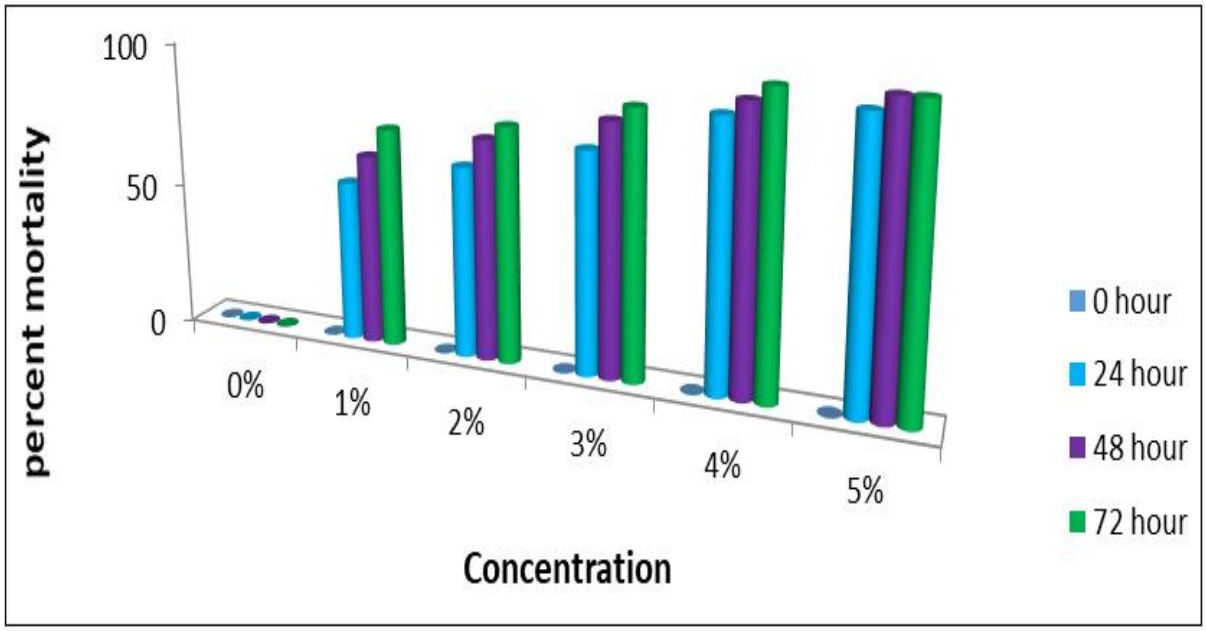

Fig. 5. Toxic effect of different concentration of fresh seed extract of *Corchorus capsularis* on larvae of *Aedes aegypti* (L.) at different time period.

Probit analysis revealed the LC_{50}, LC_{90} and LC_{95} values of the fresh seed extract of *Corchorus capsularis* with 95% confidence limit. LC_{50} value after 24 hours of exposure was 1.020, where after 48 and 72 hours it was 0.775 and 0.594 respectively. LC_{90} value after 24 hours of exposure was 4.723, where after 48 and 72 hours it was 3.3039 and 2.271 respectively. LC_{95} value after 24 hours of exposure was 7.293, where after 48 and 72 hours it was 4.475 and 3.321 respectively (Figure 06).

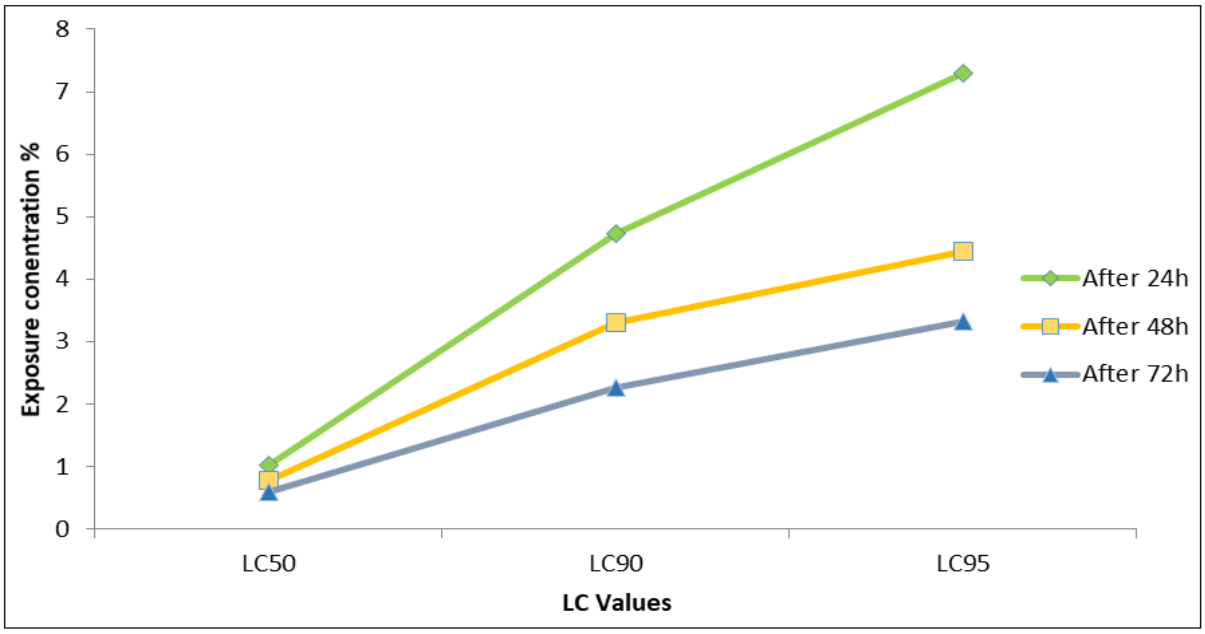

Fig. 6. The estimated LC values of fresh seed extract of *Corchorus capsularis* at different time period.

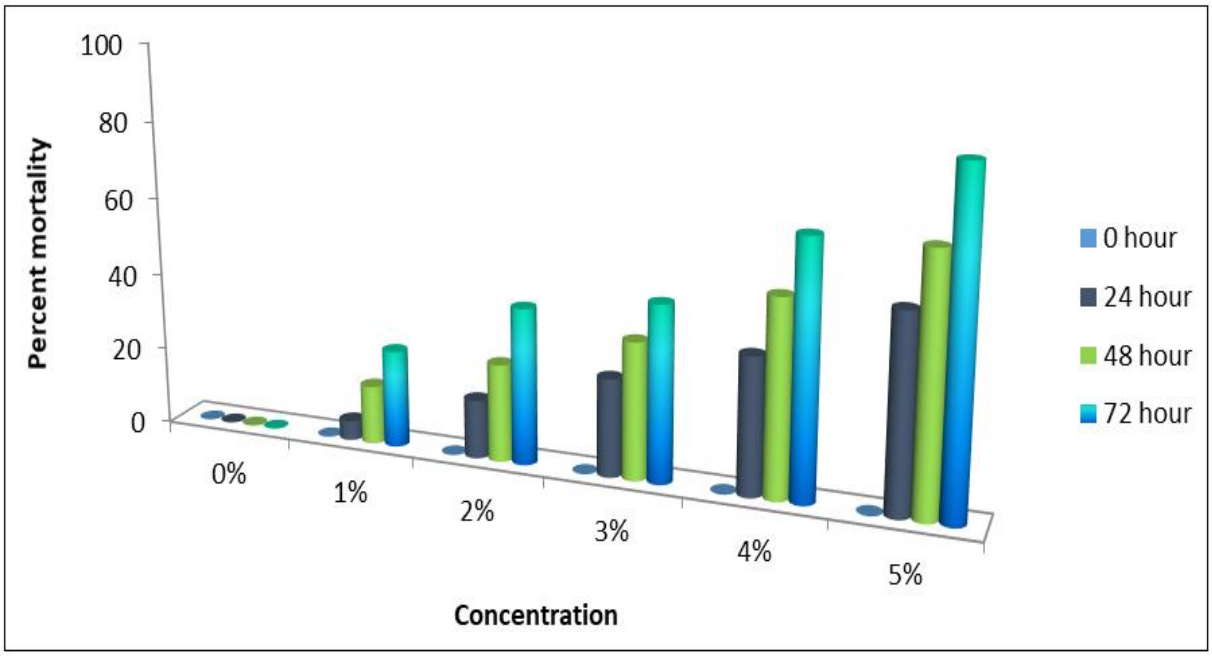

Fig. 7. Toxic effect of different concentration of fresh seed extract of *Momordica charantia* on larvae of *Aedes aegypti* (L.) at different time period.

Toxic effect of fresh seed extract of Momordica charantia

The fresh seed extract of *Momordica charantia* was effective against late 3rd instar larvae of *Aedes aegypti* (L.) After 24 hours of exposure, maximum percentage of mortality (50%) observed at 5%

concentration, which followed by 35%, 25%, 15% and 5% at 4%, 3%, 2% and 1% concentration respectively. After 48 hours of exposure maximum percentage of mortality (65%) observed at 5% concentration, at 4% concentration percent mortality was 50%, which followed by 35%, 25% and 15% at 3%, 2% and 1% respectively. Maximum mortality of all the concentrations occurred after 72 hours of exposure, in which 85% larvae killed at 5% concentration. At 4%, 3%, 2% and 1% concentration, percent mortality was 65%, 45%, 40% and 25% respectively (Figure 07).

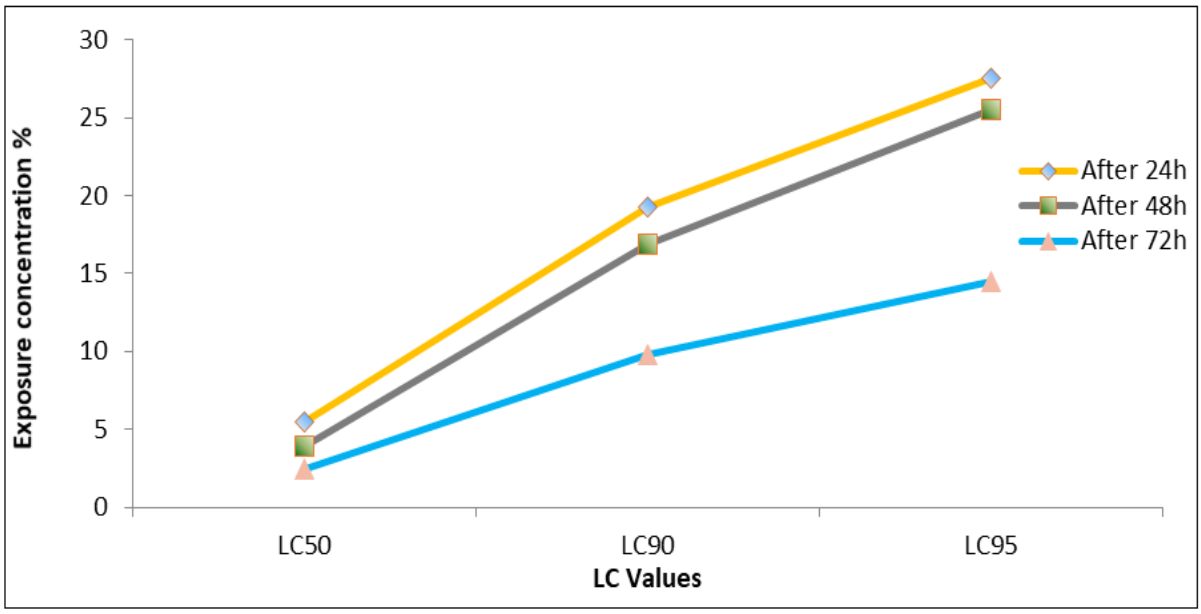

Fig. 8. The estimated LC values of fresh seed extract of *Momordica charantia* at different time period.

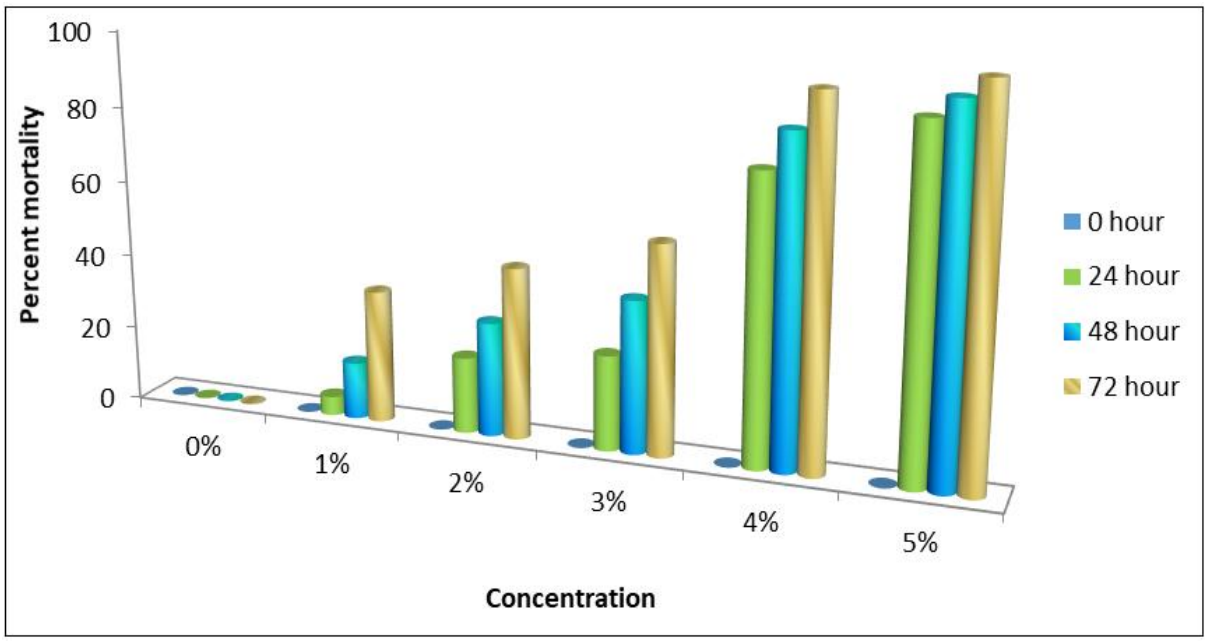

Fig. 9. Toxic effect of different concentration of fresh seed extract of *Swietenia mahagoni* on larvae of *Aedes aegypti* (L.) at different time period.

Probit analysis revealed the LC_{50}, LC_{90} and LC_{95} values of the fresh seed extract of *Momordica charantia* with 95% confidence limit. LC_{50} value after 24 hours of exposure was 5.476, where after 48 and 72 hours it was 3.889 and 2.472 respectively. LC_{90} value after 24 hours of exposure was 19.269, where

after 48 and 72 hours it was 16.845 and 9.824 respectively. LC_{95} value after 24 hours of exposure was 27.527, where after 48 and 72 hours it was 25.522 and 14.527 respectively (Figure 08).

Toxic effect of fresh seed extract of Swietenia mahagoni

The fresh seed extract of *Swietenia mahagoni* was effective against late 3rd instar larvae of *Aedes aegypti* (L.). After 24 hours of exposure, maximum percentage of mortality (90%) was observed at 5% concentration, which followed by 75%, 25%, 20% and 5% at 4%, 3%, 2% and 1% concentration respectively. After 48 hours of exposure maximum percentage of mortality (95%) was observed at 5% concentration, at 4% concentration percent mortality was 85%, which followed by 40%, 30% and 15% at 3%, 2% and 1% concentration respectively. Maximum mortality of all the concentrations occurred after 72 hours of exposure in which 100% larvae killed at 5% concentration. At 4%, 3%, 2% and 1% concentration, percent mortality was 95%, 55%, 45% and 35% respectively (Figure 09).

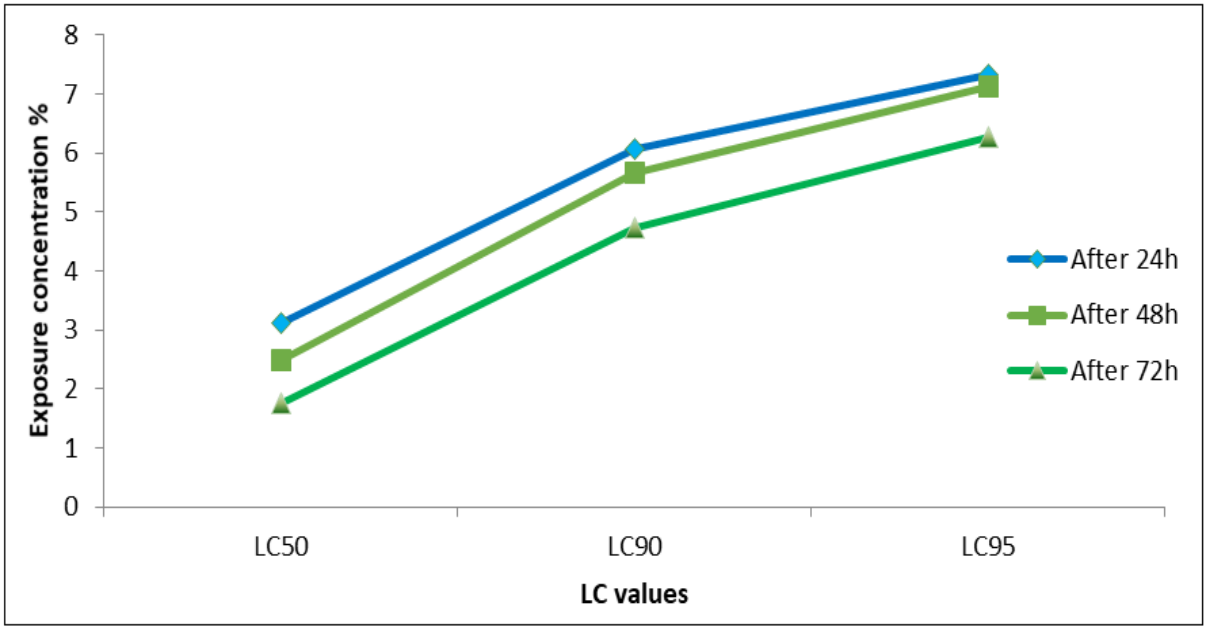

Fig. 10. The estimated LC values of fresh seed extract of *Swietenia mahagoni* at different time period.

Probit analysis revealed the LC_{50}, LC_{90} and LC_{95} values of the fresh seed extract of *Swietenia mahagoni* with 95% confidence limit. LC_{50} value after 24 hours of exposure was 3.118, where after 48 and 72 hours it was 2.494 and 1.749 respectively. LC_{90} value after 24 hours of exposure was 6.060, where after 48 and 72 hours it was 5.653 and 4.722 respectively. LC_{95} value after 24 hours of exposure was 7.316, where after 48 and 72 hours it was 7.129 and 6.258 respectively (Figure 10).

Toxic effect of fresh seed extract of Terminalia catappa

The fresh seed extract of *Terminalia catappa* was effective against Late 3rd instar larvae of *Aedes aegypti* (L.) After 24 hours of exposure, maximum percentage of mortality (60%) observed at 5% concentration, which followed by 55%, 40%, 25% and 15% at 4%, 3%, 2% and 1% concentration respectively.

After 48 hours of exposure maximum percentage of mortality (75%) observed at 5% concentration, at 4% concentration percent mortality was 65%, which followed by 50%, 35% and 25% at 3%, 2% and 1% concentration respectively. Maximum mortality of all the concentrations occurred after 72 hours of exposure in which 85% larvae killed at 5% concentration. At 4%, 3%, 2% and 1% concentration, percent mortality was 75%, 60%, 45% and 35% respectively (Figure 11).

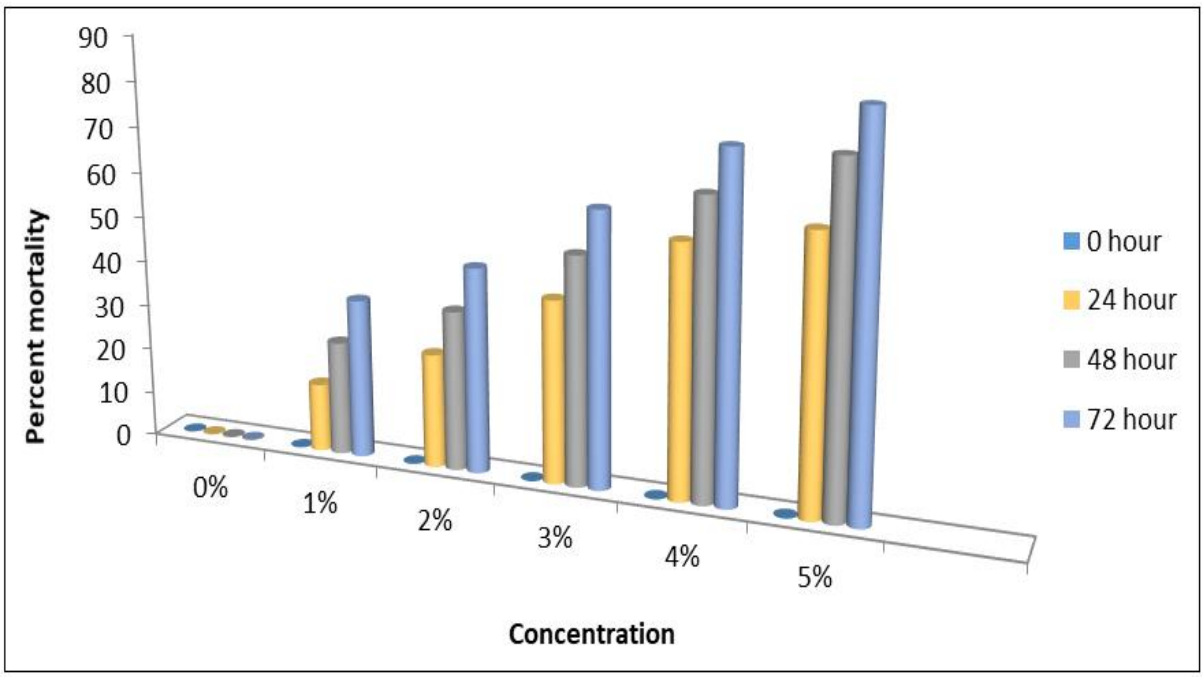

Fig. 11. Toxic effect of different concentration of fresh seed extract of *Terminalia catappa* on larvae of *Aedes aegypti* (L.) at different time period.

Probit analysis revealed the LC_{50}, LC_{90} and LC_{95} values of the fresh seed extract of *Terminalia catappa* with 95% confidence limit. LC_{50} value after 24 hours of exposure was 3.788, where after 48 and 72 hours it was 2.629 and 1.881 respectively. LC_{90} value after 24 hours of exposure was 16.904 where after 48 and 72 hours it was 12.021 and 8.512 respectively. LC_{95} value after 24 hours of exposure was 25.830, where after 48 and 72 hours it was 18.496 and 13.058 respectively (Figure 12).

Comparative toxicity

Elangovan *et al.* (2012) found that the larvicidal activity of *Corchorus capsularis* exerted by ethyl acetate was prominent than acetone and methanol extracts, in all the concentrations tested against *Aedes aegypti* larvae and the lethal concentration values LC50 of acetone, ethyl acetate and methanol extract of the *Corchorus capsularis* plant against *Aedes. aegypti* were 222.45ppm, 197.34ppm and 358.59ppm respectidly. Hexane and ethanol extracts of the *Anacardium occidentale* were subjected to larvicidal toxicity assay and showed great toxicities against *Aedes aegypti*, especially the ethanol extract with an LC50 of 2.35 mg/L on the first trial. The extracts were considered to be bioactive since they showed lethal concentrations (LC50 and LC90) extremely lower than 1000 mg/L (Torres RC *et al.*, 2015).

Koneri *et al.* (2016) found that mahogany (*Swietenia macrophylla*) seed extract against *Aedes aegypty* larvae very effective. LC50 values were at 6, 12, 18 and 24 hours after each application of 921.55 ppm, 358.09 ppm, 221.60 ppm and 142.14 ppm.

This means LC50 values was below 1000 ppm, therefore, it can be stated that allelokimia compounds contained in the ethanol extract mahogany seeds as bioactive compounds. Phytochemical analysis showed that the mahogany seed extract contained flavonoids, alkoloid, saponin, steroids and terpenoid the rate of mortality of the root extracts of Neem after 24 h were showed only root chloroform 100% mortality at the concentration level of 1000 ppm, followed by acetone (63%), refluxed in ethanol (26%) and macerated in ethanol (23%). After 48 h and at 1000 ppm. The mortality was 100, 93, 83, and 63% for chloroform, acetone, macerated in ethanol, and refluxed in ethanol respectively. The LC50 values of 48 h were 82.5, 375, 500, and 600 ppm for the acetone, chloroform, refluxed in ethanol, and macerated in ethanol respectively (Nour, AH *et al.* 2012).

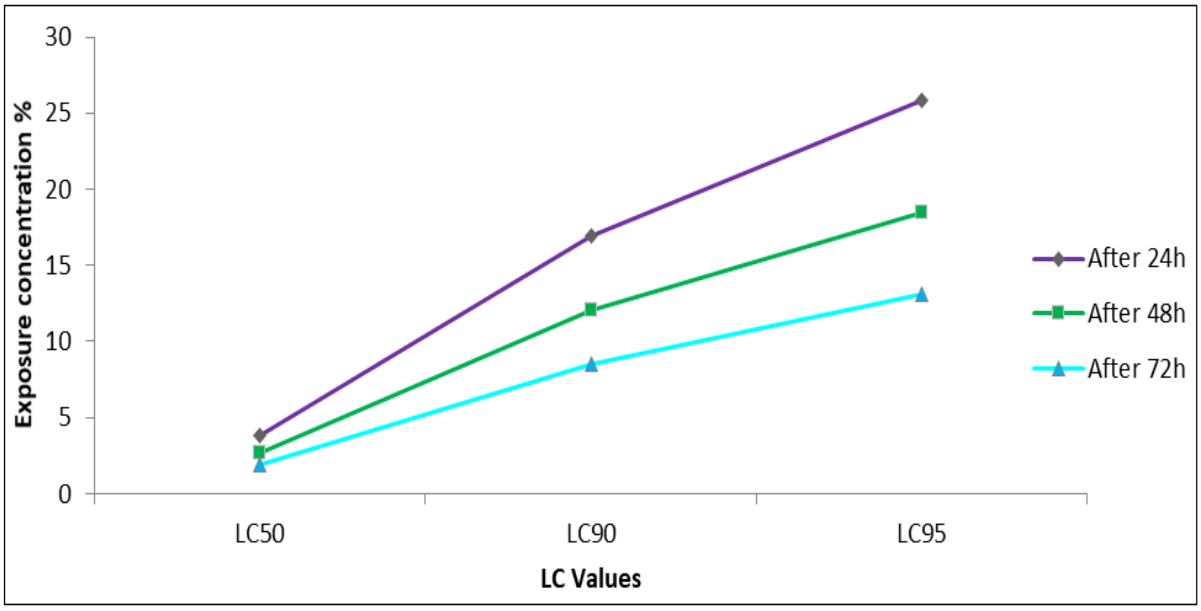

Fig. 12. The estimated LC values of fresh seed extract of *Terminalia catappa* at different time period.

Therefore, some of the obtained results differ from previous studies. This might be explained by the origin of the plants, types of solvents, method of extraction, formulation of the extracts and test material such as the larvae. Therefore, further study should be carried out to test the larvicidal potential against different type of mosquito species larvae with different formulation of extract and the dosage level.

Summary and conclusion

After 24 hours of exposure highest mortality (95%) of the larvae was observed in crude seed extract of *Corchorus capsularis* followed by 90% mortality in *Anacardium occidentale, Swietenia mahagoni* and 75% in *Azadiracta indica* respectively. Lowest mortality observed in *Momordica charantia* killing 50% larvae. Among all the test plants minimum LC_{50} value after 24 hours exposure was observed in crude seed extract of *Corchorus capsularis* (1.02), followed by *Anacardium occidentale* (1.44), *Azadiracta indica* (2.44), *Swietenia mahagoni* (3.11). The minimum LC_{90} values after 24 hours of exposure was observed in crude seed extract of *Corchorus capsularis* (4.72), followed by crude seed extract of *Swietenia mahagoni* (6.06) and *Anacardium occidentale* (6.96). The minimum LC_{95} values after 24 hours of exposure was observed in crude seed extract of *Corchorus capsularis* (7.29) followed by *Swietenia mahagoni* (7.31) and *Anacardium occidentale* (10.87). The results of this experiment indicates that the plant could be studied further in detail and its beneficial effect to the control of vector borne diseases could be utilized for healthy environment.

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