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Effect of Crude Tomato (*Lycopersicon esculentum*) Fruit Extract Against the Larvae of Dengue Vector – *Aedes aegypti*

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ABSTRACT: The principal vector of many prevalent tropical and sub tropical vector-borne communicable diseases like dengue, chikungunya, malaria, visceral leishmaniasis, Japanese encephalitis and filariasis across the globe are mosquitoes. They cause a number of deaths in the whole world every year. Therefore efficacious mosquito control is required in India and all over the world because due to the development of resistance against synthetic insecticides has caused alarming threats to mosquito control. Therefore, biological control is an alternative technique for the most challenging environmental quandaries and could provide environmentally safe cost-efficacious solution. The aim of the present study is to record the impact of the fruit extracts of *Lycopersicon esculentum* against first, second, third and fourth larval stages of dengue vector, *Aedes aegypti*, under the laboratory conditions. Mortality was visually examined for 24, 48 and 72 hours of exposure. The fruit extract exhibited promising larvicidal activity exhibiting 96.4% mortality, achieved at 40 ppm concentration level of fruit extract after 72 hours of exposure in the 1st instar and 2nd larvae of *Aedes aegypti*. The negative control showed much less mortality. Thus the present results of this study propose the crude fruit extract of *Lycopersicon esculentum* could possibly be utilized as an impeccable eco-amicable, safe and good biodegradable insecticide against the larvae of *Aedes aegypti*.

Keywords: *Lycopersicon esculentum*, *Aedes aegypti*, Larvicidal activity, mortality, LC_{50}, probit analysis.

INTRODUCTION

Mosquitoes belong to the order Diptera and family Culicidae (consisting of approximately 3,500 species), these effect more than 40% of the world's population which are prone to various vector borne diseases (VBDs) (El Hag *et al*., 1999; Dhiman *et al*., 2010; Pluempanupat *et al*., 2013). These diseases have a hazardous effect on both humans and animals. The VBDs like malaria, dengue fever, filariasis, sleeping sickness etc cause thousands of deaths annually (Pancharen and Kulwichit 2002).

The subfamily Anophelinae under hierarchy of family Culicidae encompass three medically important vectors comprising of Genera *Aedes, Anopheles* and *Culex* species. Annually affected cases of malaria in India are 1.48 million, with reported deaths of 173 persons yearly. Whilst, in 2006 and 2007 India reported the cases of chikungunya as 11,985 and affected cases of Japanese encephalitis were 5000 with 1000 mortality rates recorded. So were the cases of dengue 383 with recorded deaths to be 6 (Kumar *et al*., 2014).

The origin of *Aedes aegypti* is Central Africa, so it is a tropical and sub tropical mosquito responsible for many VBDs, out of which the most fatal are the yellow pyrexia, dengue pyrexia, dengue hemorrhagic pyrexia (DHF) and dengue shock syndrome (DSS) (Grantz, 1993).

The symptoms of dengue fever starts from mild fever to break-bone fever and a drastic drop in the blood platelet counts within 4 to 7 days of infected female *Aedes aegypti* bite. As after the blood feed only it will be able to lay eggs. The eggs are laid over the water surface in a container, or old tyres or water coolers so it is also called container breeder. The fresh eggs are white in colour but soon they change colour to black. (Figure Aa). The first larvae which emerges out of the eggs, feeds on the bacteria present in the water and very soon grows to the next larval stage by casting their skin and then from second to third instar, then fully grown fourth larvae is formed which is longer in length than the previous ones, ranging between 4-5 mm. (Figure Ab, Ac, Ad, Ae, Af, Ag).The adult *Aedes aegypti* is black in colour with white spots present on the whole body including head, thorax and abdomen. The legs exhibit white rings and wings are translucent with scales (In Figure Ag).

Aedes aegypti are diurnally active and bites after sunrise but some bite during the night also. Therefore, humans are more prone to the dengue virus transmission (Butt *et al*.,2 016). In India, as recorded by WHO (world health organization) there were more than 400 million people affected by dengue fever in Delhi, during 2014 so it was declared endemic (Kishore *et al*., 2011). Mosquito control surmises an ecumenical consequentiality because of medical suitability. However, as mosquitoes are proximately associated with humans and their dwellings, and have a number of breeding and behavioural quirks, it is profoundly

arduous to control or eliminate *Aedes aegypti* (CDC, 2016; WHO, 2016).

Synthetic insecticides were being used to eradicate mosquito vectors and were being used excessively as they were very effective and brought about immediate results (Supavarn *etal*.,1974) However, mosquitoes developed resistance gradually, against synthetic insecticides and additionally, affected biota due to their ever-increasing toxicity and being non-biodegradable in nature. Moreover, its incremented toxicity to non-target organism, adaptive vector deportment and environmental health concerns, raised constrains to the sustainable prosperity of control strategies, concretely those predicated on conventional synthetic chemicals (Kalyanasundaram and Das 1985; Morrison *et al.*, 2008; Araújo *et al*., 2021).

Since archaic times plants have been used as herbal insecticides to kill various vectors, which cause harm to humans and ecological systems. As the plants have proved to be more environmentally friendly, more effective and nontoxic to the non-target organisms, time to time so they are considered as the most effective alternative for controlling insects including mosquitoes. Now, globally, humans are using plant-based insecticides to control various species of mosquitoes and other blood sucking insects. Plant based secondary metabolites act as toxins to kill the vectors, to repel them or act as regulators to inhibit the growth of insects at different growth stages (Medina and Coussio 1977; Abdel-Halem *et al.*, 2004; Ghosh *et al* 2012; Luz *et al*., 2020).

Control of adult mosquitoes are more challenging task. Nevertheless, since mosquitoes are water breeders and, therefore, larval stages of the mosquitoes can be more effectively be controlled in water (Campbell *et al.,*1993). Hence application of plant-based insecticide in water bodies can be promising to control various vector borne diseases by controlling the larvae of mosquitoes (Singha *et al*., 2012; Kundu *et al*.,2013; Pani *et al*., 2015 ; Kanis *et al.,* 2018).

Most promising results are apparent in the largest plant family, that is, Solanaceae having 90 genera with 3,000 species present all over the World. They are a rich source of phytochemicals (Silva *et al*., 2004). The largest genus within this family, *Solanum* comprises of mostly vegetables having nearly about 1500 species which with a pool of diverse secondary metabolites like alkaloids, saponins, ascorbic acid (Roddick *et al*., 2001; Chowdhary *et al*., 2007; Gobbo-Neto, and Lopes, 2007; Liu *et al*., 2009; Jain *et al* 2011). These plant species exhibit a diverse array of biological activities, like, molluscicidal (Silva *et al.,* 2006) antimycotic (Singh *et al.,* 2007) cytotoxic, antiviral and teratogenic properties (Arthan *et al.,* 2002; Nakamura *et al.,* 1996; Lu *et al.,*2009;Subramaniam and Kovendann*et al.,* 2012;Ramesh Kumar,2017). The insecticides of herbal origin are inexpensive, more efficacious, environment convivial, facilely biodegradable(Chopra *et al*.,1956., Dharmapadda *et al.,* 2005;Govindarajan *et al.,* 2016).

The present study was carried out in the laboratory conditions to record the impact of crude fruit extract of *Lycopersicon esculentum* against the larval stages of *Aedes aegypti*. Tomato, commonly called as (*Lycopersicon esculentum*) (Figure Ba, Bb) is a annual shrub, grows to a height of 1-3 m. It possesses a woody stem and the fruit of tomato plant is edible. The fruit is brightly red in colour due to the presence of pigment lycopene (Jain and Rao 1976). The tomato is cultivated as a major crop, as well as found growing in wild habitat also, all over the world. Tomato is known to exhibit many medicinal properties, it is a chief source of vitamin C and possesses high antioxidant properties, anti-inflammatory, antispasmodic, laxative, hepatoprotective and antipyretic properties also (Neji *et al.,* 2018). Tomatoes are paramount source of phytochemicals which possess anti-cancer properties also, the active metabolites possess phenolic compounds, carotenoids and many vitamins which are used to neutralize free radicles and remove the toxins from the body. Besides biological activity of the crude extract, it contains potential cytotoxic activity (Trease and Evans 1996; George *et al*., 2010;Tiwari *et al.,* 2011; Raiola *et al*., 2014; Afreen *et al*., 2016). Tomatoes exhibit medicinal properties due to presence of secondary metabolites reveal various health benefits. It was also reported that tomato products could be used to truncate cardiovascular risk as high content of lycopene is found in them (Omodamiro and Amechi, 2013; Bhowmik *et al.,* 2012).

MATERIALS AND METHODS

Mosquito rearing: Eggs in diapauses had been collected on egg paper to be used for the culture of *Aedes aegypti* were taken from the different slum regions with hand net from local areas Prayagraj, UP, India. They were kept in a tray containing tap water. A 500 ml plastic cup is filled with 375 ml distilled water. 5 ml bovine liver powder suspension was added. A piece of egg paper containing 300 eggs were cut and placed in the cup. Overcrowding during development was avoided as this may result in smaller mosquitoes.

After 1-2 days, larvae when larvae have emerged were moved with a transfer pipette to a large (3 L) bowl containing 1.5 L water and were fed on bovine liver powder which was checked every 1-2 days. The larvae grew rapidly from first larval stage to second, then third and fourth. All the four larval stages were utilized for the study.Once larvae become pupae they were transferred into a 500 ml plastic cup containing 250 ml distilled water, which was placed into a rearing cage (quantifying 50 × 50 × 50 cm^3) covered with a fine mesh for trapping adults after their emergence. The adult males were provided with 10% sugar solution for feeding and the females were provided blood feed by placing a pigeon on top of the breeding cages and for oviposition petri dishes filled with 50 ml tap water lined with filter paper and kept inside the cages. The bowl that contained pupae or larvae was gathered. Required larval stages such as first, second, third and fourth will be collected and used for bioassay.

Cull of Plant and preparation of Fruit extract of *Lycopersicon esculentum*

The whole plant of tomato was procured from the agricultural grounds of SHUATS, Prayagraj, India. The

identification of tomato plants were done by Department of Botany, SHUATS, Prayagraj for taxonomic identification and substantiation of the species. 40gm of fresh green fruits of tomato were taken, washed with tap water and then dried. For the preparation of fruit extract it was grinded in a mortar and the grounded material was then filtered by cloth and then using the whatman no.1 filter paper kept in a funnel through which the grounded material passed.

Bioassay for assessment of larvicidal activity

The mosquito larvae were exposed to five test concentrations (10,20,30 and 40ppm each) and two controls (positive control and negative control) to find out the mortality of the materials under test in 24h, 48h, 72h and also to determine the LC_{50} value. Batches of 100 first, second, third and fourth instar larvae are transferred by means of strainers to small disposable test cups, each containing 100 ml of water. The appropriate volume of dilution was added to 100 ml in the cups to obtain the desired target dosage, starting with the lowest concentration. Three replicates were set up for each concentration and an equal number of controls are set up simultaneously with tap water, each test was run three times on different days. For long exposures, larval food was added to each test cup, particularly if high mortality was noted in control. The test containers were kept at room temperature and preferably a photoperiod of 12 h light followed by 12 h dark (12L:12D). After 24 h exposure, larval mortality was recorded. For slow-acting phyto-extracts, 48 h and 72h reading was required. Moribund larvae were counted and added to dead larvae for calculating percentage mortality. Dead larvae were those that cannot be induced to move when they were probed with a needle in the siphon or the cervical region, the results were recorded, from where the LC_{50}, values, fiducial limits and slope and heterogeneity analysis were calculated.

Data analysis:

The mortality of treated groups were corrected according to Abbott's formula,

$$\text{Mortality}(\%) = \frac{X - Y}{X} \times 100$$

where X = percentage survival in the untreated control and Y = percentage survival in the treated sample.

Data from all replicates was pooled for analysis. LC_{50} values were calculated from a log dosage–probit mortality regression line using computer software programs, or estimated using log–probit paper. Bioassays were repeated for three times, using new solutions or suspensions and different batches of larvae each time.

RESULT

Larvicidal properties of fruit extract of *Lycopersicon esculentum*:

The crude fruit extract of tomato was divided into five different concentrations; and the mortality of the *Aedes aegypti* larvae was visually examined. The entire test concentration reported considerable amount of larvicidal activity when tested against all the instar larvae of *Aedes aegypti*. The effects of the fruit extract of tomato were tested at 10,20,30 and 40 ppm each extract and showed activity against the first to fourth instar larvae of *Aedes aegypti* (Fig. A). There was moderate larvicidal activity recorded after 24 hours of exposure whereas the highest larval mortality was found in fruit extract of 40ppm.

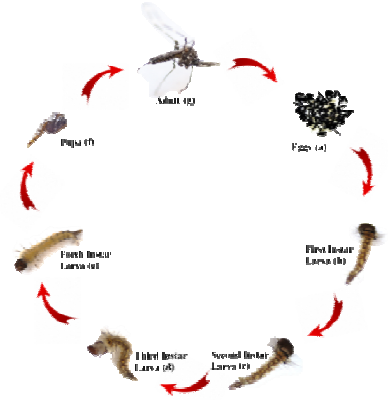

Fig. A: The Life Cycle of *Aedes aegypti*

Fig. B: The tomato Plant (a); tomato fruit (b); mature tomato fruit(c).

Larvicidal activity of crude fruit extracts: The larvicidal activity of different concentrations of green fruit extracts were shown in Fig. 1. It was calculated visually that 96.4% mortality was achieved in 40ppm concentration level of fruit after 72 hours of exposure in the 1st instar. Whereas, 92.8% mortality was visually examined at 30 ppm concentration level after 72 hours of exposure and lowest mortality percent was found being 42.5 % at 10 ppm concentration at 24 hours of exposure in the first instar larvae of *Aedes aegypti*.

The probit analysis and regression analysis were done in Table 1 for the mortality rates of 1st instar larvae in the crude fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (96.4%) at 40ppm concentration after 72 hours exposure.

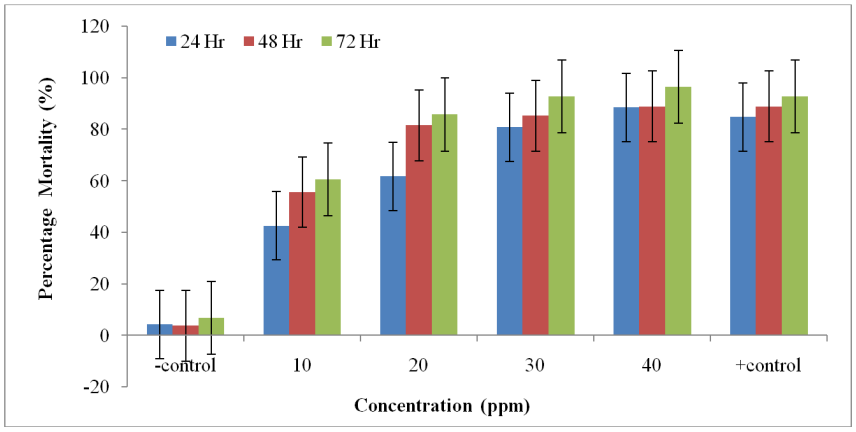

Fig. 1. Larvicidal activity of fruit extracts of tomato against 1st instar larvae of *Aedes aegypti* shown through percentage mortality. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean).

Table 1: Probit analysis and regression analysis of mortality rates of 1st instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	343.34	LFL (105.06) UFL (1122.02)	0.78	3.02
48	783.83	LFL (135.41) UFL (4537.41)	0.51	3.54
72	576.03	LFL (106.13) UFL (3126.46)	0.52	3.57

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

Statistical analysis confirmed the lowest value of LC_{50}(343.34) through visual examination after 24 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 24 hours is 105.06 – 1122.02 and the slope is 0.78. Followed by the LC_{50} (576.03) after 72 hours of exposure with 95% Fiducial Limits for LC_{50} being 106.13- 3126.46 and the slope is 0.52 and then after 48 hours of exposure LC_{50} (783.83) was visually examined with 95% Fiducial Limits (FL) for LC_{50}after 48 hours being106.13 - 3126.46.

In the given Fig. 2 the crude extract 10,20, 30 and 40 ppm of crude fruit of tomato was tested against second instar of *Aedes aegypti* larvae. It was visually examined that 96.4 percentage mortality was achieved in 40 ppm concentration level after 48 hours of exposure followed by 96.3% mortality at 40 ppm concentration level after 24 and 72hours of exposure. While lowest mortality percent was found to be 48.1 % it at 10 ppm concentration after 24 hours of exposure.

The probit and regression analysis were done for the mortality rates of 2nd instar larvae in the crude fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (96.4%) at 40ppm concentration after 48 hours exposure.

In Table 2: The lowest value of LC_{50}(287.60) was visually examined after 24 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 24 hours is 82.72 – 999.92 and the slope is 0.71. Followed by the LC_{50} (539.85) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 96.46- 3021.26 and the slope is 0.50 and then after 72 hours of exposure LC_{50} (594.16) was optically canvassed with 95% Fiducial Limits (FL) for LC_{50}after 72 hours being121.26 - 2911.20.

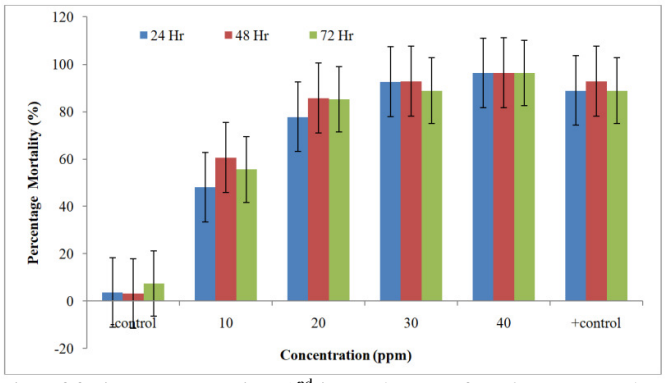

Fig. 2. Larvicidal activity of fruit extracts against 2nd instar larvae of *Aedes aegypti* shown through percentage mortality. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show the standard error of the mean).

Table 2: Probit analysis and regression analysis of mortality rates of 2nd instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	287.60	LFL (82.72) UFL (999.92)	0.71	3.24
48	539.85	LFL (96.46) UFL (3021.26)	0.50	3.62
72	594.16	LFL (121.26) UFL (2911.20)	0.56	3.44

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

In the given Fig. 3 the crude extract 10,20, 30 and 40 ppm of crude fruit of tomato was tested against 3rd instar of *Aedes aegypti* larvae. It was optically canvassed that 92.6 percent mortality was achieved in 40 ppm concentration level after 48 hours of exposure, followed by 92.3% mortality at 40 ppm concentration level after 72 hours of exposure, whereas lowest mortality percent being 15.7 % at 10 ppm concentration after 72 hours of exposure in third instar larvae of *Aedes aegypti*.

The probit analysis and regression analysis were done for the mortality rates of 3rd instar larvae in the crude fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (92.6%) at 40ppm concentration after 48 hours exposure.

In Table 3: The lowest value of LC_{50}(106.70) was observed after 72 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 72 hours is 60.15 – 189.29 and the slope is 1.73. Followed by the LC_{50} (129.31) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 63.85- 261.91 and the slope is 1.34 and then after 24 hours of exposure LC_{50} (130.05) was observed with 95% Fiducial Limits (FL) for LC_{50}after 24 hours being121.26 - 253.74.

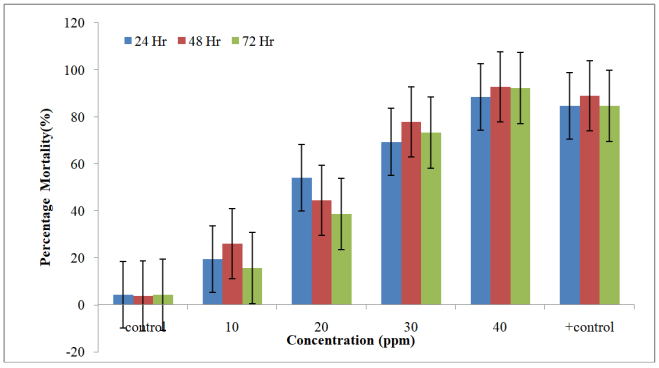

Fig. 3. Larvicidal activity of fruit extracts against 3rd instar larvae of *Aedes aegypti* shown through percentage mortality. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean).

Table 3: Probit analysis and regression analysis of mortality rates of 3rd instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	130.05	LFL (66.66) UFL (253.74)	1.46	1.92
48	129.31	LFL (63.85) UFL (261.91)	1.34	2.16
72	106.70	LFL (60.15) UFL (189.29)	1.73	1.47

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

In the given Fig. 4 the crude extract 10,20, 30 and 40 ppm of crude fruit extract of tomato was tested against 4th instar of *Aedes aegypti* larvae and was found that 96.3 percent mortality was achieved in 40 ppm concentration level after 48 hours of exposure, followed by 92.6% mortality at 40 ppm concentration level after 24 hours of exposure. While lowest mortality was observed being 14.8% at 10 ppm concentration at 24 hours of exposure in the 4th instar larvae of *Aedes aegypti* larvae.

The probit analysis and regression analysis were done for the mortality rates of 4thinstar larvae in the crude fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (92.6%) at 40ppm concentration after 48 hours exposure.

In Table 4: The lowest value of LC_{50}(106.70) was optically canvassed after 72 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 72 hours is 60.15 – 189.29 and the slope is 1.73. Followed by the LC_{50} (129.31) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 63.85- 261.91 and the slope is 1.34 and then after 24 hours of exposure LC_{50} (130.05) was visually examined with 95% Fiducial Limits (FL) for LC_{50}after 24 hours being 121.26 - 253.74.

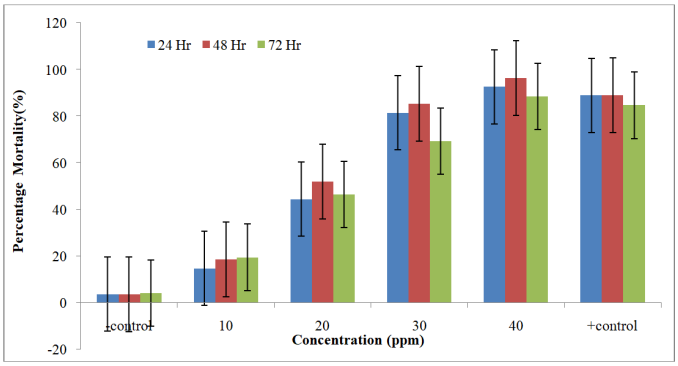

Fig. 4. Larvicidal activity of fruit extracts against 4th instar larvae of *Aedes aegypti* shown through percentage mortality. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean).

Table 4: Probit analysis and regression analysis of mortality rates of 4th instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	92.57	LF (54.06) UFL (158.50)	1.80	1.45
48	99.86	LFL (54.91) UFL (181.59)	1.58	1.83
72	127.95	LFL (66.45) UFL (246.37)	1.50	1.84

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

Effect of Emergence on crude extract of fruit of *Lycopersicon esculentum.* Crude extract (10, 20, 30 and 40ppm) of fruit tomato was tested against first instar larvae of *Aedes aegypti*(Fig. 5). It was visually examined that maximum emergence Inhibition (EI) was achieved 99.6% in 40ppm concentration level having average survival (0.7) after 72 hours of exposure .Followed by 96.4% of EI in 40ppm concentration level having average survival 0.7 after 48 hours of exposure.

Whereas the lowest (44.4%) EI was recorded at 10ppm concentration after 24 hrs of exposure.

In Table 5: The lowest value of LC_{50}(0.74) was optically canvassed after 72 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 24 hours is 0.22 – 2.53 and the slope is -1.11. Followed by the LC_{50} (0.92) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 0.29- 2.92 and the slope is -1.15 and then after 24 hours of exposure LC_{50} (1.71) was optically canvassed with 95% Fiducial Limits (FL) for LC_{50}after 24 hours being (0.66 - 4.45).

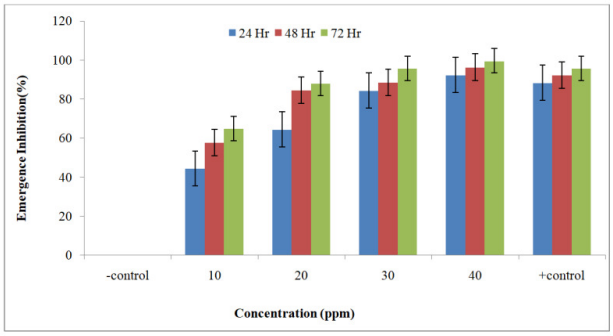

Fig. 5. EI of fruit extract against 1st instar larvae of *Aedes aegypti* shown through percentage EI. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean).

Table 5: Probit analysis and regression analysis of EI rates of 1st instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	1.71	LF (0.66) UFL (4.45)	-1.25	5.30
48	0.92	LFL (0.29) UFL (2.92)	-1.15	4.98
72	0.74	LFL (0.22) UFL (2.53)	-1.11	4.89

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

In the given Fig. 6 the crude extract (10, 20, 30 and 40ppm) of fruit of tomato was tested against second instar larvae of *Aedes aegypti*. It was visually examined that maximum EI was achieved 99.6% in 40ppm concentration level having average survival (0.3) after 48 hours of exposure. Followed by 96.2% of EI in 40ppm concentration level having average survival 1.0 after 24 hours of exposure.

Whereas lowest EI was checked visually being 50.0% at 10ppm concentration after circadian of exposure.

The probit analysis and regression analysis were done for the EIof 2nd instar larvae in the crude fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (99.6%) at 40ppm concentration after 48 hours exposure.

In Table 6: The lowest value of LC_{50}(0.52) was optically canvassed after 72 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 72 hours is 66.45 – 246.37 and the slope is 1.50. Followed by the LC_{50} (1.17) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 54.91- 181.59 and the slope is 1.58 and then after 24 hours of exposure LC_{50} (1.50) was optically canvassed with 95% Fiducial Limits (FL) for LC_{50}after 72 hours being 54.06 - 158.50.

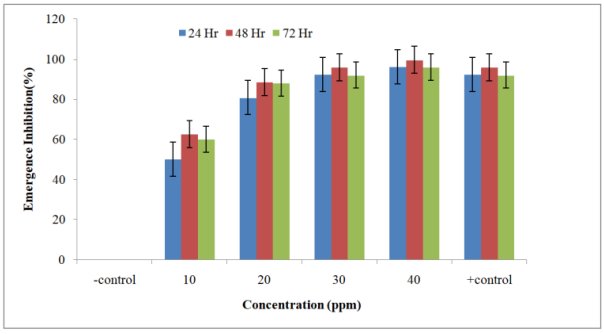

Fig. 6. EI of fruit extract against 2nd instar larvae of *Aedes aegypti* shown through percentage EI. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean).

Table 6: Probit analysis and regression analysis of EI of 2nd instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	1.50	LF (54.06) UFL (158.50)	1.80	1.45
48	1.17	LFL (54.91) UFL (181.59)	1.58	1.83
72	0.52	LFL (66.45) UFL (246.37)	1.50	1.84

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

In the above given Fig. 7 the crude extract (10, 20, 30 and 40ppm) of fruit of tomato was tested against third instar larvae of *Aedes aegypti*. It was visually examined that maximum EI was achieved 96.4% in 40ppm concentration level having average survival (0.7) after 72 hours of exposure.Followed by 96.2% of EI in 40ppm concentration level having average survival 0.7 after 48 hours of exposure. Next being 92.4% of EI in 40ppm concentration level having average survival 1.0 after 24 hours of exposure.
Whereas lowest EI was checked visually being 16.4% at 10ppm concentration after 72 hour of exposure.
The probit analysis and regression analysis were done for the mortality rates of 3rd instar larvae in the crude fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (96.4%) at 40ppm concentration after 72 hours exposure.
In Table 7: The lowest value of LC_{50}(3.57) was optically canvassed after 24 hours of exposure. Likewise 95% Fiducial Limits (FL) for LC_{50} after 24 hours is 1.74 – 7.29 and the slope is -1.57. Followed by the LC_{50} (4.39) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 2.32- 8.31 and the slope is -1.82 and then after 72 hours of exposure LC_{50} (4.54) was visually examined with 95% Fiducial Limits (FL) for LC_{50}after 72 hours being 2.42 – 8.49.

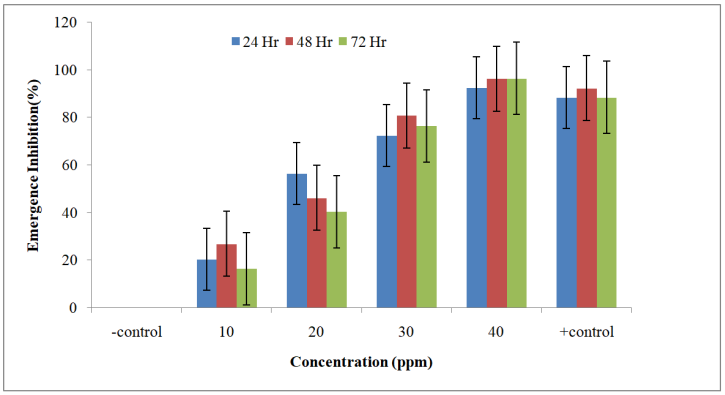

Fig. 7. EI of fruit extract against 3rd instar larvae of *Aedes aegypti* shown through percentage EI. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean)

Table 7: Probit analysis and regression analysis of EI of 3rd instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	3.57	LF (1.74) UFL (7.29)	-1.57	5.88
48	4.39	LFL (2.32) UFL (8.31)	-1.82	6.16
72	4.54	LFL (2.42) UFL (8.49)	-1.80	6.19

Where LC_{50} stands for Lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

In the above given Fig. 8 the crude extract (10, 20, 30 and 40ppm) of fruit of tomato was tested against fourth instar larvae of *Aedes aegypti* . It was optically canvassed that maximum EI was achieved 96.2% in 40ppm concentration level having average survival (0.7) after 24 and 48 hours of exposure.Followed by 92.4% of EI in 40ppm concentration level having average survival 1.0 after 72 hours of exposure.
Whereas lowest EI was visually examined being 15.4% at 10ppm concentration after circadian of exposure.
The probit analysis and regression analysis were done for the mortality rates of 4th instar larvae in the crude

fruit extract at different concentrations at 24,48 and 72 hours interval and found that the highest mortality rate (92.6%) at 40ppm concentration after24 and 48 hours exposure.

In Table 8: The lowest value of LC_{50}(3.89) was optically canvassed after 72 hours of exposure.Likewise 95% Fiducial Limits (FL) for LC_{50} after 72 hours is 1.95 – 7.76 and the slope is -1.61. Followed by the LC_{50} (4.44) after 48 hours of exposure with 95% Fiducial Limits for LC_{50} being 2.39- 8.24 and the slope is -1.91 and then after 24 hours of exposure LC_{50} (5.07) was visually examined with 95% Fiducial Limits (FL) for LC_{50}after 24 hours being 2.83 – 9.08.

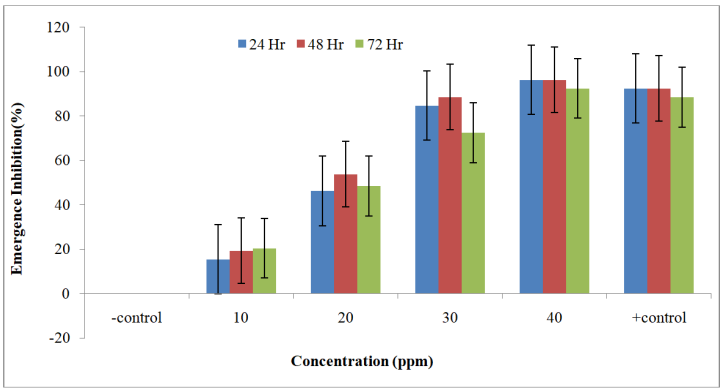

Fig. 8. EI of fruit extract against 4th instar larvae of *Aedes aegypti* shown through percentage EI. Larvae cultured in the absence of tomato fruit extract were treated as –control whereas, larvae cultured in full strength tomato fruit extract were treated as +control. (The bars above the graph show standard error of the mean).

Table 8: Probit analysis and regression analysis of EI of 4th instar larvae of *Aedes aegypti*.

Hours	LC_{50}	95% Fiducial CL	Slope	Intercept
24	5.07	LF (2.83) UFL (9.08)	-1.98	6.40
48	4.44	LFL (2.39) UFL (8.24)	-1.91	6.25
72	3.89	LFL (1.95) UFL (7.76)	-1.61	5.95

Where LC_{50} stands for lethal concentration at 50%
LFL stands for lower fiducial limit
UFL stands for upper fiducial limit

DISCUSSION

Dengue pyrexia has become a community health quandary with large number of cases being increment every year, with more rigorous forms of the disease, dengue hemorrhagic pyrexia, and DSS which may sometime effect the central nervous system involution (Hag *et al*., 1999; Pluempanupat *etal.*, 2013; Dhiman *et al.,* 2010). Mosquito control, postulates ecumenical paramountcy. So to achieve immediate results utilization of puissant synthetic insecticides were utilized. Albeit they were efficacious, they engendered many quandaries, such as insecticide resistance (Lixin *et al*., 2006), hazardous to human health and cause water pollution (WHO, 1992). The dangerous vector-borne diseases could be efficaciously dealt by the plant based insecticides at the individual as well as at the community level (Liu *et al.,* 2005). The plant-based insecticide have been given consequentiality due to non-toxic, biodegradable and eco-convivial nature to overpower the synthetic insecticides in the control of various VBD (Vohora and Kumar,1971; Yadav and Agarwal, 2011; França *et al*., 2021). Many approaches have been put forward to control the mosquito danger. Out of them the most effective is to kill the mosquitoes in its larval form so that the mosquito borne diseases can be controlled. The present study evaluates the effect of crude fruit extract against all the four larval stages of *Aedes aegypti*. It was optically canvassed that the highest mortality being 96.4% was achieved in 40ppm concentration level of fruit extract after 72 hours of exposure in the 1st instar and 2nd instar larvae of *Aedes aegypti*. Whereas, at a very low concentration of 10ppm, extract of fruit of *Lycopersicon esculentum* resulted in 60.66 and 46.2 percent mortality of 1st instar larvae after 72 h of exposure which designates its bio-control potentiality.

CONCLUSION

In the present study the effect of *Lycopersicon esculentum* fruit extract against dengue vector, *Aedes aegypti* was found to be highly effective as high mortality rates were observed probably due to the presence of secondary metabolites such as lycopene, phytoene, phytofluene, ascorbic acid and polyphenols including quercetin, kaempferol, naringenin which either in single form or in amalgamated form with other are responsible compounds for sundry larval death. The present investigation revealed that the fruit of *Lycopersicon esculentum* has a potential source of serviceable drugs due to the presence of phytoextracts

like phytoene, lycopene having the highest concentration about 85%, phytofluene, ascorbic acid and pro-vitamin A, carotenoid β-carotenoid, polyphenols including quercetin, kaempferol, naringenin and can be utilized in the treatment of many diseases. The future scope studies are required to isolate the active component from the crude plant extract for opportune mosquito control management.

FUTURE SCOPE

The present study reflects the larvicidal potency of fruit extracts obtained from *Lycopersicon esculentum* against *Aedes aegypti* larvae which is the basic and most important step in the development of a larvicide of botanical source. The identification and isolation of the active component is a part of further research at molecular level for an efficacious, environment convivial, facilely biodegradable biopesticide.

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Conflict of Interest. None.

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