Original Research Article

Biological activity of *Cupressus sempervirens* extracts against*Musca domestica*.

Abstract:

The biological activity against the larval, pupal and adult stages, moreover, the efficacy on reproductive potential, antifeedant and repellency activity of ethanolic, acetone and petroleum ether, leaves and stems extracts of*C. sempervirens*against the housefly, *M. domestica*was evaluated. The larval and pupal duration, pupal mortality, adult emergence and growth index were highly affected by different extracts tested. The antifeedant and repellent activity of was varied depending on solvent, plant parts used in extraction and the dose of extract.Tested extracts significantly reduced the fecundity and increased the sterility. Based on LC_{50}, the toxicity may be arranged as follows: leaves > stems. Petroleum ether extract from leaves was more effective in inducing the fecundity, antifeedant, repellent actions and egg-hatchability than those from stems.These results may provide an opportunity to develop alternatives to costly organic pesticides using some available cheap plants, which are usually safe to the environment and to other living organisms.

Keywords:*C. sempervirens,M. domestica,*toxicity, fecundity, antifeedant, pesticides.

Introduction

The housefly, *M. domestica*(Diptera: Muscidae) is cosmopolitan, itgenerally breeds in decaying organic matter and feeds in manure, garbage and food left out by humans(Morey and Khandagle, 2012**)**. The housefly is an important medical insect pests that causes irritation, spoils food and acts as a vector for more than 100 human and animal pathogenic organisms such as entomopathogenic bacteria, enterovirus and protozoa cysts (Hanan, 2013). Adult houseflies have been shown to transmit pathogens from their sponging mouthparts, through vomitus on the sticky parts of the feet and through the intestinal tract, thereby contaminating food and propagating disease (De Jesús *et al*., 2004).

Control of housefly largely relies on chemical insecticides. Unfortunately, houseflies have developed resistance to most of synthetic insecticides (Khan *et al*., 2013). In addition, syntheticinsecticides have adverse effect on environment, health and threat of persistence the bio-magnifications through the food chain (Kumar *et al*., 2012; Ito *et al*., 2015).Recently, the application of botanical products has drawn much attention as effective alternatives to the synthetic pesticides; these plant products are reported to be more effective, less expensive, biodegradable and safe for mankind and environment than synthetic counterparts (Singh *et al*., 1996). Therefore, alternatives to conventional insecticides are required to be developed from the active ingredients of plant origin, and these compounds may serve as insecticides, antifeedants, repellents as well as attractants (Murugesan*et al*., 2016; Ito and Ighere, 2017).

The present study aimed to evaluate the biological, antifeedant and repellent activities of *C. sempervirens*plant extracts against the larvae and adults of the housefly, *M. domestica*.

Materials and Methods

1. Laboratory maintenance of *M. domestica*.

The culture of the houseflywas maintained for several generations under controlled conditions of 27±2 °C and 70-75RH and 12-12 light/dark. The emerged flies were fed on dry diet (milk powder) and sucrose solution. Eggs were collected from paper strips or from cotton pads of feeding.Larvae were reared on an artificial diet (wheat bran, milk, powder yeast; 200:100:5gm) per 200 ml of distilled water according a method described by (Busvine,1962).

2. Extraction of plant materials.

The plant parts were left to dry after collecting from natural habitats at room temperature for 7 days and pulverized to powder separately in a hammer mill.The extraction was performed using 70% ethanol, acetone and petroleum ether solvents. One hundred grams of powder from each part of the plant for each solvent separately were extracted five times with 300ml of aqueous 70% ethanol, acetone and petroleum ether at room temperature. After 24 hours the supernatants were decanted, filtrated through Whatman filter paper No. 5 and dried in a rotary evaporator at 40 ^{o}C for 2-3 hours for ethanol and 40-60 min. for other solvents. The dry extracts were weighed and kept in deep freezer at -4^{o}C till using for experiments.

3. Experimental bioassay.

Twenty-five 3rdinstar larvae were transferred intodifferent ranges of concentrations of each concerned extract that was prepared to detect mortalities.Three replicates were used for each tested concentration. Mortality was recorded daily and dead larvae and pupae were removed until adult emergence.Larval duration was calculated as the intervals between the commencements of first instar larvae and thecommencement of pupation, it was calculated for each larva and then the mean value was taken.

The pupation percentage (P%) was estimated by using the following equation: P = A/B×100.*Where:* A = number of pupae, B = number of tested larvae.The pupal mortality percentage (PM%) was estimated by using the following equation: PM =A–B/A× 100.*Where:* A = number of produced pupae, B = number of observed adults.Pupal duration was calculated as interval between the commencement of pupation and thecommencement of adult emergence, it was calculated for each one and then the mean value was taken.

The emerged adult males and females were counted and the adult emergence (AE%) was calculated byusing the following equation: AE%= A/B×100. Where: A = number of emerged adults, B = numberof tested pupae.

The adult females that succeeded to emerge from treated larvae with each concentration were collected andtransferred with normal adult males obtained from the colony to the wooden cages by using anelectric aspirator recommended by (WHO), and fed with 10% sugar solution for three days, then, the adult malesand females were starved for one day. At fifth day, the starved females were allowed to take a blood meal froma pigeon and allowed to lay egg rafts on clean water. The number of egg/raft was counted by using binocular andthen mean value was taken.The Egg-hatchability percentage was calculated by using the following equation:Egg hatchability % = A/B×100. Where: A = total no. of hatched eggs, B = total no. of eggs laid.The Sterility percentage was estimated according to the formula of (Toppozada*et al.*1966): Sterility percentage = 100 – [a×b /A×B]×100.

Standard cages were used to test the repellent activity of plant extracts. Cotton pieces soaked in 10% sucrose solution and different concentrations of plant extracts added to the wooden cages containing certain number of starved individuals 5-7 day-old for three hours. Control tests were carried out alongside with the treatments using cotton pieces soaked in 10% sucrose solution with 2 drops of Tween80. Each test was repeated three times to get a mean value of repellent.

4. Statistical analysis.

Statistical analysis of the data was carried out according to the method of (Lentner *et al.*, 1982). The analysis was revised and graphics were drawn by Excel for Microsoft office 2010.The obtained data were assessed by calculation of the mean (M) and standard deviation (SD). The LC_{50} was calculated using multiple linear regression (Finney, 1971).

Results

5. Biological activity of *C. sempervirens* against*M. domestica*.

1-1- Ethanolic extract.

Data given in (Table 1) shows the effect of ethanol extract of*C. sempervirens*(leaves) against different biological aspects of *M. domestica.*The larval mortality percent (LM) and the mean larval duration (MLD) were concentration-dependent. There was a negative correlation between the P% and the concentration used. The mortality percent of pupae were recorded 12.5, 11.8, 8.4 and 8.7% at the concentrations of 2000, 1700, 1400 and 1100 ppm; respectively.

Table (1): Effect of ethanol extract of *C. sempervirens*(leaves) on mortality percent, developmentaland growth index of different stages of *M. domestica.*

Conc. ppm	LM %	MLD	P %	PM %	MPD	LPM %	AE% (a)	MD (b)	GI (a/b)
2300	100.0	--	--	--	--	100.0	0.0	--	--
2000	84.0	4.2±0.3[d]	16.0	12.5	4.6±0.2 [a]	96.4	87.5	8.8±0.5 [a]	9.9
1700	68.0	3.7±0.11[c]	32.0	11.8	4.0±0.7 [a]	79.6	88.2	7.7±0.8 [a]	11.5
1400	52.0	3.5±0.20[b]	48.0	8.4	4.3±1.1 [a]	60.4	91.6	7.9±1.5[a]	11.6
1100	36.0	3.2±0.19[a]	64.0	8.7	3.8±0.3 [a]	44.5	91.3	7.0±1.0 [a]	13.0
800	20.0	3.0±0.12[a]	80.0	0.0	4.1±0.6 [a]	20.0	100.0	7.1±1.61 [a]	14.1
Control	2.8	2.9±0.19	97.2	0.0	3.9±0.45	2.8	100.0	6.8±0.64	14.7

Within each column, means with different letter are significantly different (P<0.05) &MLD, MPD and MD are calculated as (Days±SD).

The mean pupal duration (MPD) was non-significantly (P>0.05) affected. The larval and pupal mortality percent (LPM %) was gradually increased as the concentration used increased. The AE % was recorded 87.5 % for adults resulted from larvae treated with 2000 ppm and this percent was increased as the concentrations decreased. The growth index (GI) for larvae and pupae was not affected at all concentrations used as compared with the control group.

Table (2): Effect of ethanol extract of *C. sempervirens*(stems) on mortality percent, developmentaland growth index of different stages of *M. domestica.*

Conc. ppm	LM %	MLD	P %	PM %	MPD	LPM %	AE% (a)	MD (b)	GI (a/b)
2300	100.0	--	--	--	--	100.0	0.0	--	--
2000	84.0	4.2±0.37 [b]	16.0	0.0	3.8±0.22 [a]	84.0	100.0	8.0±0.59 [a]	12.5
1700	62.8	3.7±0.12 [a]	37.2	0.0	4.0±0.20 [a]	62.8	100.0	7.7±0.32 [a]	13.0
1400	38.8	3.5±0.40 [a]	61.2	0.0	4.0±0.13 [a]	38.8	100.0	7.5±0.53 [a]	13.3
1100	29.2	3.2±0.78 [a]	70.8	0.0	3.8±0.28 [a]	29.2	100.0	7.0±1.06 [a]	14.3
800	16.0	3.0±0.93 [a]	84.0	0.0	4.1±0.14 [a]	16.0	100.0	7.1±1.07 [a]	14.1
Control	8.0	2.9±0.24	92.0	0.0	3.9±0.19	8.0	100.0	6.8±0.43	14.7

Within each column, means with different letter are significantly different (P<0.05) &MLD, MPD and MD are calculated as (Days±SD).

The effect of ethanol extract of *C. sempervirens* (stems) against different biological aspects of *M. domestica* given in (Table 2).Complete larval mortality 100.0 % was caused at the highest concentration 2300 ppm, meanwhile the lowest value 16.0 % was occurred at the lowest concentration used 800ppm compared to 8.0 % for the control group. The MLD was insignificantly (P>0.05) affected by all concentrations used except the highest concentration 2000 ppm, which prolonged it to 4.2±0.37 (days) against the control group. There was a negative correlation between the P % and the concentration used. The PM % was insignificantly (P>0.05) affected by all concentrations used. The LPM % was gradually increased as the concentration used increased. The GI for larvae and pupae was not affected at all concentrations used as compared with the control group.

1-2- Acetone extract.

The biological activity of acetone extract of *C. sempervirens* (Leaves) against the 3rd instar larvae of *M. domestica* was recorded in (Table 3). Results obtained revealed that, the LM % was concentration-dependent; the highest LM % (100.0) was caused by the concentration 1500 ppm. The MLD was insignificantly (P>0.05) affected by all concentrations used. A reduction in P % was recorded at all concentrations used.

Table (3): Effect of acetone extract of *C. sempervirens*(leaves) on mortality percent, developmentaland growth index of different stages of *M. domestica*.

Conc. ppm	LM %	MLD	P %	PM %	MPD	LPM %	AE% (a)	MD (b)	GI (a/b)
1500	100.0	--	--	--	--	100.0	0.0	--	--
1300	89.2	1.9±0.10 [c]	10.8	74.1	3.8±0.25[d]	96.4	25.9	5.7±0.35 [d]	4.5
1100	72.0	2.5±0.24 [a]	28.0	56.0	3.9±0.23 [d]	77.6	44.0	6.4±0.47 [c]	6.9
900	48.0	2.6±0.22 [a]	52.0	76.9	3.7±0.19 [d]	55.6	23.1	6.3±0.41 [c]	3.7
700	36.0	2.8±0.17 [a]	64.0	68.8	3.8±0.11 [d]	42.8	31.2	6.6±0.28 [c]	4.7
500	22.8	3.0±0.23 [a]	77.2	62.2	3.8±0.14 [d]	28.8	37.8	6.8±0.37 [b]	5.6
Control	6.8	2.8±0.41	93.2	0.0	5.4±0.29	6.8	100.0	8.2±0.70	12.2

Within each column, means with different letter are significantly different (P<0.05) &MLD, MPD and MD are calculated as (Days±SD).

There was a toxic effect of acetone extract on the pupae resulted from treated larvae, the highest PM % (74.1 %) was induced at the concentration 1300 ppm. The MPD was significantly (P<0.05) affected by all concentrations used. The LPM % was increased as the

concentration used increased. A sharp reduction in AE % among the adults developed from the treated larvae at all concentrations was exhibited. A very retarded effect on growth of larvae, pupae and adult was observed especially at the highest concentration 1300 ppm.

Data given in (Table 4) shows the biological activity of acetone extract of *C. sempervirens* (stems) against the 3rd instar larvae of *M. domestica.*The highest LM % (100.0 %) was occurred at the concentration of 1500 ppm, while the lowest percent 17.2 %was occurred at the concentration of 500 ppm. The MLD was insignificantly (P>0.05) affected by all concentrations used except the highest concentration 1300ppm.

Table (4): Effect of acetone extract of *C. sempervirens*(stems) on mortality percent, developmentaland growth index of different stages of *M. domestica*.

Conc. ppm	LM %	MLD	P %	PM %	MPD	LPM %	AE% (a)	MD (b)	GI (a/b)
1500	100.0	--	--	--	--	100.0	0.0	--	--
1300	90.8	1.9±0.10 [b]	9.2	10.6	3.8±0.29 [a]	98.8	89.4	5.7±0.39 [a]	15.7
1100	69.2	2.5±0.24 [a]	30.8	10.0	3.9±0.21 [a]	76.0	96.1	6.4±0.45 [a]	15.0
900	48.0	2.6±0.19 [a]	52.0	9.5	3.7±0.14 [a]	52.4	90.5	6.3±0.33 [a]	14.4
700	30.8	2.8±0.33 [a]	69.2	0.0	3.8±0.10 [a]	30.8	100.0	6.6±0.43 [a]	15.2
500	17.2	2.7±0.15 [a]	82.8	0.0	3.8±0.15 [a]	17.2	100.0	6.5±0.30 [a]	15.4
Control	12.0	2.7±0.27	88.0	7.7	4.6±0.65	16.7	92.3	7.3±0.92	12.6

Within each column, means with different letter are significantly different (P<0.05) &MLD, MPD and MD are calculated as (Days±SD).

There was a negative correlation between the P % and the concentration used. No significant effect on the pupal duration was recorded.The GI did not affected by acetone extract at all concentrations used as compared with the control group.

1-3- Petroleum ether extract.

Table (5): Effect of Petroleum ether extract of *C. sempervirens* (leaves) on mortality percent, developmentaland growth index of different stages of *M. domestica*.

Conc. ppm	LM %	MLD	P %	PM %	MPD	LPM %	AE% (a)	MD (b)	GI (a/b)
1000	100.0	--	--	--	--	100.0	0.0	--	--
800	84.0	4.2±0.22 [a]	16.0	81.1	7.3±0.41 [c]	92.0	18.9	11.5±0.63 [c]	1.6
600	66.7	3.9±0.18 [a]	33.3	84.3	6.9±0.19 [c]	74.8	15.7	10.8±0.37 [c]	1.5
400	53.3	3.3±0.36 [a]	46.7	73.2	7.1±0.91 [c]	60.0	26.8	10.4±1.27 [b]	2.6
200	28.0	2.8±0.21 [a]	72.0	59.7	6.6±0.78 [c]	33.6	40.3	9.4±0.99 [a]	4.3
Control	12.0	2.7±0.27	88.0	7.7	4.6±0.65	16.7	92.3	7.3±0.92	12.6

Within each column, means with different letter are significantly different (P<0.05) &MLD, MPD and MD are calculated as (Days±SD).

Data given in (Table 5) indicated the biological activity of petroleum ether extract of *C. sempervirens* (Leaves) against the 3rd instar larvae of *M. domestica.*Complete LM %(100.0 %) was caused at the highest concentration used 1000 ppm. Meanwhile, the LM %

decreased to 28.0 at the lowest concentration 200 ppm. The MLD was insignificantly (P>0.05) affected by all concentrations used.A negative correlation between the P % and the concentration was observed; the P % was 0.0 at the highest concentration 1000 ppm and 72.0 at the lowest concentration 200 ppm. A toxic effect on the pupae resulted from treated larvae was observed.The MPD was affected by petroleum ether extract tested. A remarkable reduction in the AE % was also observed.The GI was greatly affected by tested extract.

On the other hand, the biological activity of stems petroleum ether extract was revealed in (Table 6).

Table (6): Effect of Petroleum ether extract of *C. sempervirens* (stems) on mortality percent, developmental and growth index of different stages of *M. domestica*.

Conc. ppm	LM %	MLD	P %	PM %	MPD	LPM %	AE% (a)	MD (b)	GI (a/b)
1000	**100.0**	--	--	--	--	**100.0**	**0.0**	--	--
800	**84.0**	**3.9±0.98** [a]	**16.0**	**100.0**	--	**100.0**	**0.0**	--	--
600	**66.7**	**3.5±0.12** [a]	**33.3**	**47.6**	**4.0±0.7** [a]	**99.6**	**52.4**	**7.7±0.8** [a]	**6.8**
400	**53.3**	**3.4±0.96** [a]	**46.7**	**47.3**	**4.3±1.1** [a]	**96.8**	**52.7**	**7.9±1.5**[a]	**6.7**
200	**28.0**	**2.9±0.23**[a]	**72.0**	**27.6**	**3.8±0.3** [a]	**92.2**	**72.4**	**7.0±1.0** [a]	**10.3**
Control	**6.8**	**2.2±0.40**	**93.2**	**0.0**	**4.5±0.21**	**6.8**	**100.0**	**6.7±0.61**	**14.9**

Within each column, means with different letter are significantly different (P<0.05) &MLD, MPD and MD are calculated as (Days±SD).

Data obtained showed that, the LM%was concentration-dependent. The MLD was insignificantly prolonged at all the concentrations used. The P % of the treated larvae was decreased as the concentration increased.The PM % and AE %were found to be affected by extract used. The MPD was insignificantly (P>0.05) affected by all concentration used as compared with the untreated group.The GI was greatly affected by petroleum ether stems extract, where it recorded 6.8, 6.7 and 10.3 at the concentrations 800, 700 and 600 ppm; respectively, compared to 14.9 for the control group.

From the aforementioned results and based on the LC_{50} values Fig. (1) it is obvious that, the toxicity values of the tested ethanolic, acetone and petroleum ether extracts of *C. sempervirens*(leaves and stems) may be arranged in a descending order as follows: Petroleum ether extract > Acetone extract > Ethanolic extract.

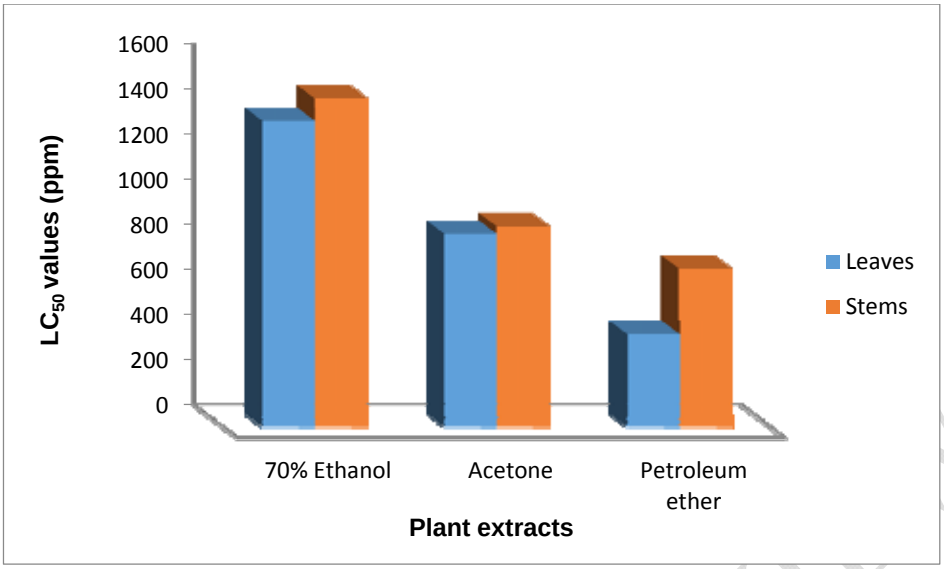

Fig.(1): LC_{50} values for ethanol, acetone and petroleum ether extracts from leaves and stems of *C. sempervirens* against 3rd instar larvae of *M. domestica*.

2- Reproductive potential.

The fecundity of females resulted from the larvae treated with leaves petroleum ether extract of *C. sempervirens*was significantly (P<0.001) decreased from 42.3±1.7 eggs/female at the lowest concentration 200 ppm to 38.0±1.4 at the highest concentration 800 ppm compared to 58.8±2.1 eggs/ female for control (Table 7). There was a slight decrease in the hatchability percent of eggs laid by females resulted from treated larvae. Also, a marked increase in the percentage of sterility for all females emerged from treated larvae was recorded.

Table (7): Effect of petroleum ether extract of *C. sempervirens* (leaves) on fecundity, fertility and sterility index of female *M. domestica*.

Conc. (ppm)	No. of tested females	Fecundity		Hatched eggs		Non-hatched eggs		Sterility Index (SI)
		Total	Mean±SD	Total	%	Total	%	
800	2	76	38.0±1.4 d	72	94.7	4	5.3	38.2
600	4	159	39.8±1.7d	154	96.8	5	3.2	33.9
400	7	291	41.6±2.1d	283	97.3	8	2.7	30.5
200	8	338	42.3±1.7d	332	98.2	6	1.8	28.7
Control	18	1059	58.8±2.1	1049	99.1	10	0.9	0.0

On the other hand, the fecundity of females resulted from the larvae treated with stems petroleum ether extract of *C. sempervirens*was decreased by increasing the concentration and the statistical analysis revealed that, there was a significant (P<0.001) decrease in the mean number of eggs laid by females resulted from treated larvae at the all concentrations used (Table 8). A marked decrease in the hatchability percent and remarkable increase in the percentage of sterility index were also recorded.

Table (8): Effect of petroleum ether extract of *C. sempervirens* (stems) on fecundity, fertility and sterility index of female *M. domestica*.

Conc. (ppm)	No. of tested	Fecundity		Hatched eggs		Non-hatched eggs		Sterility Index (SI)
		Total	Mean±SD	Total	%	Total	%	
900	2	77	38.5±2.1[d]	73	94.8	4	5.2	39.0
800	3	117	39.3±1.2[d]	111	94.9	6	5.1	37.7
700	6	264	44.1±3.3[d]	253	95.8	11	4.2	29.4
600	7	327	46.7±1.7[d]	318	97.2	9	2.8	24.1
Control	20	1205	60.2±2.9	1198	99.4	7	0.6	0.0

3- Antifeedant and repellency activities.

The antifeedant and repellent activity (RA) of ethanolic, acetone and petroleum ether leaves extracts of *C. sempervirens* was shown in (Table 9), data obtained revealed that at the LC_{50} concentrations, the repellency percent recorded 45.6, 61.4 and 78.9 % for the tested extracts; respectively as compared with the untreated group.

Table (9): Effect of LC_{50} concentration from ethanol, acetone and petroleum ether extracts of *C. sempervirens*(leaves) as antifeedant or repellent for *M. domestica*.

Extract	LC_{50} value	Fed No.	Fed%	Non-fedNo.	Non-fed %	RA%
70% Ethanol	1363.0	10.3±0.64	51.7± 2.91	9.7 ± 0.63	48.3 ± 2.92	45.6
Acetone	860.4	7.3±1.23	36.7± 5.80	12.7 ±1.24	63.3 ±5.74	61.4
Petroleum Ether	412.01	3.6±1.52	18.3 ±7.63	16.3 ±1.53	80.0 ±5.01	78.9
Control	0.0	19.0 ±1.20	95.0 ± 5.01	1.0 ± 1.12	5.0 ± 5.03	0.0

In contrast, the antifeedant and RA of ethanolic, acetone and petroleum ether stems extracts of *C. sempervirens* against starved *M. domestica* adults were varied according to the solvents used in extraction (Table 10).

Table (10): Effect of LC_{50} concentration from ethanol, acetone and petroleum ether extracts of *C. sempervirens*(stems) as antifeedant or repellent for *M. domestica*.

Extract	LC_{50} value	Fed No.	Fed%	Non-fed No.	Non-fed %	RA%
70% Ethanol	1462.5	14.7± 1.54	73.3 ±7.61	5.3 ± 1.52	26.7±7.63	21.4
Acetone	893.7	10.7 ± 1.51	53.3 ±7.63	9.3 ±1.54	46.7±7.61	42.9
Petroleum Ether	706.1	5.3 ±1.20	26.7 ± 5.82	14.7±1.21	73.3 ± 5.84	71.4
Control	0.0	18.7 ± 1.52	93.3 ± 7.64	1.3 ±1.51	6.7 ±7.60	0.0

The petroleum ether extract was more effective than acetone and ethanolic extracts during the entire testing period of 2h post treatment. The RA % was 71.4 % for the

petroleum ether extract, while it recorded 42.9 and 21.4 % for acetone and ethanolic extracts; respectively compared with the control group.

Discussion and conclusion

The plant tested in this study is known to be eco-friendly and non-toxic to vertebrates (EL-Sheikh *et al*., 2011). Moreover, it is clearly proved that crude or partially purified plant extracts are less expensive and highly efficacious for the control of *M. domestica* rather than the purified compounds or extracts (Jang *et al*., 2002 andCavalcanti*et al*., 2004). The results of this study may offer an opportunity for developing alternatives to rather expensive and environmentally hazardous organic insecticides.

An insecticide dose not has to cause high mortality on target organisms in order to be acceptable. Sukumar*et al*., (1991) suggested the existence of variations in toxicities of phytochemical compounds on target species depending on the plant part from which they were extracted. In addition, Maurya *et al*., (2009) noted that other variations were due to responses by species and developmental stages of species to the specified extract, solvent of extraction, geographical origin of the plant, photosensitivity of compounds in the extract, effect on growth and reproduction and other factors.The larval mortality percent was increased as concentration increased for all extracts tested. Based on LC_{50} values, the toxicity tested of ethanolic, acetone and petroleum ether extracts of leaves were more effective than those of stems. Also, the petroleum ether extracts were more effective than acetone and ethanolic extracts for all plant parts used. These results are in agreement with the previously mentioned suggestions of Maurya *et al*., (2009).

Different extracts tested varied the larval and pupal duration depending on plant part, solvent and concentration of the extract. Prolongation of the larval duration was similar to that reported in *M. domestica* by Gad-Allah, (1991), using *Melia azedarach*, Ande, (2001) using *Peganumharmala*, *Acalyphaindica* and *Calotropis gigantic* and El-bermawy*et al*. (2011) for *Cupressus macrocarpa* (leaves) powders.Prolongation in the pupal duration was also recorded in this study, Similar observation was also recorded on *M. domestica* by Assar, (2003) using *Atriplex inflate* and Bakr*et al*.(2003) using *Artemisia monosperma*.The pupation rate was varied according to plant part and solvent used in extraction, moreover, the pupation percent was decreased as the concentration of plant extract increased. Similar effects of some botanical plant extracts have been reported on *M. domestica* by (Ande, 2001; Assar, 2003;Bakr*et al*. 2003 and El-bermawy*et al*.2011).

The decrease in the percentage of adult emergence of *M. domestica* due to treatment with the tested plant extracts was similar to those of Muse *et al*., (2003) where, the mean number of males and females of *Chrysomya chloropyga*emerging from larvae feeding diet containing 5 % of *Lantana camara* powder, were significantly less than those of the control, Khalaf*et al*., (2009) who found that, high reduction in *Synthesiomyianudiseta*adult emergence was induced by larval treatment with *C. macrocarpa* volatile oils. The growth index of *M. domestica* was clearly affected by the plant extracts tested. It decreased as the concentration increased. Retardation in growth was induced by different parts of plant tested, such results are in agreement with earlier studies using different plant extracts against other dipteran species by Jeyabalan*et al*. (2003) using *Pelargonium citrosa* leaf extracts on *Anopheles stephensi*, Nathan *et al*. (2006) using *Melia azedarach* on *An. stephensi* and Sharma *et al*. (2006) sing *Artemisia annua* extract against *Culex autnauetesctetus*.

The results obtained also indicated that, treatment of *M. domestica* larvae with plant extracts caused a decrease in egg production. Different authors reported some illustrations revealing the possible reasons for the reduction of fecundity and as a result increasing sterility following the treatment with plant extracts. The weakened physical stage of the treated insects (Tripathi*et al*., 2003). Mild suppressing effect exerted by the plant extract on the insect's mating-decisive factor influencing the subsequent number of eggs laid by the insect (Engelmann, 1970). Partial sterilization of females and/or males, or the inability of the sperms to be transferred to the females during copulation (Ismail, 1980). Reduction in the number of normal sperms produced by male insect (El-Meniawi*et al*., 1999).Blockage of ovarian activity, as the tested botanical products may interfere with oogenesis, which in turn, results in a complete and irreversible sterility of insect female flies (Khan *et al*., 2007).

Reduction in the egg hatching percent by plant extracts was similar to findings reported by many authors against *M. domestica*, among these are: *Melia azedarach* extract Radwan, (2000), leaves and flowers extracts of *Daturainnoxia*Al-Zubaidi *et al*., (2002), *A. inflate* Assar, (2003). Tested extracts displayed various degree of repellency at various concentrations against *M. domestica* and this may reflect the complexity of the chemical composition of their constituents and the petroleum ether extract was more effective in repellent action as compared with the acetone and ethanol extracts, These results are in consistence with Bisseleua *et al.* (2008) using petroleum ether extracts of *Griffonia simplicifolia.*

It could be concluded that, toxicity of tested extracts varied according to plant part, solvent used in extraction and concentration of the extract. Based on LC_{50}, the toxicity values were arranged as follows: leaves > stems.Petroleum ether extract from leaves was more effective in inducing the fecundity,antifeedant, repellent actions and egg-hatchability than those from stems.So, the plant extracts used may be considered as new promising controlling agents for the housefly, *M. domestica*.

References

Al-Zubaidi, FS, Al Rubaie, HM and Al Okaily, LN (2002): The effects of terpenoid compounds extracted from *Daturainnoxia* Mill on the biological performance of *Musca domestica* L. (Diptera: Muscidae). *Proc. of the 2nd. Inter. Conf. on Biological Sciences, Fac. Sci. Tanta Univ.*

Ande, AT (2001): Biological activities of some plant materials against the housefly, *Musca domestica*. *Ni. S. Exp. Bio. J.* 1(4):293-296.

Assar, AA (2003): Biological effects of the water extract of *Atriplex* inflate (Chenopodiaceae) on the housefly, *Musca domestica* vicina. (Diptera: Muscidae). *J. Egypt. Ger. Soc. Zool.* 41 (E): 15-28.

Bakr, ME, Nassef, NE, Assar, AA, El-Sobky, MM and Shams El-Din, SA (2003): Biological and morphological effects of water extracts of some plants on the housefly, *Musca domestica* vicina. (Diptera: Muscidae). *J. Egypt. Ger. Soc. Zool*. 41 (E): 29-47.

Bisseleua, HBD, Gbewonyo, SWK and Obeng-Ofori, D. (2008): Toxicity, growth regulatory and repellent activities of medicinal plant extracts on *Musca domestica* L. (Diptera: Muscidea). *Afr. J. Biot.* 7(24): 4635-42.

Busvin, JR (1962): A laboratory technique for measuring the susceptibility of houseflies and blow

flies to insecticides. *Lab. Prot. London*. (11): 464-468.

Cavalcanti, ES, Morais, SM, Lima, MA and Santana, EW (2004): Larvicidal activity of essential oils from Brazilian plants against *Ae. aegypti*L. *Mem. Inst. Oswaldo. Cruz*. 99(5): 541-544.

De Jesús, AJ, Olsen, AR, Bryce, JR and Whiting, RC (2004): Quantitative contamination and transfer of *Escherichia coli* from foods by houseflies, *Musca domestica* L. (Diptera: Muscidae). *Inter. J. Food Microbial*.93: 259-262.

El-bermawy, SM, Elkattan, NAI, Ahmed, SK and Abdel-Gawad, RM (2011): Screening for bioactive materials against housefly, *Musca domestica* L. (Diptera: Muscidae). *Functional Plant Biotech*. 5(1): 45-51.

El-Meniawi, FA,Hashem, M, El-Mesieri, SM and Rawash, IA (1999): Physiological effects of neem seed extracts on the reproductive activities of the cotton leaf worm, *Spodoptera littoralis* Boisd. *Alex. J. Agric. Res.* 44(1): 79-96.

EL-Sheikh, TMY, Hassan, MI, Moselhy, WA, Amer, MS and Shehata, AZ (2011): Evaluation of the biological activity of *Cupressus sempervirens* (Cupressaceae) extracts against the mosquito vector Culex *pipiens* L. (Diptera: Culicidae). *Egypt. Acad. J. biolog. Sci*., 4 (1): 33 - 48

Engelmann, F (1970): The physiology of insect reproduction. *Pergamon Press. New york.*

Finney, DJ (1971): Probit analysis Third edition. *Cambridge Univ. Press.* 333 p.

Gad-Allah, SZ (1991): The effect of some plant extracts on *Musca domestica* vicina. *Unpublished M. Sci. Thesis, Fac. Sci., Cairo Univ., Egypt.*

Hanan, BA (2013): Evaluation of insecticidal activities of *Menthapiperta*and*Lavandulaangustifolia* essential oils against housefly, *Musca domestica*L. (Diptera: Muscidae). *J. Entomol. Nematol*. 5: 50-54.

Ismail, IE (1980): Physiological studies on the effect of juvenile hormone analogues upon the cotton leaf worm *Spodoptera littoralis*Boisd (Lep.,Noctuidae) . *Unpublished Ph.D. Thesis, Cairo, Univ. Egypt.*

Ito EE,Nmor, JC, Ake JEG, and Uteboe K (2015). Larvicidal Activities of *Pistiastratiotes* (water lettuce) against 3rd and 4th instar larvae of *Aedes aegypti*. *Advances in Research*, 3(6): 589-595.

Ito EE and Ighere EJ (2017):Bio-insecticidal Potency of Five Plant Extracts against Cowpea Weevil, *Callosobruchusmaculatus* (F.), on Stored Cowpea, *Vignaunguiculata* (L). *Jordan Journal of Biological Sciences*, 10(4): 34-39.

Jang, YS, Baek, BR, Yang, YC, Kim, MK and Lee, HS (2002): Larvicidal activity of *leguminous* seeds against *Ae. aegypti* and *C. pipiens*pallens. *J. Am. Mosq. Control Assoc*. 18(3): 210-213.

Jeyabalan, D, Arul, N and Thangamathi, P (2003): Studies on effects of *Pelargonium citrosa* leaf extracts on malarial vector, *A. stephensi* Liston. *Biores. Tech.* 89(2): 185-189.

Khalaf, AA, Hussein, KT and Shoukry, KK (2009): Biocidal Activity of two botanical volatile oils against the larvae of *Synthesiomyianudiseta* (Wulp) (Diptera: Muscidae). *Egypt Acad. J. Bio. Sci.* 2 (1): 89-101.

Khan, M. Hossain, MA and Islam, MS (2007): Effects of neem leaf dust and a commercial formulation of a neem compound on the longevity, fecundity and ovarian development of the melon fly, *Bactoceracucurbitae*(Coquillett) and the oriental fruit fly, *Bactroceradorsalis* (Hendel) (Diptera: Tephritidae). *Pak. J. Biol. Sci.* 10: 3656-61.

Khan, HAA, Shad, SA and Akram, W (2013): Resistance to new chemical insecticides in the housefly, *Musca domestica* L., from dairies in Punjub, Pakistan. *Parasito. Res.*12: 2049-54.

Kumar, PS, Mishra, A and Malik, SS (2012): Housefly (*Musca domestica* L.) control potential of *Cymbopogon citratus* Staff (Poales: Poaceae) essential oil and monoterpenes. *Parasitol Res*. 112: 69-76.

Lentner, C, Lentner, C and Wink, A (1982): Students t-distribution tables. In Geigy scientific Tables Vol. 2.International Medical and Pharmaceutical information, Ciba–Geigy Limited, Basal, Switzerland.

Maurya, P, Sharma, P, Mohan, L,Batabyal, L and Srivastava, CN (2009): Evaluation of the toxicity of different phytoextracts of *Ocimumbasilicum* against *Anopheles stephensi* and *Culex quinquefasciatus*. *Journal of Asia-Pacific Entomology*.12: 113-115.

Morey, RA and Khandagle, AJ (2012): Bioeffeicacy of essential oils of medicinal plants against housefly, *Musca donestica* L. *Parasito. Res*. 111: 1799-05.

Murugesan, S, Senthilkumar, N, Babu, DS and Rajasugunasekar, D (2016): Chemical constituents and toxicity assessment of the leaf oil of *Lantana camara* Linn from Tamilnadu regions. *Asian J. Plant Sci. Res.* 6(3): 32-42.

Muse, WA, Lajide, L and Adediri, CO (2003): Effect of some Nigerian plants on survival, oviposition, and emergence of adult blowfly, *Chrysomya chloropyga* (Wied.) (Diptera: Calliphoridae). *J. Asia-Pacific Entomol*. 6 (1): 69-75.

Nathan, SS, Savitha, G, George, DK, Narmadha, A, Suganya, L and Chung, PG (2006): Efficacy of *Melia azedarach* L. extract on the malarial vector *A. stephensi* Liston (Diptera: Culicidae). *Biores. Tech.* 79: 1316-23.

Radwan, MEH (2000): Effect of crude methanolic extracts of leaves and fruits of chinaberry tree *Melia azedarach* L. on the adult female housefly *Musca domestica* vicina. *Unpublished M.Sc. Thesis, Fac. Sci. Alex. Univ., Egypt.*

Sharma, P, Mohan, L and Srivastava, CN (2006): Growth inhibitory nature of *Artemisia annua* extract against *Culex autnauetesctetus*(Say). *J. Asia-Pacific Entomol.* 9(4): 389-395.

Singh, A, Singh, DK, Mishra, TN and Agarwal, RA (1996): Molluscicides of plant origin. *Biol. Agri.Horti*. 13: 205-252.

Sukumar, K, Perich, MJ and Boobar, LR (1991): Botanical derivatives in mosquito control: A review. *Am. Mosq. Contr. Assoc.* 7(2): 210-237.

Toppozada, A, Abdallah, S and El-Defrawi, ME (1966): Chemo-sterilization of larvae and adults of the Egyptian cotton leafworm, *Prodenialittura* by apholate, metepa and hempa. *J Econ. Entomol.*59: 1125-28.

372 Tripathi, AK, Prajapati, V, Khanuja, SPS and Kumar, S (2003): Effect of d-limonene on three
373 stored-product beetles. *J. Econ. Entomol.* 96(3): 990-995.

374

375