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Research Article
Efficacy of *Trigonella stellata* (Fabaceae) and *Eucalyptus citriodora* (Verbenaceae) Extracts against the House Fly, *Musca domestica* (Diptera:Muscidae)

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Abstract

Background and Objective: *Musca domestica* is an important mechanical vector of many pathogenic agents causing serious problems to human livestock. Application of chemical insecticides for control of *M. domestica* resulted in well-known problems to human, environment and non-target organisms, thus there is an urgent need to develop a new materials to avoid the hazards of chemical insecticides. The present study investigated the effect of different extracts from leaves of *Trigonella stellata* and *Eucalyptus citriodora* on *M. domestica* third instars larvae, resulted pupae and reproductive potential of females resulted from treated larvae. **Materials and Methods:** *Musca domestica* reared under controlled conditions of temperature, relative humidity and photoperiod. Tested plants collected and leaves were extracted with ethanol 70%, chloroform and hexane. Different concentrations of each extract were mixed with larval artificial diet instead of water to detect the activity of tested extracts against *M. domestica*. **Results:** Larvicidal bioassay showed that hexane extracts from tested plants recorded the highest activity against *M. domestica* as compared with other 2 extracts. The LC_{50} values of *T. stellata* and *E. citriodora* (leaves) hexane extracts recorded 81.07 and 187.79 ppm, respectively. All tested extracts significantly ($p<0.05$) reduced the fecundity and increased the sterility index of females resulted from treated larvae. Sterility index recorded 64.21 and 59.28% by 130 and 250 ppm of *T. stellata* and *E. citriodora* (leaves) hexane extracts, respectively. **Conclusion:** The findings of the present study suggested that *T. stellata* and *E. citriodora* tested extracts considered to be promising alternative agents for the control of *M. domestica*.

Key words: *Musca domestica*, fabaceae, verbenaceae, larvicidal, reproductive potential activity, toxicity

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The house fly, *Musca domestica* L. is an important mechanical vector distributed throughout the tropical and warm temperate regions, as well as some cooler areas[1]. It is the carrier of many pathogenic bacteria as *Escherichia coli*, *Staphylococcus aureus*, *Vibrio cholera*, *Shigella* and *Salmonella* sp.[2] as well as its ability to transmit protozoa and helminth eggs causing several health problems to human beings and livestock[3]. Adult houseflies can transmit pathogens by their sponging mouthparts, through vomiting, on their body and leg hairs, on the sticky parts of the feet and through the intestinal tract causing food contamination[4].

The usage of chemical insecticides for many decades resulted in many well-known and serious problems, such as developing insect resistance[5] and substantial hazards to a variety of non-target organisms and environment in the form of biomagnification[6]. Thus, there is an urgent need to develop a new materials which will be safe, ecofriendly and low cost in order to avoid the hazards of chemical insecticides. On the other hand, natural compounds from plants (botanical insecticides) are expected to be possible alternatives[1]. These compounds affect insect populations by reducing their developmental, survival and reproductive rate[7,8]. From these points of view, the present study evaluated the activity of different crude extracts of *Trigonella stellata* and *Eucalyptus citriodora* against different stages of *M. domestica*.

MATERIALS AND METHODS

Tested flies: The house flies, *Musca domestica* reared in Medical Entomology Insectary, Animal House, Department of Zoology, Faculty of Science, Al-Azhar University under controlled conditions of temperature (25-27°C), relative humidity (55- 60%) and (12-12) light-dark regime. Larvae were reared on an artificial diet (wheat bran, milk, powder yeast; 200:100:5 g) per 200 mL distilled water, while emerged flies were fed on dry diet (milk powder) and sucrose solution (cotton pads soaked in 10% sucrose solution)[9].

Plants and extraction: *Trigonella stellata* and *Eucalyptus citriodora* belonging to Fabaceae and Verbenaceae collected during June, 2017 from El- Fayoum Governorate, Egypt. Leaves of two plants washed and dried under shade at room temperature and then ground into a powder. Samples of 100 g of powder were extracted using ethanol 70%, chloroform and hexane at a rate of 3 mL g^{-1} for 24 h extraction period at room temperature, then the supernatant were decanted and filtered through Whatman filter paper (No. 5) and the solvents were evaporated to dryness under vacuum using a rotary evaporator with a water bath adjusted[10] to 40°C. The dry extracts were kept in a deep freezer (-18) until used.

Larvicidal bioassay: Different concentrations of each extract were mixed with larval artificial diet instead of water to detect mortality percepts. Ethanol 70% tested materials were dissolved in 0.1 mL of ethanol 70%, while the tested materials of chloroform and hexane extracts were dissolved in 2 drops of Tween80 as emulsifier to facilitate the dissolving oils of tested material in water. About 25 of third instar larvae were put immediately into plastic cups contained media with different concentrations of extracts. Three replicates were used for each tested concentration. Control larvae received 0.1 mL of ethanol 70% or 2 drop of Tween80 in 100 mL water[11]. Mortality in larvae and pupae was recorded daily until adult emergence. Larval and pupal mortality was calculated using the equation of Briggs[12]. Growth index was estimated after Hassan *et al.*[11].

Reproductive potential of resulted females: Females that succeeded to emerge from third larval instar treated with each concentration were collected and transferred with untreated males obtained from the colony and were fed for 5 days. After oviposition, the eggs were counted using a binocular and then the mean values were taken. Sterility index was estimated according to the formula of Tappozada *et al.*[13].

Statistical analysis: Data were subjected to ANOVA to find out the differences among the activity of plant extracts using Tucky's HSD test at 5% probability level. The LC_{50} were calculated using probit analysis[14]. All the statistical analyses were carried out using Statistical Package Social Science (SPSS) software[15] version 23. Results represented as Mean±SD.

Ethical approval: The data of this study was approved by National Research Centre Ethics Committee (approved at date of 1/7/2015).

RESULTS

Ethanol extract of *Trigonella stellata* (leaves) recorded complete larval mortality (100.0%) at 700 ppm and the pupal

mortality recorded 100.0% at 600 ppm. Also, the adult emergence recorded 66.3 and 27.8% at the highest concentrations (400 and 500 ppm), respectively. Meanwhile, at 50, 100, 150, 200, 250, 300 and 350 ppm the chloroform extract recorded 6.7, 20.0, 33.3, 46.7, 65.3, 90.7 and 100.0% larval mortality, the highest pupal mortality (58.3%) induced by chloroform extract at the highest concentration (300 ppm). In addition, the highest and lowest larval mortality (100 and 6.7%) recorded by hexane extract at 150 and 30 ppm and pupal mortality recorded 44.4% at the highest concentration (130 ppm). Also, *T. stellata* tested extracts insignificantly ($p>0.05$) affected the larval period except for hexane extract at the higher concentrations (90, 110 and 130 ppm), where the larval period prolonged significantly ($p<0.05$) to record 2.38±0.15, 2.55±0.06 and 2.71±0.04 days vs. 1.95±0.05 days for the control group. Also, chloroform and hexane extracts significantly affected ($p<0.001$) the pupal period at all concentrations used. A very retarded effect on growth of larvae, pupae and adult *M. domestica* was observed by *T. stellata* ethanol, chloroform and hexane extracts, where the growth index recorded 3.57, 4.87 and 6.08 at 500, 300 and 130 ppm, respectively, compared with 15.46, 16.50 and 16.34 for the untreated groups (Table 1).

The complete larval mortality (100%) attained by ethanol, chloroform and hexane extracts of *E. citriodora* leaves at 900, 500 and 350 ppm. Chloroform extract recorded the highest pupal mortalities (100 and 70%) at 450 and 400 ppm, respectively. In addition, *E. citriodora* tested extracts significantly ($p<0.05$) prolonged the developmental period of larvae and pupae as compared with the untreated groups (Table 2).

Based on LC_{50} and LC_{90} values recorded that, hexane extract of *T. stellata* and *E. citriodora* (leaves) were the most effective extract against *M. domestica* larvae compared with chloroform and ethanol extracts (Table 3).

Data arranged in Table 4 indicated that, there was a significant ($p<0.05$) decrease in fecundity of females resulted from larvae treated with *T. stellata* tested extracts. Also, the lowest hatchability percentages of eggs laid (77.23 and 78.46) recorded for females resulted from larvae treated with 130 and 110 ppm of hexane extract. The sterility index recorded 50.78, 62.22 and 64.21 at 500, 250 and 130 ppm by *T. stellata* ethanol, chloroform and hexane extracts, respectively (Table 4). On the other hand, ethanol extract of *E. citriodora* (leaves) significantly ($p<0.001$) decreased the fecundity of females resulted from treated pupae at 600 and 700 ppm as the number of eggs laid/female recorded 41.63±1.30 and 39.20±3.03 vs. 59.0±3.95 egg/female for the control group. Also, the lowest hatching percent recorded by hexane extract was 80.22% at 250 ppm, respectively, compared with 98.22% for the untreated group. In addition, a remarkable increase in the percentage of sterility index was observed, where it was

Table 1: Effect of *T. stellata* (leaves) tested extracts on different stages of *M. domestica*

Extracts	Concentration (ppm)	Larval Mort. (%)	Pupal Mort. (%)	Adult emergence (%)	Larval period (Days±SD)	Pupal period (Days±SD)	Developmental period (Days±SD)	Growth index
Ethanol 70%	Control	0.0	0.0	100.0±0.0	1.83±0.93^{a}	4.64±0.21^{a}	6.47±0.21^{a}	15.46
	100	13.3±2.3	0.0	100.0±0.0	1.87±0.21^{a}	4.67±0.05^{a}	6.54±0.04^{a}	15.29
	200	26.7±6.1	3.8±3.3	96.2±3.3	1.88±0.06^{a}	5.01±0.03^{a}	6.90±0.08^{a}	13.94
	300	46.7±2.3	18.7±5.6	81.3±5.6	1.95±0.04^{a}	5.15±0.05^{b}	7.10±0.02^{b}	11.45
	400	56.0±4.0	33.8±7.8	66.3±7.8	2.01±0.08^{a}	5.34±0.13^{c}	7.35±0.20^{c}	9.02
	500	77.3±2.3	72.2±25.5	27.8±25.5	2.28±0.14^{a}	5.51±0.20^{d}	7.79±0.32^{d}	3.57
	600	90.7±2.3	100.0±0.0	0.0	2.56±0.07^{a}	5.62±0.27^{d}	8.17±0.34^{d}	0.0
	700	100.0±0.0	-	-	-	-	-	-
Chloroform	Control	0.0	0.0	100.0±0.0	1.85±0.61^{a}	4.21±0.13^{a}	6.06±0.12^{a}	16.50
	50	6.7±2.3	0.0	100.0±0.1	1.99±0.02^{a}	5.29±0.08^{d}	7.27±0.07^{d}	13.76
	100	20.0±4.0	0.0	100.0±0.2	2.07±0.06^{a}	5.52±0.03^{d}	7.59±0.07^{d}	13.18
	150	33.3±2.3	0.0	100.0±0.0	2.19±0.03^{a}	5.61±0.02^{d}	7.80±0.04^{d}	12.82
	200	46.7±2.3	11.4±4.6	88.6±4.6	2.33±0.07^{a}	5.72±0.03^{d}	8.05±0.10^{d}	11.01
	250	65.3±6.1	9.9±8.8	80.1±8.8	2.43±0.09^{a}	5.86±0.03^{d}	8.30±0.11^{d}	9.65
	300	90.7±6.1	58.3±38.2	41.7±38.2	2.57±0.02^{a}	6.00±0.02^{d}	8.57±0.02^{d}	4.87
	350	100.0±0.0	-	-	-	-	-	-
Hexane	Control	0.0	0.0	100.0±0.0	1.95±0.05^{a}	4.17±0.31^{a}	6.12±0.28^{a}	16.34
	30	6.7±2.3	0.0	100.0±0.0	1.93±0.12^{a}	5.68±0.05^{d}	7.61±0.14^{d}	13.14
	50	29.3±6.1	7.8±4.1	92.2±4.1	2.08±0.30^{a}	6.03±0.03^{d}	8.11±0.04^{d}	11.37
	70	41.3±2.3	15.9±3.6	84.1±3.6	2.21±0.02^{a}	6.15±0.04^{d}	8.37±0.04^{d}	10.05
	90	60.0±4.0	23.2±3.7	76.8±3.7	2.38±0.15^{b}	6.26±0.05^{d}	8.64±0.05^{d}	8.89
	110	74.7±2.3	42.1±8.4	57.9±8.4	2.55±0.06^{c}	6.36±0.03^{d}	8.91±0.04^{d}	6.50
	130	85.3±2.3	44.4±9.6	55.6±9.6	2.71±0.04^{d}	6.44±0.05^{d}	9.15±0.03^{d}	6.08
	150	100.0±0.0	-	-	-	-	-	-

Means followed by the same letter are not significantly different ($p>0.05$)

Table 2: Effect of *E. citriodora* (leaves) tested extracts on different stages of *M. domestica*

Extracts	Concentration (ppm)	Larval Mort. (%)	Pupal Mort. (%)	Adult emergence (%)	Larval period (Days±SD)	Pupal period (Days±SD)	Developmental period (Days±SD)	Growth index
Ethanol 70%	Control	0.0	0.0	100.0±0.0	1.77±0.03[a]	3.83±0.25[a]	5.61±0.24[a]	17.83
	300	6.7±2.3	0.0	100.0±0.0	1.80±0.10[a]	3.89±0.19[a]	5.69±0.19[a]	17.57
	400	17.3±2.3	0.0	100.0±0.0	1.98±0.03[c]	4.26±0.04[b]	6.24±0.02[d]	16.03
	500	26.7±2.3	0.0	100.0±0.0	2.05±0.05[d]	4.99±0.03[d]	7.04±0.06[d]	14.20
	600	45.3±2.3	4.7±4.1	95.3±4.1	2.20±0.04[d]	5.24±0.04[d]	7.44±0.05[d]	12.81
	700	66.7±2.3	7.9±6.8	92.1±6.8	2.37±0.04[d]	5.41±0.05[d]	7.78±0.04[d]	11.84
	800	80.0±4.0	20.6±4.2	79.4±4.2	2.51±0.07[d]	5.57±0.04[d]	8.14±0.09[d]	9.75
	900	100.0±0.0	-	-	-	-	-	-
Chloroform	Control	0.0	0.0	100.0±0.0	2.16±0.06[a]	3.88±0.19[a]	6.04±0.25[a]	16.56
	200	6.7±4.6	0.0	100.0±0.1	2.21±0.05[a]	4.25±0.10[c]	6.45±0.14[b]	15.50
	250	28.0±4.0	5.6±0.31	94.4±0.31	2.26±0.06[a]	4.85±0.06[d]	7.11±0.02[d]	13.28
	300	42.7±2.3	11.6±3.9	88.4±3.9	2.31±0.04[b]	5.28±0.02[d]	7.59±0.06[d]	11.65
	350	73.3±2.3	25.4±9.9	74.6±9.9	2.34±0.05[b]	5.58±0.06[d]	7.92±0.03[d]	9.42
	400	83.3±8.1	70.0±26.5	30.0±26.5	2.44±0.05[d]	5.72±0.05[d]	8.15±0.09[d]	3.68
	450	92.0±6.9	100.0±0.0	0.0	2.56±0.05[d]	5.88±0.04[d]	8.43±0.08[d]	0.0
	500	100.0±0.0	-	-	-	-	-	-
Hexane	Control	0.0	0.0	100.0±0.0	1.93±0.07[a]	4.13±0.14[a]	6.06±0.10[a]	16.50
	50	9.3±2.3	0.0	100.0±0.0	2.21±0.02[d]	5.71±0.03[d]	7.92±0.01[d]	12.63
	100	24.0±0.0	3.5±3.1	96.5±3.1	2.29±0.02[d]	5.93±0.05[d]	8.21±0.05[d]	11.75
	150	38.7±2.3	6.6±0.23	93.4±0.23	2.34±0.03[d]	6.15±0.04[d]	8.49±0.04[d]	11.00
	200	49.3±2.3	10.5±4.3	89.5±4.3	2.46±0.04[d]	6.30±0.03[d]	8.77±0.02[d]	10.21
	250	68.0±4.0	16.3±5.2	83.7±5.2	2.57±0.02[d]	6.33±0.04[d]	8.90±0.06[d]	9.40
	300	86.7±2.3	30.5±4.8	69.5±4.8	2.66±0.04[d]	6.40±0.05[d]	9.06±0.06[d]	7.67
	350	100.0±0.0	-	-	-	-	-	-

Means followed by the same letter are not significantly different (p>0.05)

Table 3: Relative efficiency of *T. stellata* and *E. citriodora* (leaves) tested extracts against *M. domestica* larvae

Plant specie	Extracts	LC_{50} (LC_{90}) (ppm)	Slope	95% confidence limits		χ^2
				Lower (LC_{50} (LC_{90}))	Upper (LC_{50} (LC_{90}))	
T. stellata	Ethanol 70%	341.78 (609.39)	0.150	305.18 (588.54)	378.38 (630.23)	1.11[n.s]
	Chloroform	194.38 (317.95)	0.324	185.04 (311.29)	203.72 (324.60)	2.07[n.s]
	Hexane	81.07 (133.79)	0.760	78.09 (130.92)	84.04 (136.66)	2.60[n.s]
E. citriodora	Ethanol 70%	606.59 (858.14)	0.159	593.23 (853.29)	619.95 (862.99)	1.85[n.s]
	Chloroform	316.04 (440.88)	0.320	292.69 (421.93)	339.38 (459.84)	2.39[n.s]
	Hexane	187.79 (319.07)	0.305	182.59 (315.66)	192.99 (322.48)	1.53[n.s]

χ^2: Chi square value, n.s: Non-significant (p>0.05)

Table 4: Effect of *T. stellata* (leaves) tested extracts on reproductive potential of *M. domestica* females

Extracts	Concentration (ppm)	No. of tested females	Eggs laid		Hatched eggs		Sterility index
			Total	Mean±SD	Mean±SD	Percentage	
Ethanol 70%	Control	22	1286	58.45±3.29[a]	56.86±3.14[a]	97.28±1.07[a]	0.00
	100	13	619	47.62±4.13[b]	44.15±3.96[c]	92.71±2.0[b]	22.36
	200	9	440	48.89±3.02[b]	44.11±2.57[c]	90.26±1.69[d]	22.39
	300	8	361	45.13±3.27[c]	39.63±2.93[d]	87.81±0.82[d]	30.31
	400	5	188	37.60±2.19[d]	32.20±1.92[d]	85.64±1.17[d]	43.37
	500	3	101	33.67±4.04[d]	28.00±3.61[d]	83.12±1.21[d]	50.78
Chloroform	Control	18	1043	57.94±2.94[a]	56.28±2.72[a]	97.14±0.79[a]	0.00
	50	10	445	44.50±3.24[d]	40.40±2.68[d]	90.83±1.19[b]	28.19
	100	10	396	39.60±1.27[d]	35.40±1.17[d]	90.30±3.23[b]	36.47
	150	7	249	35.57±2.76[d]	31.14±1.68[d]	87.69±2.30[d]	44.58
	200	5	157	31.40±1.67[d]	25.80±1.30[d]	82.18±1.20[d]	54.15
	250	4	105	26.25±2.06[d]	21.25±1.50[d]	81.01±2.13[d]	62.22
Hexane	Control	16	1003	62.69±2.50[a]	61.50±2.56[a]	98.10±0.66[a]	0.00
	30	12	528	44.0±3.62[d]	38.42±2.89[d]	87.37±1.59[d]	37.49
	50	11	408	37.09±2.59[d]	31.18±2.44[d]	84.03±1.49[d]	49.32
	70	9	304	33.78±2.78[d]	27.67±2.35[d]	81.90±1.16[d]	55.01
	90	8	270	33.75±3.06[d]	27.00±2.0[d]	80.12±1.88[d]	56.03
	110	4	125	31.25±2.99[d]	24.50±2.08[d]	78.46±1.19[d]	60.13
	130	2	57	28.50±2.12[d]	22.00±1.41[d]	77.23±0.78[d]	64.21

Means followed by the same letter are not significantly different (p>0.05)

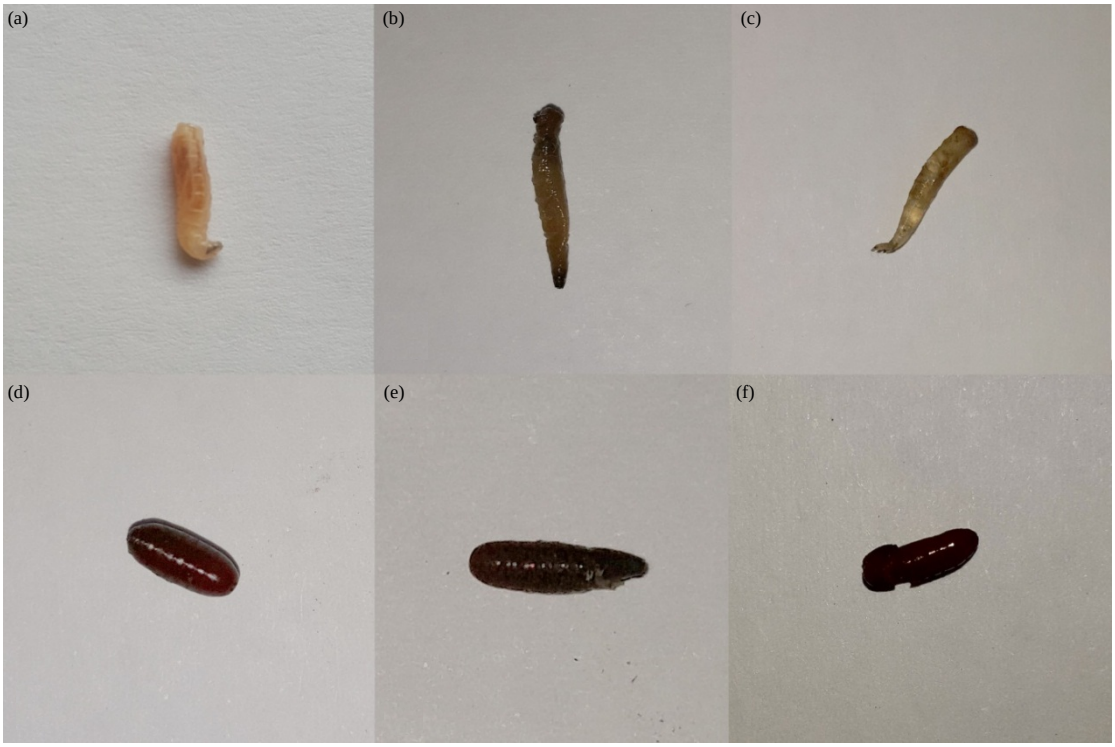

Fig. 1(a-f): (a, d) Normal larvae and pupae, (b, c) Malformations in larval stage and (e, f) Malformations in pupal stage

Table 5: Effect of *E. citriodora* (leaves) tested extracts on reproductive potential of *M. domestica* females

Extracts	Concentration (ppm)	No. of tested females	Eggs laid		Hatched eggs		Sterility index
			Total	Mean±SD	Mean±SD	Percentage	
Ethanol 70%	Control	15	885	59.00±3.95^{a}	57.73±4.11^{a}	97.83±0.84^{a}	0.00
	300	11	781	55.79±3.60^{a}	52.79±3.62^{a}	94.60±0.80^{b}	8.56
	400	9	459	51.00±2.74^{a}	47.56±2.96^{b}	93.21±1.22^{c}	17.64
	500	9	437	48.56±4.22^{b}	44.56±3.94^{c}	91.75±0.84^{d}	22.81
	600	8	333	41.63±1.30^{d}	37.75±1.39^{d}	90.68±0.93^{d}	34.60
	700	5	196	39.20±3.03^{d}	35.00±2.55^{d}	89.33±1.72^{d}	39.33
Chloroform	Control	14	868	62.00±2.35^{a}	60.86±2.45^{a}	98.15±0.61^{a}	0.00
	200	10	588	58.80±4.02^{a}	54.50±4.17^{a}	92.64±1.15^{d}	10.49
	250	10	552	55.20±3.43^{a}	50.30±3.34^{c}	91.10±0.67^{d}	17.36
	300	8	403	50.38±2.13^{c}	45.13±2.10^{d}	89.57±0.93^{d}	25.85
	350	6	275	45.83±1.72^{d}	39.67±1.63^{d}	86.55±1.55^{d}	34.82
	400	3	119	39.67±1.53^{d}	33.33±1.53^{d}	84.03±1.44^{d}	45.22
Hexane	Control	17	1074	63.18±2.40^{a}	62.06±3.46^{a}	98.22±0.55^{a}	0.00
	50	10	515	51.50±1.84^{c}	46.20±1.55^{d}	89.72±1.14^{d}	25.54
	100	8	406	50.75±3.01^{c}	44.88±2.64^{d}	88.43±0.98^{d}	27.68
	150	5	210	42.00±2.83^{d}	36.00±2.35^{d}	86.73±2.13^{d}	41.30
	200	4	133	33.25±3.59^{d}	27.75±3.10^{d}	83.44±0.81^{d}	55.29
	250	4	126	31.50±2.65^{d}	25.25±1.89^{d}	80.22±1.91^{d}	59.28

Means followed by the same letter are not significantly different (p>0.05)

39.33, 45.22 and 59.28% by *E. citriodora* (leaves) ethanol, chloroform and hexane extracts at 700, 400 and 250 ppm, respectively (Table 5).

Clear malformations in *M. domestica* larvae and pupae induced after treatment of the third larval instar with tested extracts were represented in Fig. 1. Morphological larval abnormalities (Fig. 1b , c) include brown pigmentation and a weakness in cuticle. Morphological pupal abnormalities (Fig. 1e, f) include larvi form pupation, irregular shaped and shrinkage pupae and larval-pupal intermediates.

DISCUSSION

Results of the present study showed that, the toxicity ethanol 70%, chloroform and hexane extracts of *Trigonella stellata* and *Eucalyptus citriodora* (leaves) against *M. domestica* larvae and resulted pupae varied according to solvent used in extraction and the concentration of the extract, hexane extract from tested plant species was the most effective extract as compared with ethanol 70% and chloroform extracts. These results confirmed earlier reports for *Calotropis procera* and *Anonna squamosa* leaves crude ethanolic extracts where, LC_{50} values recorded 282.5 and 550 ppm against 3rd larval instar of *M. domestica*[16], *C. procera* (seeds) ethanolic extracts where, complete mortality (100.0%) in *M. domestica* third larval instar achieved[17] by 500 ppm, *C. procera*, *Piper longum* and *Polygonum hydropiper* whole-plant boiled extracts where, LC_{50} were 557.89, 981.02 and 773.27 µL against *M. domestica* larvae[18], *Ocimum basilicum* crude extract where, LC_{50} recorded 110 ppm against *M. domestica* larvae[19], *Lantana camara* leaves ethanol 70%, acetone and petroleum ether extracts which recorded 1462.6, 959.3 and 607.3 ppm (LC_{50}) against *M. domestica* third larval instar[20] and petroleum ether extract of *Lagenaria siceraria* which was found to be more effective against third larval instar of *M. domestica* with LC_{50} 101.4 ppm than chloroform, acetone and methanol extracts with LC_{50} 433.8, 432.1 and 468.5 ppm, respectively[11]. In addition, prolongation in *M. domestica* larval and pupal periods by all tested extracts agree the previous results of *Lupinustermis*, *C. procera* and *Atriplex inflate*[21,22], using *Artemisia monosperma*, *Conyza dioscoridis*, *Clerodedron inerme* and *Clocasia antiqorum*[23], *L. camara* and *Cupressus macrocarpa* (leaves) powders[24] and *L. camara* (leaves and stems)[20].

Also, a reduction in *M. domestica* adult emergence percent as a result of tested extracts was observed. Similar observations noted by chloroform extract of *Ricinus communis* which recorded 12.75 and 25.55% reduction in *M. domestica* adult emergence after treating third larval instar[25], *Petiveria alliacea* and *Flueggae virosa* which induced 10.0, 9.0, 11.9, 11.9 and 13.8% reduction in *M. domestica* adult emergence at the concentration[26] of 15.0% and *L. siceraria* (leaves) methanol and chloroform extracts which recorded the lowest *M. domestica* adult emergence percent (16.5%) at 1000 and 800 ppm, respectively[11]. In addition, the growth index of *M. domestica* was decreased as the concentration of the extract increased; such results are in agreement with the results obtained by Fouda *et al.*[20] using *L. camara* (leaves and stems) extracts against *M. domestica*.

On the other hand, the effect of tested extracts extended to females resulted from treated larvae, fecundity of resulted females decreased and the sterility index increased as compared with the control groups. Earlier authors revealing the possible reasons for the reduction of insect fecundity, as a result of treatment with plant extracts to the weakened physical stage of the treated insects[27], mild suppressing effect exerted by the plant extract on the insect's mating-decisive factor[28], reduction in the number of normal sperms produced by males[29], a blockage in 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[30] and a delay or reduction of ova giving some opportunities not for retention but for possible egg re-sorption within ovaries. Also, delay could be due, in part, to a lower metabolic rate[31,32]. Reduction in fecundity and increasing sterility index of *M. domestica* were similar to observations reported by *A. inflate*[22], aqueous leaf extract of *Nicotiana tabacum*[33] and methanol, acetone, chloroform and petroleum ether extract of *L. siceraria* leaves[11].

Malformations in *M. domestica* larvae and pupae as a result of tested extracts including brown pigmentation and a weakness in larval cuticle, larviform pupation and irregular shaped, shrinkage pupae are similar to those obtained by using essential oils against *Lucilia sericata* and *M. domestica* different stages[34,35].

CONCLUSION

The findings of the present study revealed that, *Trigonella stellata* and *Eucalyptus citriodora* tested extracts considered as important alternative agents for the control of the house fly, *Musca domestica*. Also, more studies are needed to reach the bioactive compounds in two plant species.

SIGNIFICANCE STATEMENT

The findings of the present study suggested that *Trigonella stellata* and *Eucalyptus citriodora* tested extracts considered to be promising alternative agents for the control of *Musca domestica*. The hexane extracts from tested plants recorded the highest activity against *M. domestica* as compared with ethanol and chloroform extracts.

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