

## Biological Effects of some Plant Extracts against Filariasis Vector Mosquito, *Culex pipiens*

<sup>1</sup>Ahmed I. Hasaballah and <sup>2</sup>Walaa A. Moselhy

<sup>1</sup>Department of Zoology, Faculty of Science, Al-Azhar University, Nasr City, Cairo, Egypt.  
E-mail: ahsience09@yahoo.com

<sup>2</sup>Department of Zoology, Faculty of Science (Girls), Al-Azhar University, Nasr City, Cairo, Egypt.

### ABSTRACT

This study was carried out to evaluate the biological effects of petroleum ether extract of some plants on different stages of *Culex pipiens* mosquito. Petroleum ether extracts of 4 plants namely *Azadirachta indica*, *Phragmites australis*, *Rosmarinus officinalis* and *Rhizophora mucronata* were tested. The obtained results indicated that the mean larval duration was partially affected by type of the plant and concentration and a remarkable reduction in the percentage of pupation by all plant extracts tested was recorded. The petroleum ether extracts of all tested plants showed prolonged activity on the duration of the resulted pupae. There was a positive correlation between the concentration and pupal mortality percentage. A remarkable reduction in the percentage of adult emergence was observed and the reduction was concentration-dependent. Also, results obtained indicated a remarkable reduction in the fecundity of *C. pipiens* adult females for all tested plants especially those of *A. indica* and *Rh. mucronata*, where the induced effect was part of the plant and concentration of the extract-dependent. The hatchability percentage of eggs laid by females resulted from treated larvae also decreased and the decrease was concentration-dependent.

**Key words:** Biological activity, petroleum ether, Neem, fecundity and *Culex pipiens*.

### Introduction

Mosquitoes play a serious role as vectors of many vertebrate blood pathogens. *Culex pipiens* is a very common mosquito species in Egypt, it is the predominant vector of *Wuchereria bancrofti* that causes filariasis or elephantiasis in humans (Khalil *et al.*, 1930; Abdel-Hamid *et al.*, 2013), Rift Valley fever virus (Meagan *et al.*, 1980; El-Bahnasawy *et al.*, 2013a) and West Nile virus (El-Bahnasawy *et al.*, 2013b).

Phytochemicals are botanicals which are naturally occurring insecticides obtained from floral resources. Applications of phytochemicals in mosquito control were in use since the 1920s, but the discovery of synthetic insecticides such as DDT in 1939 sidetracked the application of phytochemicals in mosquito control program. After facing several problems due to injudicious and over application of synthetic insecticides in nature, re-focus on phytochemicals that are easily biodegradable and have no ill-effects on non-target organisms was appreciated. Since then, the search for new bioactive compounds from the plant kingdom and an effort to determine its structure and commercial production has been initiated. In recent years, phytochemicals make up to 1 percent of world's pesticide market (Isman, 1997).

Recent studies stimulated the investigation of insecticidal properties of plant-derived extracts and concluded that they are environmentally safe, degradable, and target specific (Senthil *et al.*, 2005). Some plants known to contain toxic ingredients, which can play a useful role in the control of disease vectors. Sukumar *et al.*, (1991) reviewed the bioactivity observed for 344 plant species against mosquitoes. Some phytochemicals acted as general toxicants to all mosquito stages, whereas others interfere with growth and reproduction.

The present study was carried out to evaluate the biological effects of petroleum ether extracts of 4 plants namely *Azadirachta indica* (leaves), *Phragmites australis* (stems), *Rosmarinus officinalis* (stems) and *Rhizophora mucronata* (leaves) under laboratory conditions against *Culex pipiens* mosquito (Diptera : Culicidae).

### Materials and Methods

#### Selection of plants:

The selection was based on the reported pharmacological properties or on their traditional uses in life. The common and scientific names of the four tested plants, their habitat, location and collection site are given in table 1.

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**Corresponding Author:** Walaa A. Moselhy, 2Department of Zoology, Faculty of Science (Girls), Al-Azhar University, Nasr City, Cairo, Egypt.  
E-mail: walaa\_moselhi@yahoo.com

**Table 1:** The common and scientific names of the four tested plants, their habitat, location and collection site.

Common name	Scientific name	Part used	Habitat	Source of collection
Neem	<i>Azadirachta indica</i>	Leaf	Cultivated in desert land.	8 Km west Elareesh, North Sinai governorate.
Common reed	<i>Phragmites australis</i>	Stem	Swamps, edges of lakes and ponds	El mansoura city.
Rosemary	<i>Rosmarinus officinalis</i>	Stem	A woody, perennial herbs cultivated in the clay soil.	3 Km west Elareesh, North Sinai governorate.
Mangrove	<i>Rhizophora mucronata</i>	Leaf	Brackish and saline salts of shores and marshes.	5 Km south sunken ship, Hurgada.

#### Preparation of phytochemical extracts:

The different plant parts were left to dry at room temperature (27-30°C) for 5 to 8 days according to the plant species and pulverized to powder separately in a hammer mill. The extraction was performed using petroleum ether solvent.

One hundred grams of each plant powder was separately extracted with petroleum ether at room temperature. After 24hr., the supernatants were decanted, filtrated through Whatman filter paper No. 5 and concentrated in a rotary evaporator at 40°C for 40-60 minutes. Dry extracts were weighed, and kept at -4°C till used for experiments. In order to study the biological effects of the concerned plant extracts, the tested material of the petroleum ether extracts was dissolved in 2 drop of Tween 80 as emulsifier to facilitate the dissolving of tested material in water and different of concentrations of each concerned extract was prepared (Latha *et al.*, 1999).

#### Test organisms:

The test organism namely *Culex pipiens* that reared in the laboratory at faculty of Science, Al-Azhar University.

#### Application of extracts:

Twenty-five 1<sup>st</sup> instar larvae were put into 250 ml plastic cups contained different concentrations of the used extracts (dissolved in 100 ml of dechlorinated tap water). Three replicates were used for each tested concentration. A group of 25 larvae was put in a plastic cup filled with 100 ml dechlorinated tap water (control group). All plastic cups were incubated under controlled conditions at temperature of 27±2°C, relative humidity 70±10% & 12-12 light-dark regime.

#### Bioassay procedure:

Larval duration was calculated as the intervals between the commencement of first instar larvae and the commencement of pupation, it was calculated for each larva and then the mean value was taken.

The pupation percentage was estimated by using the following equation: pupation% = A/B×100. Where: A = number of pupae, B = number of tested larvae (El-Shekh 2006).

The pupal mortality percentage was estimated by using the following equation: PM% = A-B/A× 100. Where: A = number of produced pupae, B = number of observed adults (El-Shekh 2006).

Pupal duration was calculated as the interval between the commencement of pupation and the commencement 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 percent was calculated by using the following equation: Adult emergence % = A/B×100. Where: A = number of emerged adults, B = number of tested pupae (El-Shekh 2006).

The adult females that succeeded to emerge from treated larvae with each concentration were collected and transferred with normal adult males obtained from the colony to the wooden cages (20×20×20 cm) by using an electric aspirator recommended by (WHO), and fed with 10% sugar solution for three days, then, the adult males and females were starved for one day. At fifth day, the starved females were allowed to take a blood meal from a pigeon and allowed to lay egg rafts on clean water. The number of egg/raft was counted by using binocular and then mean value was taken.

The Egg-hatchability (fertility) 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 (El-Shekh 2006).

#### Data analysis:

The analysis was done by Excel for windows program version 2 Microsoft office 2010. The obtained data were assessed by calculation of the mean (M) and standard deviation (SD).

## Results

The biological activity of petroleum ether extract of different plants against *C. pipiens* has been studied. The biological activity of these plants included the larval duration, pupation rate, pupal mortality, pupal duration, adult emergence, fecundity and egg-hatchability. The obtained results are shown in tables (2-5).

Data mentioned in table (2) showed that, petroleum ether extract of *Azadirachta indica* leaves prolonged the mean larval duration to 10.23, 11.7, 13.06 and 14.7 days at concentrations 10, 20, 30 and 40ppm; respectively, while it was shortened to 6.56 days at concentration of 1ppm compared with 7.1 days for the control group.

The pupation percentage of the treated larvae decreased as the concentration increased, where it recorded 0.0% at the highest concentration 50ppm and 64.0% at the lowest concentration 1ppm. The control group recorded 90.7% pupation.

The mean duration of pupae resulted from treated larvae was prolonged at concentrations: 20, 30 and 40ppm where it was 2.16, 2.13 and 2.3 days; respectively, while it was shortened to 1.46 days at concentration of 1ppm compared with 1.76 days for the untreated group.

A positive correlation between the concentration and pupal mortality percentage was observed. The highest mortality percentage was 100% at 30ppm and the lowest mortality percentage was 6.3% at 1ppm, while the pupal mortality in the control group was 0.0%.

Results in table (2) showed a reduction in adult emergence percentage which decreased as the concentration increased. The adult emergence percentages were 93.7, 84.6, 70.0 and 50.0% at 1, 5, 10, and 20ppm; respectively, vs. 100% of control group.

The petroleum ether extract of *A. indica* leaves exerted a remarkable reduction on the adult fecundity. Where the fecundity was 151, 137.7, 98.7 and 65.3 eggs/♀ at 1, 5, 10 and 20ppm, respectively; vs. 192 eggs/♀ in case of the control group. Moreover, the fertility % was concentration dependent, where the lowest fertility percentage 27.6% was induced by 20ppm compared to 88.5% for the control group (Table 2).

**Table 2:** The effect of petroleum ether extract of *A. indica* (leaves) against *C. pipiens*.

Conc. ppm	No. of tested larvae	Mean larval duration (days)±SD	Pupation %	Mean pupal duration (days)±SD	Pupal Mortality%	Adult Emergence %	No. of eggs laid (Mean ±SD)	No. of hatched eggs	
								Total	%
50	25	-	-	-	-	-	-	-	-
40	25	14.7±0.57	4.0	2.3±0.6	0.0	0.0	0.0	0.0	0.0
30	25	13.06±0.9	10.7	2.13±0.32	100	0.0	0.0	0.0	0.0
20	25	11.7±1.15	21.3	2.16±0.28	50.0	50.0	65.3±5.5	450	27.6
10	25	10.23±1.32	38.7	1.8±0.43	30.0	70.0	98.7±4.7	775	31.4
5	25	7.26±2.05	50.7	1.8±0.14	15.4	84.6	137.7±6.8	1800	58.1
1	25	6.56±0.5	64.0	1.46±0.45	6.3	93.7	151±5.3	3025	80.1
Control	25	7.1±1.0	90.7	1.76±0.05	0.0	100	192±5.3	4250	88.5

Data recorded in table (3) illustrated that, petroleum ether extract of *Phragmites australis* stems increased the mean larval duration to 9.3, 12 and 14.9 days at the concentrations 40, 50 and 75ppm; respectively, while it was shortened to 7.1, 7.2 and 7.7 days at concentration of 10, 20 and 30ppm; respectively, compared to 7.9 days for the control group.

The pupation percentage among the treated larvae decreased as the concentration increased. The pupation % ranged from 5.33 to 72.0% at the highest and lowest concentrations 75 and 10ppm; respectively vs. 94.7% pupation of control larvae.

The petroleum ether extract prolonged the pupal duration especially at the concentration of 75ppm where it was 2.8 days, compared to 1.7 days for the control group.

The lethal effect of petroleum ether extract of *Ph. australis* stems extended to the pupal stage. The highest pupal mortality (100%) was at concentration 75ppm and the lowest mortality 0.0% was at 10ppm as in case of the control group.

There was a remarkable reduction in the percentage of the adult emergence at the concentrations of 75 and 50ppm, as it recorded 0.0 and 25.0%; respectively. Meanwhile, at the other concentrations: 40, 30, 20 and 10ppm the adult emergence was 71.4, 88.9, 92.3 and 100%; respectively, vs. 100% for the control group.

The pronounced effect of *Ph. australis* extract on the number of laid eggs was shown in table (3) at concentrations 50, 40, 30, 20 and 10ppm where it was 80.3, 82.0, 98.7, 137.7 and 149.3 eggs/♀ respectively as compared with the corresponding control (201.7 eggs/♀).

Results elucidated that the fertility percentage was concentration dependent, where at 50, 40, 30, 20 and 10ppm, it was 74.7, 70.7, 73.98, 67.6 and 82.4%; respectively, vs. 92.3% for the control group.

**Table 3.** The effect of petroleum ether extract of *Ph. australis* (stems) against *C. pipiens*.

Conc. ppm	No. of tested larvae	Mean larval duration (days)±SD	Pupation %	Mean pupal duration (days)±SD	Pupal Mortality %	Adult Emergence %	No. of eggs laid (Mean ±SD)	No. of hatched eggs	
								Total	%
100	25	-	-	-	-	-	-	-	-
75	25	14.9±0.2	5.33	2.8±0.6	100	0.0	0.0	0.0	0.0
50	25	12±0.6	14.8	2.2±0.3	75.0	25.0	80.3±0.57	1500	74.7
40	25	9.3±0.6	30.7	2.1±0.4	28.6	71.4	82.0±6.24	1450	70.7
30	25	7.7±1.2	36.0	1.9±0.3	11.1	88.9	98.7±4.7	1825	73.98
20	25	7.2±0.4	50.8	1.75±0.2	7.7	92.3	137.7±6.8	2325	67.6
10	25	7.1±0.2	72.0	1.7±0.3	0.0	100	149.3±4.04	3075	82.4
Control	25	7.9±0.1	94.7	1.7±0.12	0.0	100	201.7±7.63	4650	92.3

Petroleum ether extract of *Rosmarinus officinalis* stems increased the mean larval duration to 9.7 and 12.9 days at the concentrations: 2000 and 2500ppm; respectively, while it was shortened to 7.5 days at concentration of 250ppm, compared to 8.1days for the control group (Table 4).

As shown in table (4) the pupation percentage of the treated larvae with *R. officinalis* extract increased as the concentration decreased. The pupation percentage recorded 5.3, 17.7, 29.3, 46.7, 70.7 and 94.8% at the concentrations: 2500, 2000, 1500, 1000, 500 and 250ppm; respectively, compared to 100% for in case of the untreated group.

The pupal duration prolonged to 2.03, 2.3and 2.6 days at concentrations 1500, 2000 and 2500ppm; respectively, while it was shortened to 1.8 and 1.7 days at concentrations of 250 and 500ppm compared to 1.9 days for the control group.

The pupal mortality percentage was affected at only the three high concentrations 2500, 2000 and 1500ppm, where the pupal mortality percentage was 100, 60.0 and 42.9%; respectively. There was no pupal mortality recorded in the lower concentrations and the control group.

There was a remarkable reduction in the percentage of the adult emergence only at the concentrations of 2500, 2000 and 1500ppm, as it recorded 0.0, 40.0 and 57.1%; respectively. Meanwhile, at the other concentrations: 1000, 500 and 250ppm the adult emergence was 91.7, 100 and 100%; respectively, vs. 100% for the control group.

The fecundity was decreased by increasing the concentration where the average number of eggs was 125.0, 138.7, 151.0, 182.0 and 185.3 eggs/♀ at the concentrations 2000, 1500, 1000, 500 and 250ppm; respectively, vs. 203.3 eggs/♀ for the control group.

A reduction in fertility percentage was observed. Moreover, the fertility percentage was decreased as the concentration increased the lowest fertility percentage 48.0% was induced by 2000ppm and the highest fertility percentage 83.6% was induced by 250ppm, compared to 90.98% for the control group (Table 4).

**Table 4:** The effect of petroleum ether extract of *R. officinalis* (stems) against *C. pipiens*

Conc. ppm	No. of tested larvae	Mean larval duration (days)±SD	Pupation %	Mean pupal duration (days)±SD	Pupal Mortality %	Adult Emergence %	No. of eggs laid (Mean ±SD)	No. of hatched eggs	
								Total	%
3000	25	-	-	-	-	-	-	-	-
2500	25	12.9±0.83	5.3	2.6±0.26	100	0.0	0.0	0.0	0.0
2000	25	9.7±0.57	17.7	2.3±0.15	60.0	40.0	125.0±5	1500	48.0
1500	25	8.9±0.17	29.3	2.03±0.05	42.9	57.1	138.7±2.3	2250	64.9
1000	25	8.7±9.57	46.7	1.9±0.2	8.3	91.7	151.0±4.6	2875	76.2
500	25	8.3±1.15	70.7	1.7±0.25	0.0	100	182.0±3.5	3750	82.4
250	25	7.5±0.5	94.8	1.8±0.1	0.0	100	185.3±5.03	3875	83.6
Control	25	8.1±0.15	100	1.9±0.11	0.0	100	203.3±5.8	4625	90.98

Petroleum ether extract of *Rhizophora mucronata* leaves prolonged the larval duration to 9.5, 12.3, 13.6, and 14.4 days at concentrations 750, 1000, 1500 and 2000ppm; respectively compared to 8.5 days for the control group (Table 5).

The pupation % of the treated larvae with the extract of *Rh. mucronata* increased as the concentration decreased. The pupation percentage recorded 9.3, 26.7, 42.7, 57.3, 74.7 and 89.2% at the concentrations: 2000, 1500, 1000, 750, 500 and 250ppm; respectively, compared to 94.8% in case of the untreated group.

The mean duration of pupae developed from the treated larvae was slightly prolonged at concentrations: 1000, 1500 and 2000ppm, as it recorded 2.2, 2.3 and 2.1 days; respectively, vs. 2 days for the control group. On the other hand, the mean pupal duration was slightly shortened at concentrations: 750 and 500ppm where it was 1.9 and 1.8; respectively.

Table (5) showed that there was no pupal mortality resulted from the lowest concentration of *Rh. mucronata* extract (250 ppm). As the concentration increased, the mortality increased where 500, 750, 1000, 1500, 2000ppm resulted in 15.8, 21.4, 72.7, 85.7 and 100% mortality; respectively.

The adult emergence percentage decreased as the concentration increased. The adult emergence percentages were 100, 84.2, 78.6, 27.3 and 14.3% at 250, 500, 750, 1000 and 1500ppm; respectively, vs. 100% for the control group.

The petroleum ether extract of *Rh. mucronata* (leaves) exerted a remarkable reduction in the adult fecundity. The number of laid eggs was 121.7, 107.3, 96.3, 78.0 and 75.7 eggs/♀ at 250, 500, 750, 1000 and 1500ppm, respectively; vs. 204.0 eggs/♀ for the control group.

The hatchability percentage increased as the concentration decreased. It was 26.4, 28.2, 57.09, 72.7 and 83.01% at 1500, 1000, 750, 500 and 250ppm; respectively, compared to 92.15% for the control group.

**Table 5.** The effect of petroleum ether extract of *Rh. mucronata* (leaves) against *C. pipiens*

Conc. ppm	No. of tested larvae	Mean larval duration (days)±SD	Pupation %	Mean pupal duration (days)±SD	Pupal Mortality %	Adult Emergence %	No. of eggs laid (Mean ±SD)	No. of hatched eggs	
								Total	%
3000	25	-	-	-	-	-	-	-	-
2000	25	14.4±0.7	9.3	2.1±0.2	100	0.0	0.0	0.0	0.0
1500	25	13.6±1.03	26.7	2.3±0.3	85.7	14.3	75.7±5.5	500	26.4
1000	25	12.3±0.57	42.7	2.2±0.2	72.7	27.3	78.0±8	550	28.2
750	25	9.5±0.8	57.3	1.9±0.2	21.4	78.6	96.3±5.5	1375	57.09
500	25	8.7±0.6	74.7	1.8±0.3	15.8	84.2	107.3±2.5	1950	72.7
250	25	8.9±0.8	89.2	2±0.0	0.0	100	121.7±5.5	2525	83.01
Control	25	8.5±0.4	94.8	2±0.0	0.0	100	204.0±3.6	4700	92.15

## Discussion

In the present study, the used plants are eco-friendly, not toxic to human, with toxic effect depend on the plant species, plant part and concentration of extract. Such results may offer an opportunity for developing alternatives to rather expensive and environmentally hazardous organic insecticides. Results of the mortality and biological effects of the studied plant extracts on *C. pipiens* as discussed later confirm their potential for control of the mosquito populations.

The effect of the tested plant extracts on the larval duration of *C. pipiens* was concentration-dependent. The larval duration of *C. pipiens* treated with petroleum ether extract of *A. indica* (leaves), *Ph. australis* (stems), *R. officinalis* (stems) and *Rh. mucronata* (leaves) showed prolonged effect. These results are in agreement with Murugan *et al.* (1996) and Nathan *et al.* (2005b) who used sub-lethal doses of *Azadirachta indica* neem extract against *A. stephensi* larvae, suggesting the toxicity of neem extracts.

The obtained results indicated a remarkable reduction in the percentage of pupation by all plant extracts tested. The pupation percentage among the pupae developed from treated larvae decreased as the concentration of the plant extract increased. Bell (1978) showed that pupae might exhibit a higher tolerance to chemicals agents than active stages. Papachristos and Stamopoulos (2002) have reported that larvae of *Acanthoscelides obtectus* (Say) were more susceptible than pupae to the fumigant toxicity of the essential oils from *Lavanda hybrida* (Rev), *Rosmarinus officinalis* L. and *Eucalyptus globules* (Lab).

The petroleum ether extracts of *A. indica*, *Ph. australis*, *R. officinalis* and *Rh. mucronata* tested against *C. pipiens* larvae showed prolonged activity on the duration of the resulted pupae. Similar observations on other plant extracts effect on several insects have been reported. For example, Sadek (2003) showed that the time of pupation of *Spodoptera littoralis* of larvae increased by the extract of *Adhatoda vasica*. Zhong *et al.* (2001) have also highlighted that extract from *Rhododendron molle* flowers increased the duration of development of *Pieris rapae*.

The survivorship of pupae resulted from the treated larvae with plant extracts was varied. There was a positive correlation between the concentration and pupal mortality percentage of *A. indica* (leaves) and *Ph. australis* (stems), while, the pupal mortality of *C. pipiens* treated with petroleum ether extract of *R. officinalis* (stems) and *Rh. mucronata* (leaves) showed high percentages at the higher concentration.

A remarkable reduction in the percentage of emerged adult from treated larvae with plant extracts was observed. The reduction was concentration-dependent. All plant extracts tested induced reduction in the

percentage of adult emergence. The complete inhibition in the adult emergence (0.0% adult emergence) was at concentrations: (30, 40 and 50ppm), (75 and 100ppm), (2500 and 3000ppm) and (2000 and 3000ppm) for *A. indica* (leaves), *Ph. australis* (stems), *R. officinalis* (stems) and *Rh. mucronata* (leaves); respectively.

Plant extracts tested showed variable effects on the fecundity of *C. pipiens* adult females, where the induced effect was part of the plant and concentration of the extract-dependent. The fecundity of *C. pipiens* treated with petroleum ether extract of showed a remarkable reduction, the mean fecundity was: (151 eggs/♀ at the concentration of 1ppm, 65.3 eggs/♀ at the concentration of 20ppm) and (121.7 eggs/♀ at the concentration of 250ppm, 75.7 eggs/♀ at the concentration of 1500ppm) for *A. indica* and *Rh. mucronata* leaves; respectively. The fecundity of *C. pipiens* females treated with petroleum ether extract of *Ph. australis* and *R. officinalis* stems showed obvious effect at all concentrations. A remarkable decrease in the hatchability percentage of eggs laid by females resulted from treated larvae was observed. The decrease was concentration-dependent i.e. the hatchability percentage of eggs decreased as the concentration of the extracts increased for all tested plants. These results are in consistent with those obtained by many authors using different plant extracts against different mosquito species (Saxena *et al.*, 1993; Shalaby *et al.*, 1998; Khalaf, 1999; El-Bokl, 2003; Jeyabalan *et al.*, 2003; and Nathan *et al.* 2005 a and b).

Ghosh *et al.*, 2012 suggested that the extraction of active biochemical from plants depends upon the polarity of the solvents used. Polar solvents extract polar molecules and non-polar solvents extract non-polar molecules. This was achieved by using mainly eleven solvent systems ranging from hexane/petroleum ether, the most non polar (polarity index of 0.1) that mainly extracts essential oil to that of water, the most polar (polarity index of 10.2) that extracts biochemicals with higher molecular weights such as proteins, glycans, *etc.*. Chloroform and ethyl acetate are moderately polar (polarity index of 4.1) that mainly extracts steroids, alkaloids, *etc.*. It was found that the most effective studied solvents were that of minimum polarity such as hexane or petroleum ether or that with maximum polarity such as aqueous/steam distillation.

Kishore *et al.*, 2011 isolated the bioactive ingredient in the neem plant *Azadirachta indica* that named Azadirachtin. Rattan, 2010 documented that generally the active toxic ingredients of plant extracts are secondary metabolites that are evolved to protect them from herbivores. The insects feed on these secondary metabolites potentially encountering toxic substances with relatively non-specific effects on a wide range of molecular targets. These targets range from proteins (enzymes, receptors, signaling molecules, ion-channels and structural proteins), nucleic acids, biomembranes, and other cellular components. This in turn, affects insect physiology in many different ways and at various receptor sites, the principal of which is abnormality in the nervous system (such as, in neurotransmitter synthesis, storage, release, binding, and re-uptake, receptor activation and function, enzymes involved in signal transduction pathway). Rattan reviewed the mechanism of action of plant secondary metabolites on insect body and documented several physiological disruptions, such as inhibition of acetylcholinesterase (by essential oils), GABA-gated chloride channel (by thymol), sodium and potassium ion exchange disruption (by pyrethrin) and inhibition of cellular respiration (by rotenone). Such disruption also includes the blockage of calcium channels (by ryanodine), of nerve cell membrane action (by sabadilla), of octopamine receptors (thymol), hormonal balance disruption, mitotic poisoning (by azadirachtin), disruption of the molecular events of morphogenesis and alteration in the behaviour and memory of cholinergic system (by essential oil), etc.

## Conclusion

Today, environmental safety is considered to be of paramount importance. An insecticide does not need to cause high mortality on target organisms in order to be acceptable but should be ecofriendly in nature. Phytochemicals may serve as these are relatively safe, inexpensive and readily available in many parts of the world.

The outcome results showed that the effect of the different plant extracts tested against *C. pipiens* larvae on the mean larval duration was concentration-dependent. The obtained results indicated a remarkable reduction in the percentage of pupation by all tested plant extracts. The petroleum ether extracts of all tested plants showed prolonged activity on the duration of the resulted pupae. There was a positive correlation between the concentration and pupal mortality percentage. A remarkable reduction in the percentage of adult emerged was observed and the reduction was concentration-dependent. A remarkable reduction in the fecundity of *C. pipiens* adult females was the resulted effect of all tested plants especially those of *A. indica* and *Rh. mucronata*. The hatchability percentage of eggs laid by females developed from treated larvae was also decreased and the decrease was concentration-dependent.

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