CATRINA (2023), 27(1): 13-22

Influence of Temperature on The Efficiency of *Commiphora molmol* and Acetylsalicylic Acid Against *Culex pipiens* (Diptera: Culicidae)

Faten F. Abo El-Dahab, Mohamed M. Baz, Yasser A. El-Sayed, Rasha M. Abdel Hameed and Abla D. Abdel-Meguid*

Entomology Department, Faculty of Science, Benha University, Benha B.O., 13518, Egypt

ABSTRACT

The most important factor influencing the growth and survival of mosquito larvae is temperature. As a result, changes in the surrounding temperature may have an effect on the chemicals' toxicity to mosquitoes. The goal of the current study was to determine how temperature affected *Culex pipiens*' reactions to *Commiphora molmol* resin, Mirazid, crystalline (CASA), and acetylsalicylic acid in pharmaceutical form (PASA). Bioassay tests were carried out on the 3rd instar larvae under laboratory conditions, and the LC_{50} of each compound was determined. The LC_{50} of the four compounds were used to study the temperature-toxicity relationship, while the LC_{50} of Mirazid and (PASA), as the most toxic compounds, were used for further biochemical studies. Results indicated that, Mirazid was the most toxic compound, with LC_{50} of 28.3 ppm followed by *C. molmol* resin with LC_{50} of 41.6 ppm while the CASA was the least toxic compound with LC_{50} of 799.7 ppm. The temperature has a considerable impact on *Cx. pipiens* larval susceptibility to the tested compounds. High temperature (36℃) resulted in high mortality rate (72.88, 78.20, 58.8 and 62.12 % for of *C. molmol* resin, Mirazid, CASA and PASA, respectively. Moreover, there were significant changes in α- esterase, β–esterase and glutathione -S-transferase levels as well as the total protein content in the treated larvae due to the change in temperature. The efficacy of Mirazid and *C. molmol* resin under wide range of temperatures made these compounds suitable candidates for controlling *Cx. pipiens*.

Keywords: Acetylsalicylic acid; *C. molmol*; *Culex pipiens;* Intermediary metabolism; Temperature; Toxicity.

INTRODUCTION

Culex pipiens (Diptera: Culicidae) is common in Egypt. This mosquito species transmits several human and animal illnesses, such as Elephantiasis, Rift Valley fever, St. Louis encephalitis, and West Nile fever (Vinogradova, 2000). Chemical insecticides are the most widely used method of mosquito control (Elono *et al*., 2018; Sayed *et al*., 2018; Liu *et al*., 2019; Wilson *et al*., 2020; Wang *et al*., 2020; Mapossa *et al*., 2021 and Kaura *et al*., 2022), but their indiscriminate use may lead to insecticide resistance, environmental pollution, and adverse effects on human health (Zayed *et al*., 2019). These negative impacts have forced the development of novel control strategies. Certain plant families (e.g., Meliaceae) are a well-known source of pesticides (Isman, 2020). The plant produces these secondary metabolites as part of its natural defence against pest infestations (Howe and Jander, 2008). Oleo-gum-resin derived from plants of the genus *Commiphora* (Burseraceae) is extensively used in traditional medicine to treat a variety of ailments (Grbi *et al*., 2018).

Essential oils and botanical extracts mediated by *Commiphora* spp. have been utilized in many purposes as egg-laying deterrents and larvicides against several mosquito species (Massoud and Labib, 2000; Regnault-Roger *et al*., 2012; da Silva *et al*., 2015 and Muturi *et al*., 2020). Acetylsalicylic acid (ASA), a synthetic derivative of the naturally occurring compound, is indeed derived from salicylic acid, a significant component of the herbal extract found in the bark and leaves of the *Salix* tree. Several researchers have demonstrated that salicylic acid and *Salix safsaf* extract have larvicidal effects against mosquitoes (Mondal *et al*., 2014) and *Musca domestica* (Mansour *et al*., 2011; Selem & El-Sheikh, 2015 and Hasaballah *et al*., 2021).

The most significant abiotic factor influencing the survival and development of mosquito at juvenile stages is temperature (Delatte *et al*., 2009 and Christiansen-Jucht *et al*., 2014). The efficiency of insecticides against the target pests is dependent not only on the active ingredient but also on the insect's surroundings including Temperature, light, moisture, bacteria and pH, (Zayed *et al*., 2019). Therefore, any change in the surrounding temperature might be expected to affect the toxicity of the molecule to ectothermic species. Temperature also influences protein content and enzyme activities, which play a significant role in the survival of several insect species (Imasheva *et al*., 1998).

The efficiency of the control program is strongly based on resistance management strategies. For the development of these strategies, it is important to know the factors influencing resistance and to identify the mechanisms involved as well. The objective of this study is to evaluate the larvicidal effectiveness of *Commiphora molmol* oleo gum resin, Mirazid, and crystalline and pharmaceutical forms of acetylsalicylic acid against *C. pipiens*, as well as their temperature-toxicity relationship. The most toxic compounds were

* *Corresponding author e-mail: Abla_desouky@yahoo.com*

also used to clarify how the organism's metabolic processes changed when the temperature changed.

MATERIALS AND METHODS

Insect rearing

Culex pipiens larvae were collected from their natural breeding sites at Shiblanga Village, Qalyubiyya Governorate, Egypt. The mosquito species was identified in accordance with Harbach (1985), and it was raised for seven generations at 27 ± 2℃ and a 12:12h (Light: Dark) photoperiod (Zayed *et al*., 2019) in the insectary of the Medical Entomology Department, Faculty of science, Benha University ,Benha, Egypt. Larvae were reared in white enamel pans (35 - 40 cm in diameter and 10 -12 cm in depth) containing de-chlorinated tap water. They were fed tropical fish food (Tetramin®). Adult mosquitoes were reared in wooden cages (35×35×40 cm) at 27 ± 2℃, 12:12h (L: D), and 75 ± 5% RH and 10% sucrose solution, via a cotton piece, and blood via a pigeon. The eggs were collected and transferred into clean enamel pans.

Compounds tested

Commiphora molmol (myrrh) oleo gum resin was purchased from a local market of medicinal plants, agricultural seeds, and herbs, Dokki, Giza, Egypt, while Mirazid capsules (300 mg) a pharmaceutical form (myrrh derivative) was produced by Pharco Pharmaceutical Company, Egypt (Fig.1). Two formulations of Acetylsalicylic acid (ASA) were used: Crystalline Acetylsalicylic acid (CASA) which was purchased by El Nasr Co. for chemical, Cairo, Egypt, and a Pharmaceutical form of acetylsalicylic acid (PASA) Green Aspirin, 320 mg tablets which was produced by The Arab Drug Company for Pharmaceutical & Chemical industries.

Figure (1): Examples of the drug use of *Commiphora molmol* plant. A, Natural resin obtained from stem scratching; B, Pharma-ceutical form of Oleo-gum resin (Mirazid).

Larvicidal bioassays

Bioassay of *C. molmol* resin, Mirazid, CASA and PASA were performed to determine the median lethal concentration (LC_{50}) of each compound against *Cx. pipiens* larvae. *C. molmol* resin, CASA and PASA were dissolved in de-chlorinated tap water, while Mirazid was dissolved in Ethylene glycol (1 capsule/ml Ethylene glycol) and the resulting solution was then diluted with de-chlorinated tap water to a final 100 ml as the stock solution. Resin and Merazid drug were prepared in six serial concentrations (10, 20, 40, 80, 160, and 320 ppm), as well as CASA and PASA (200, 400, 800, 1200, 1600, and 2000 ppm). The larvicidal bioassays were conducted using the method of WHO (2005). Twenty-five 3rd instar larvae of *Cx. pipiens* were transferred into each 250ml beaker containing 200 ml of distilled water and test concentration. Water or ethylene glycol was used as negative control. Three replicates for each concentration were undertaken. All experiments were maintained at laboratory conditions (27±2℃ and 75±5% RH). The mortality counts were recorded after 48 h of treatment.

Effect of temperature on the larvicidal activity of the tested compounds

To determine the effect of temperature on the larvicidal efficacy of the aforementioned compounds against *Cx. pipiens*, three groups per compound of twenty-five 3rd instar larvae each were released into a glass beaker containing the LC_{50} of each compound, as determined earlier in this study (41.6, 28.4, 799.7, and 570.9 ppm for *C. molmol* resin, Mirazid, CASA, and PASA, respectively) (Table 3). Each group was incubated independently at 15, 26, and 36℃. In parallel, a control of untreated larvae exposed to the different temperature degrees. Each experiment was replicated three times. Mortality rate was calculated 48 h after exposure.

Biochemical assays

To determine the effect of temperature on the total protein and the activities of some detoxification enzymes of *Cx. pipiens* 3rd instar larvae, the predetermined LC_{50} of Mirazid and PASA, as the most toxic compounds were used (28.3 and 570.9 ppm, respectively). Larvae reared at different temperature regimes (15, 26 & 36℃) for 48 h and submitted to biochemical assays for α- and β-esterase, glutathione S-transferase (GST) activities and total protein content.

Sample preparation

After 48h of treatment at each temperature, surviving *Cx. pipiens* larvae were separately homogenized in 500 µl distilled water using a cooled glass Teflon homogenizer (ST- Mechanic Preczyina, Poland). The homogenates were centrifuged at 8000 rpm for 20 min at 4℃ (6 MR, USA). The supernatant (source of protein and enzymes) was frozen at -18℃ for future use.

Protein assay

The method described by Bradford (1976) was used to determine the total protein of *Cx. pipiens* larvae. Bovine Serum albumin was used as the standard and Coomasie brilliant blue G-250 as the dye binding to proteins.

Esterase activity

Alpha and beta-naphthyl acetate was utilized as substrates for alpha- and beta-esterases, respectively, according to the technique of Van-Asperen (1962). 5ml substrate solution ($3x10^{-4}$M alpha-or beta-naphthyl-acetate, 1% acetone, and 0.1M phosphate buffer, pH7) was added to 20 µl of larval homogenate. To halt the enzymatic process, 1 ml of diazoblue color reagent (made by combining 2 parts of 1% diazoblue B and 5

parts of 5% sodium lauryl sulphate) was added to the mixture after precisely 15 min of incubation at 27℃. The blank included 5 ml of substrate solution and 1 ml of diazo blue coloring reagent. The developed color was read at 600 or 555 nm for α- and β-naphthol, respectively. Absorbance level for individual larva was compared with the help of a standard curve of absorbance for known concentrations of α-and β-naphthol, respectively. Standard curves were prepared by dissolving 20 mg of alpha- or beta-naphthol in 100 ml of phosphate buffer, pH7 (Stock solution). 10 ml of stock solution were diluted up to 100 ml by the buffer. Aliquots of 0.1,0.2,0.4,0.8 and 1.6 ml of diluted solution (equal to 2,4,8,16 and 32 µg naphthol) were pipetted into test tubes and completed to 5 ml by phosphate buffer.1ml of diazoblue reagent was added and the developed color was measured in the UV spectrophotometer (Shimadzu UV-3600PC Series) against blank. The enzyme activity was expressed as µg of α/β naphthol produced/min/mg larval protein.

Glutathione S-transferase (GST) assays

GST activity was estimated following the procedure of Habig *et al*. (1974). One ml of potassium phosphate buffer (pH 6.5) and 100µl of the reduced glutathione (GSH) were added to 200µl of the homogenate. The reaction started by adding 25µl of the substrate solution, 1-chloro 2,4-dinitrobenzene (CDNB). The CDNB and GSH concentrations were changed to 1 mM and 5 mM, respectively. The mixes were incubated for 5 min at 30℃. By using an UV-spectrophotometer (Shimadzu UV-3600PC Series), the change in absorbance level was recorded at 340 nm every 30 seconds for 5 min against a blank. Reaction mixture without the enzyme was used as blank, to determine the nano mole substrate conjugated/ min/larva by using the molar extinction coefficient, 9.6/mM/cm.

Statistical analyses

The probit analysis (Finney, 1971) was used to determine the LC_{50} of each compound. In the investigations on the link between temperature and toxicity, the Chi-square test (X^2) was undertaken for each temperature range. Version 11.5 (SPSS 2007) of the Statistical Package for Social Science (SPSS) software was used for analyses, and the significance level was set at $p \leq 0.05$. The biochemical test data were evaluated using the statistical program Costat and one-way analysis of variance (ANOVA) (Cohort Software, Berkeley). When the ANOVA results were significant ($p \leq 0.05$), Duncan's multiple range test was employed to compare the means.

RESULTS

In the present study, the early 3rd instar larvae of *Cx. pipiens* were used to determine the toxicity of *C. molmol* resin, Mirazid, and crystalline and pharmaceutical form of acetylsalicylic acid after 48 h exposure at laboratory conditions**.**

Effect of *C. molmol* resin and Mirazid on 3rd instar larvae of *Cx. Pipiens*

As indicated from Table (1), all tested larvae were more sensitive to Mirazid with mortality percent 100% at a concentration 160 ppm, while *C. molmol* resin achieved 100% mortality at 320 ppm. The results also revealed that, the mortality percentage was increased by increasing the concentrations and this increase was very highly significant ($p \leq 0.001$).

Effects of CASA and PASA on third instar larvae of *Cx. pipiens*

Data presented in Table (2) show the mortality percentages of *Cx. pipiens* 3rd instar larvae due to the exposure to different concentrations of CASA and PASA. Toxicity was significantly ($p \leq 0.001$) enhanced by increasing the concentrations, and the PASA was most toxic, it induced 100% mortality at a concentration of 1600 ppm, while the CASA achieved 92.8% mortality at the same concentration.

Larvicidal effects of the four compounds against *Cx. pipiens* 3rd instar larvae and their relative potency

The Probit analysis (Table 3) revealed that the LC_{50} values after 48 h exposure were 41.6, 28.3, 799.7, 570.9 ppm for *C. molmol* resin, Mirazid, CASA and PASA, respectively. Thus, Mirazid was the most potent compound. Whereas, CASA was the least toxic compound. Mirazid was 1.47, 28.26, 20.17 folds as toxic as *C. molmol* resin, CASA and PASA, respecttively.

Effect of temperature on the toxicity of the four compounds to *Cx. pipiens*

The relationship between temperature and the larvicidal efficacy of the aforementioned compounds against *Cx. pipiens* 3rd instar larvae was evaluated in this study and results are presented in Table (4). *C. pipiens* displayed low mortality rate when exposed to the tested compounds at low temperatures, but the mortality rate increased when exposed to the tested compounds at high temperatures. At 15℃, the recorded mortalities were 48.2, 50.1, 44.1 and 46.2 % for larvae treated with *C. molmol* resin, Mirazid, CASA and PASA respectively. At 26℃, mortality increased to 54.8, 58.9, 51.6 and 52.5 %, while at 36℃ the mortality reached 72.88, 78.20, 58.80 and 62.12 % for *C. molmol* resin, Mirazid, CASA and PASA respectively. This increase was significant ($p \leq 0.05$) in case of *C. molmol* resin and Mirazid. No mortality was observed in the control groups at all temperature degrees.

Biochemical effects

The biochemical assay results of *Cx. pipiens* 3rd instar larvae treated with the LC_{50} of Mirazid and PASA after 48 h from application at different temperatures were presented in Tables (5-8).

Effect of temperature on the total protein content of *Cx. pipiens* third instar larvae

Data in Table (5) show the mean total protein in mg protein/g. fresh body weight. The mean total protein increases remarkably in the control group by increasing the temperature from 15℃ to 26℃, it was 65.6 ± 2.2 mg/g.bw at 15 °C and reached to 87.4 ± 6.17 mg/g.bw at 26℃, then decreased again to 68.2 ± 16.8 mg/g.bw at 36℃. Results also revealed that the mean total protein estimated in the larvae treated with Mirazid was

Table (1): Larvicidal activity of *C. molmol* resin and Mirazid against 3rd instar larvae of *Culex pipiens*, 48 h post-treatment at laboratory conditions.

Tested Conc.(ppm)	Mortality % ± S.E	
	***C. molmol* resin**	**Mirazid**
Control	0.8±0.80^{e}	0.8±0.80 ^{f}
10	12.0±2.53^{e}	23.2±2.94 ^{e}
20	28.8±3.44^{d}	36.8±3.20 ^{d}
40	45.6±4.66^{c}	56.8±6.50 ^{c}
80	70.4±7.33^{b}	82.4±5.31 ^{b}
160	88.0±5.37^{a}	100±0.00 ^{a}
320	100±0.00 ^{a}	100±0.00 ^{a}
P value	0.000 ***	0.000 ***
$LSD_{0.05}$	12.15	10.38

Means followed by the same letter within a column are not significantly different (p>0.05);
*** very highly significant (p≤0.001); LSD, least significant difference; SE, Standard Error.

Table (2): Larvicidal activity of crystalline and pharmaceutical form of acetylsalicylic acid against 3rd instar larvae of *Cx. pipiens* 48 hours post-treatment at laboratory conditions.

Tested Conc.(ppm)	Mortality % ± S.E	
	CASA	PASA
Control	0.8±0.80 ^{f}	1.6±0.98^{f}
200	11.2±2.33 ^{e}	12.0±3.79^{e}
400	22.4±4.83 ^{d}	27.2±3.88^{d}
800	39.2±1.50 ^{c}	60.0±3.35^{c}
1200	56.0±4.00 ^{b}	90.4±2.71^{b}
1600	92.8±4.45^{a}	100±0.00^{a}
2000	100±0.00 ^{a}	100±0.00^{a}
P value	0.000 ***	0.000 ***
$LSD_{0.05}$	8.99	7.66

Means followed by the same letter within a column are not significantly different (p>0.05);
*** very highly significant (p≤0.001); LSD, least significant difference; SE, Standard Error.

Table (3): Comparison between the larvicidal effects of the four compounds against 3rd instar larvae of *Culex pipiens*

Tested Compounds	LC_{50}	95% Confidence limits (ppm)		Slope	$\chi 2$ (d.f.)	Relative Potency
		Lower	Upper			
C. molmol	41.6	32.5	50.7	1.08	2.01 $_{(3)}$	1.47
Mirazid	28.3	24.2	32.7	3.02	2.20 $_{(3)}$	1.00
CASA	799.7	698.5	980.9	0.06	3.06 $_{(3)}$	28.26
PASA	570.9	490.5	651.3	2.24	1.06 $_{(4)}$	20.17

X^2: Chi-square value; *d.f*, degree of freedom.

45.0±6.9, 65.8±1.65 and 43.5±5.6 mg/g.bw, while in the larvae treated with PASA, the protein content was 55.2 ±4.8, 80.5±4.98 and 52.4±2.95 mg/g.bw at 15, 26 and 36℃, respectively. This means that the tested materials induce reduction in the mean total protein content than those of the control at all the tested temperature degrees and these differences were statistically significant.

Effect of temperature on α-esterase activity of *Cx. pipiens* 3rd instar larvae

α-esterase activity in µg α-naphthol/min/g.bw of 3rd instar larvae treated with Mirazid and PASA are given in Table (6). The obtained data indicate that, the activity of α-esterase in the control group was slightly increased by increasing the temperature from 15 to 26℃. On other hand at 36℃ α-esterase activity decreased. A highly significant decrease in α-esterase activity (p≤0.01) was observed at 15℃ when the larvae of *Cx. pipiens* were exposed to Mirazid and PASA for 48h, it was 146±24.3 and 150±11.4 µg α-napht-hol/min/g.bw in Mirazid and PASA-treated larvae, respectively compared to 257±40.6 µg α-napht-hol/min/g.bw in the control. The activity significantly increased at 26℃, the mean α-esterase activity was 214±26.6 and 249±32.4 µg α-naphthol/min/g.bw in Mirazid and PASA-treated larvae, respectively.

At 36℃ the activity decreased again till reached 165.7±13 and 188.7±3.1 in Mirazid and PASA-treated larvae, respectively, compared to 209.3±5.13 µg α-naph-thol/min/g.bw in the control. This indicates that the tested materials induce reduction in α-esterase level

of treated larvae than the control at all temperature degrees.

Effect of temperature on β -esterase activity of *Cx. pipiens* third instar larvae

Data in Table (7) show that β-esterase activity of *Cx. pipiens* 3rd instar larvae increased in the control group from 240±15.3 µg β-naphthol/min/g.bw at 15℃ to 338.3±11.6 µg β-naphthol/min/g.bw at 26℃ after 48h exposure, then decreased again at 36℃, it was 246.3±20.7µg β-naphthol/min/g.bw The mean β-esterase activities of larvae treated with Mirazid and PASA were 280.6±13 and 299.7±17.6µg β-naphthol/min/g.bw, respectively at 15℃. These values were significantly increased than controls by 16.67 and 24.87% after 48h exposure, respectively. Meanwhile, treatment with Mirazid and PASA induces significant reduction in β-esterase activities of treated larvae at temperatures 26℃ and 36℃, the activities were 303.3±17.4 and 173.7±15.9µg β–naphthol/min/g.bw for Mirazid treated larvae and 328.3±10.7 and 179±3.60µg β-naph-thol/min/g.bw for PASA treated larvae compared to 338.3±11.6 and 246.3±20.7 µg β-naphthol/min/g.bw of the control, respectively.

Effect of temperature on GST activity of *Cx. pipiens* third instar larvae

According to Table (8), the level of GST increased in the control groups by increasing the temperature, the mean activities were 17.8±3.37, 23 ±5.1 and 45.2±4.87 mmole subconjugated $min^{-1}g\ bw^{-1}$ at 15 °C, 26℃ and 36℃, respectively. The treated larvae showed an increase in GST activity of between 42.13% and 72.47% at 15 °C. However, the activity continued to rise by 39.56% and 119.56%, respectively, for PASA and Mirazid-treated larvae at 26℃. On the other side, at 36℃ GST activity of treated larvae was significantly decreased ($p \leq 0.05$). The recorded activities were 34.9±2.76 and 41.6±1.41 mmole subconjugated $min^{-1}g.bw^{-1}$ in Mirazid and PASA-treated larvae, respectively compared to 45.2±4.87 mmole subconjugated $min^{-1}g.bw^{-1}$ of the control.

DISCUSSION

In our study we evaluated the toxicity of *C. molmol* resin, Mirazid, CASA and PASA against the 3rd larval instar of *Cx. pipiens*, as well as temperature-toxicity relationship of the tested compounds to *Cx. pipiens*. *Cx. pipiens* larvae were shown to be vulnerable to the tested materials, with Mirazid proved to be the most effective. Myrrh resin consists of chemical compounds with poisonous characteristics (Ahmad *et al*., 2017). Muturi *et al*. (2020) discovered that many representatives of the *Commiphora* spp. generate mosquito-repelling bioactive chemicals. The biochemical study of total proteins in *Cx. pipiens* larvae indicated that the observed toxicity was likely caused by the suppression of certain detoxifying enzyme activities (Massoud *et al*., 2001).

Table (4): Effect of temperature on the toxicity of the four compounds against *Culex pipiens* larvae, previously treated with the LC_{50} of each compound.

Tested Compounds	Temperature (ºC)					
	15		26		36	
	M %±SE	χ^2 (d.f.)	M %±SE	χ^2 (d.f.)	M %±SE	χ^2 (d.f.)
C. molmol	48.2 ± 3.66^{bcC}	2.27 (4)	54.8 ± 4.85^{bB}	2.91 (4)	72.88 ± 3.20^{eA}	11.14^{*} (4)
Mirazid	50.1 ± 3.20^{cC}	0.06 (4)	58.9 ± 3.27^{cB}	7.76 (4)	78.20 ± 2.94^{dA}	30.04^{*} (4)
CASA	44.1 ± 1.52^{bB}	4.01 (4)	51.6 ± 2.17^{bB}	0.07 (4)	58.80 ± 1.26^{cA}	2.70 (4)
PASA	46.2 ± 3.35^{bB}	2.53 (4)	52.5 ± 3.88^{bB}	2.07 (4)	62.12 ± 4.29^{bA}	9.04 (4)
Control	0.00 ± 0.00^{a}	-	0.00 ± 0.00^{a}	-	0.00 ± 0.00^{a}	-

Means followed by the same letter per column are not significantly different (p>0.05); Means within the raw and followed by the same superscript capital letter are not significantly different (p>0.05); SE, standard error; M%: mortality %; X^2, Chi-square value.

Table (5): Effect of different temperature on the total protein content of *Culex pipiens* 3rd instar larvae, treated with Mirazid and PASA after 48h exposure.

Tested compounds	Total protein content ±SD (mg/g bw)†					
	Temperature tested (ºC)					
	15		26		36	
	Mean	Change%	Mean	Change%	Mean	Change%
Control	65.6 ± 2.2^{a}	-	87.4 ± 6.17^{a}	-	68.2 ± 16.8^{a}	-
Mirazid	45.0 ± 6.9^{b}	-31.4	65.8 ± 1.65^{b}	-24.71	43.5 ± 5.55^{b}	-36.21
PASA	55.2 ± 4.8^{c}	-15.89	80.5 ± 4.98^{a}	-7.89	52.4 ± 2.95^{c}	-23.16
P value	0.007^{**}	-	0.036^{*}	-	0.006^{**}	-
$LSD_{(0.05)}$	10.01	-	9.35	-	7.517	-

†BW, body weight; Means within the column and followed by the same letter are not significantly different (p >0.05); SD, standard deviation; p; probability, LSD; least significant difference; *, significant ($p \leq 0.05$); **, highly significant ($p \leq 0.01$).

Table (6): Effect of temperature on α-esterase activity of *Culex pipiens* 3rd instar, larvae treated with Mirazid and PASA after 48h exposure

Tested Compounds	α-esterase activity ± SD (µg α-naphthol/min/g bw)					
	Temperature (°C)					
	15		26		36	
	Mean	Change%	Mean	Change%	Mean	Change%
Control	257 ±40.6[a]	-	257.3±39.6[a]	-	209.3±5.13[a]	-
Mirazid	146 ±24.3[b]	-43.19	214±26.6 [a]	-16.83	165.7±13[b]	-20.83
PASA	150 ±11.4[b]	-41.63	249±32.4 [a]	-3.23	188.7±3.1[b]	-9.84
P value	0.0041[**]	-	0.319[NS]	-	0.003[**]	-
LSD(0.05)	55.14	-	67.29	-	17.186	-

†BW, body weight; Means within a column and followed by the same letter are not significantly different (p >0.05); SD, standard deviation, p; probability, LSD; least significant difference; *, significant (p ≤0.05); **, highly significant (p ≤0.01).

Table (7): Effect of temperature on β-esterase activity of *Culex pipiens* 3rd instar larvae treated with Mirazid and PASA after 48h exposure.

Tested compounds	β-esterase activity ±SD (µg β-naphthol/min/g bw)					
	Temperature					
	15		26		36	
	Mean	Change%	Mean	Change%	Mean	Change%
Control	240±15.3[a]	-	338.3±11.6[a]	-	246.3±20.7[a]	-
Mirazid	280.6±13.0[b]	16.92	303.3±17.4[b]	-10.35	173.7±15.9[b]	-29.47
ASA	299.7±17.6[b]	24.87	328.3±10.7[a]	-2.96	179±3.60[b]	-27.32
P value	0.03[*]	-	0.05[*]	-	0.009[**]	-
LSD(0.05)	29.44	-	28.58	-	30.46	-

†BW, body weight; Means within a column and followed by the same letter are not significantly different (p >0.05); SD, standard deviation, LSD; least significant difference, *, significant (p ≤0.05); **, highly significant (p ≤0.01).

Table (8): Effect of temperature on GST activity of *Culex pipiens* 3rd instar larvae treated with Mirazid and PASA after 48h exposure.

Tested compounds	GST activity ± SD (m mole sub conjugated/min/g BW)†					
	15		26		36	
	Mean	Change%	Mean	Change%	Mean	Change%
Control	17.8±3.37[a]	-	23.0 ±5.1[a]	-	45.2±4.87[a]	-
Mirazid	25.3±3.80[ab]	42.13	32.1±4.46[b]	39.56	34.9±2.76[b]	-22.78
PASA	30.7±2.90[b]	72.47	50.5±6.4[c]	119.56	41.6±1.41[a]	-7.96
P value	0.0075[**]	-	0.0122[*]	-	0.0233[*]	-
LSD(0.05)	9.969	-	7.781	-	6.64	-

†BW, body weight; Means within a column and followed by the same letter are not significantly different (p >0.05); SD, standard deviation, LSD; least significant difference, *, significant (p ≤0.05); **, highly significant (p ≤0.01).

Mirazid was more efficacious than *C. molmol* resin as a result of its higher myrrh volatile oil content (Massoud *et al*. 2012). Massoud and Labib (2000) and Habeeb *et al*. (2009) revealed that the oleo-resin extract and the essential oil of *C. molmol* were toxic to the larvae of *Cx. pipiens*. Other plant extracts and essential oils from the *Commiphora* spp. have sh-own toxicity against mosquitoes (Baranitharan and Dhanasekaran, 2014; da Silva *et al.*, 2015 and Mut-uri *et al*., 2020). Our findings demonstrate that acet-ylsalicylic acid isolated from *Salix safaf* in the form of either crystalline or pharmaceutical form showed larvicidal activity against *Cx. pipiens*. Mondal *et al*. (2014) demonstrated larvicidal activity of salicylic acid and 3, 5-di nitro salicylic acid against *Cx. quinquefasciatus*, which is consistent with our results. Meanwhile, Alvandy *et al*. (2014) found that *Salix alba* L. extract in various solvents had larvicidial effects on *Ephestia kuehniella* larvae and toxic effects on *M. domestica* (Mansour *et al.*, 2011; Selem & El-Sheikh, 2015 and Hasaballah *et al.*, 2021).

The results revealed that when the temperature increased, *Cx. pipiens'* sensitivity increased dramatically. Due to the greater irritation of mosq-uitoes at higher temperatures, there may be a more rapid absorption of the drug, a quicker knockdown, and a larger mortality rate (Hodjati and Curtis, 1999). The increased chemical penetration into the bodies of *Cx. pipiens* larvae may have also contributed to the increased toxicity. At low temperatures, the toxicity of the compounds decreased, perhaps because the biotransformation process slowed down (Khan & Akram, 2014 and Swelam *et al*., 2022). Our findings are in accord with those of El-Sayed and El-Bassiony (2016), Agyekum *et al*. (2021), and Salinas *et al*. (2021), who found that an increase in temperature is often associated with an increase in the toxicity of pesticides to several mosquito species.

To provide a reasonable explanation for the temperature-dependent variation in the reactivity of *Cx. pipiens* larvae to the utilized chemicals, biochemical experiments were carried out on the average total protein and three enzymes known to be involved in pesticide detoxification, alpha-esterase, beta-esterase, and GST. Temperature influences not only pesticide components but also affects protein content and enzyme activities for the survival of a variety of species (Imasheva *et al*., 1998).

The present data showed that, the mean total protein increased by increasing the temperature from 15 to 26℃, then decreased again at 36℃ and the tested materials induced reduction in the mean total protein compared to the control at all temperature degrees. It was probable that, Mirazid and PASA treatment led to decreased feeding (Tarigan *et al*., 2016). In consistence with our findings Massoud *et al*. (2001), Larson *et al*. (2010) and Dris *et al*. (2017) reported a significant reduction in the mean total protein of the larvae of different mosquito species treated with plant extracts. Sonmez and Gulel (2008) and Zayed *et al*. (2019) evaluated the temperature impact on the total protein of the bean beetle *Acanthoscelides obtectus* and *Cx. pipiens* treated with Lambda- cyhalothrin, Delta-methrin and Permethrin and obtained comparable results.

Inhibition of enzyme activity is a well-known method for halting a vast variety of crucial physiological and biochemical processes (Zorlu *et al*., 2018). In our investigation, the activities of alpha- and beta-esterase were lower in treated than in untreated larvae at all temperatures. In response to temperature, the alpha- and ß-esterase activity raised from 15℃ to 26℃, then declined at 36℃. The insect's protein content may have decreased, which may account for the decline in activity (Oni *et al*., 2019). Fahmy and Amin (2019) reported a similar pattern as the activity of alpha- and beta- esterases in the red palm weevil increased as the temperature climbed from 15℃, until the optimum temperature (35℃) was achieved, and then declined. Our findings are similar to those of Koodalingam *et al*. (2011), Lija-Escaline *et al*. (2015), Karthi *et al*. (2020), Sengodan *et al*. (2020) and Prakash *et al*. (2021) working on other mosquito species.

At 15 and 26℃, the examined compounds significantly increased GST activity in treated larvae, emphasizing that this enzyme plays a major role in detoxification. At 36℃, however, GST activity reduced. GST is an 85 percent protein-based enzyme that plays a critical role in the detoxification of hazardous substances that enter insect bodies, therefore the reduction in its activity produced by Mirazid and PASA may be connected to a decrease in the insect's protein content at 36℃. The reduction or stimulation of enzyme activity in insects exposed to entomotoxic plants may result in metabolic imbalance (Agra-Neto *et al*., 2015). Our results agree with those of Zayed *et al*. (2019), who showed a significant increase in GST activity in *Cx. pipiens* larvae and adults in response to a temperature raised from 20 to 30℃. Similar results were also observed by Shahat *et al*. (2020), Sengodan *et al*. (2020) and Prakash *et al*. (2021) when evaluated the effect of *Origanum syriacum*, *Rhizophora mucronata* and *Decalepis hamiltonii* extracts against mosquito species and observed disturbance in GST activity.

CONCLUSION

This study analyzes the efficacy of *C. molmol* resin, Mirazid, CASA, and PASA in controlling *Cx. pipiens*. It was observed that larval mortality increased as temperatures rose. High larval exposure temperatures modify the activity levels of alpha-esterase, beta-esterase, and GST enzymes. Temperature has a significant impact not only on the development and survival of mosquito larvae, but also on their susceptibility to particular pesticides through modifying the amount of detoxifying enzymes that compromise insect resistance. Studying the changes of control measure's outcome due to temperature decrease/increase will definitely impact the decision of choosing certain control measure or products. The choice will go to the product that still work efficiently under wide range of climatic factors. Thus, The efficacy of Mirazid and *C. molmol* resin under wide range of temperatures made these compounds suitable candidates for controlling *Cx. pipiens*.

ACKNOWLEDGEMENT

We acknowledge the Entomology Department at Benha University's Faculty of Science for conducting this study there.

REFERENCES

AHMAD, S.R., A. Al-GHADEER, R. Ali, W. QAMAR, AND S. ALJARBOA. 2017. Analysis of inorganic and organic constituents of myrrh resin by GC–MS and ICP-MS: An emphasis on medicinal assets. Saudi Pharmaceutical Journal 25(5): 788–794

AGRA-NETO, A.C., T.H. NAPOLEAO, E. PONTUAL, AND N.D.L. SANTOS. 2015. Effect of

Moringa oleifera lectins on survival and enzyme activities of *Aedes aegypti* larvae susceptible and resistant to organophosphate. Parasitology Research 113(1): 175-84

ALVANDI, S., K.Z. RAFIEI, AND S.M. NABAEI. 2014. Investigation on the larvicidial effects of *Salix alba* L. and *Pinus sylvestris* L. extracted in different solvents on larvae of flour moth *Ephestia kuehniela* (Zel.) (Lep. Pyralidae). Journal of Entomological Research, 6(2): 121–128

AGYEKUM, T.P., P.K. BOTWE, J. ARKO-MENSAH, I. ISSAH, A.A. ACQUAH, et al. 2021. A systematic review of the effects of temperature on *Anopheles* mosquito development and survival: implications for malaria control in a future warmer climate. International Journal of Environmental Research and Public Health 18(14), 7255; https://doi.org/10.3390/ijerph18147255

BARANITHARAN, M., S. DHANASEKARAN. 2014. Mosquito larvicidal properties of *Comm-iphora caudata* (Wight & Arn.) (Bursaceae) against *Aedes aegypti* (Linn.) *Anopheles stephensi* (Liston), and *Cx. quinquefasciatus* (Say). Interna-tional Journal of Current microbiology and applied sciences 3: 262–268

BRADFORD, M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of proteins utilizing the principle of protein-dye binding. Analytical Biochemistry 72:248-254

CHRISTIANSEN-JUCHT, C.D., P.E. PARHAM, A. SADDLER, J.C. KOELLA, AND M.G. BAS-ANEZ. 2014. Temperature during larval develop-ment and adult maintenance influences the survival of *Anopheles gambiae* ss. Parasites & vectors 7(1): 489-500

DA SILVA, R.C., P. MILET-PINHEIRO, P.C.B. DA SILVA, AND A.G. DA SILVA. 2015. (E)-caryophyllene and α-humulene: *Aedes aegypti* oviposition deterrents elucidated by gas chromatography-electrophysiological assay of *Commiphora leptophloeos* leaf oil. PLOS ONE | DOI:10.1371/journal.pone.0144586

DELATTE, H., G. GIMONNEAU, A. TRIBOIRE, AND D. FONTENILLE. 2009. Influence of temperature on immature development, survival, longevity, fecundity, and gonotrophic cycles of *Aedes albopictus*, vector of chikungunya and dengue in the Indian Ocean Journal of Medical Entomology 46: 33–41

DRIS, D., F. TINE-DJEBBAR, H. BOUABIDA, AND N. SOLTANI. 2017. Chemical composition and activity of an *Ocimum basilicum* essential oil on *Culex pipiens* larvae: Toxicological, biometrical and biochemical aspects. South African Journal of Botany 113: 362-369

ELONO, A.L.M., K. FOIT, S. DUQUESNE, M. LIESS. 2018. Controlling *Culex pipiens*: antagonists are more efficient than a neonicotinoid insecticide. Journal of Vector Ecology 43(1):26-35

EL-SAYED, S.H., AND G.M. EL-BASSIONY. 2016. Larvicidal, biological and genotoxic effects, and temperature-toxicity relationship of some leaf extracts of *Nerium oleander* (Apocynaceae) on *Culex pipiens* (Diptera: Culicidae). Journal of Arthropod-Borne Diseases 10(1): 1–11

FAHMY, N.M., AND T.R. AMIN. 2019. Partial kinetic analysis of haemolymph esterases from the red palm weevil; *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Curculionidae). Egyptian Academic Journal of Biological Sciences (C. Physiology and Molecular biology) 11(3): 169-180

FINNEY, D.J. 1971. Probit analysis. Cambridge Univ. Press, Cambridge, 333 pp.

GRBIC, L.M., N. UNKOVIC, I. DIMKIC, AND P. JANACKOVIC. 2018. Frankincense and myrrh essential oils and burn incense fume against micro-inhabitants of sacral ambients. Wisdom of the ancients. Journal of Ethnopharmacology 219: 1–14

HABEEB, S.M., A.H. EL-NAMAKY, AND M.A. SALAMA. 2009. Efficiency of *Allium cepa* and *Commiphora molmol* as a larvicidal agent against fourth stage larvae of *Culex pipiens* (Diptera: Culicidae). American-Eurasian Journal of Agricul-tural & Environmental Sciences 5: 196–203

HABIG, W.H., M.J. PABST, AND W.B. JAKOBY. 1974. Glutathione S-transferase the first enzymatic step in mercapturic acid formation. Journal of Biological Chemistry 249:7130-7139

HARBACH, R.E. 1985. Pictorial keys to the genera of mosquitoes, subgenera of Culex and the species of Culex (Culex) occurring in southwestern Asia and Egypt, with a note on the subgeneric placement on *Culex deserticola* (Diptera: Culicidae). Mosquito systematics. 17(2): 83-107.

HASABALLA, A.I., T.A. SELIM, M.A. TANANI, AND E.E. NASR. 2021. Lethality and vitality efficiency of different extracts of *Salix safsaf* leaves against the house fly, *Musca domestica* L. (Diptera: Muscidae). African Entomology 29(2): 479-490

HODJATI, M.H., AND C.F. CURTIS. 1999. Effects of permethrin at different temperatures on pyrethroid-resistant and susceptible strains of Anopheles. Medical and veterinary Entomology 13: 415-422

HOWE, G.A., AND G. JANDER. 2008. Plant immunity to insect herbivores. Annual Review of Plant Biology 59: 41–66

IMASHEVA, A.G., V. LOESCHCKE, AND O. LAZEBNY. 1998. Stress temperatures and quantitative variation in *Drosophila melanogaster*. Semantic Scholar 81(3): 246-253

KARTHI, S., K. UTHIRARAJAN, V. MANOHAR, M. VENKATESAN, K. CHINNAPERUMAL, S.P. VASANTHA, AND P KRUTMUANG. 2020. Larvicidal enzyme inhibition and repellent activity of red mangrove *Rhizophora mucronata* (Lam.) leaf extracts and their biomolecules against three medically challenging arthropod vectors. Mol-ecules 25(17): 3844-63

KAUR, T., N.S. WALTER, U. KAUR, AND R. SEHGAL. 2022. Different Strategies for Mosquito Control: Challenges and Alternatives. Mosquito-Research Advances in Pathogen Interactions, Immunity, and Vector Control Strategies. DOI:10.57-72/intechopen.104594

KHAN, H.A.A., AND W. AKRAM. 2014. The effect of temperature on the toxicity of insecticides against *Musca domestica* L.: Implications for the effective management of diarrhea. PLoS One 9(4): e95636. DOI: 10.1371/journal.pone.0095636

KOODALINGAM, A., P. MULLAINADHAN, AND A. MUNUSAMI. 2011. Effects of extract of soap nut *Sapindus emarginatus* on esterases and phosphatases of the vector mosquito, *Aedes aegypti* (Diptera: Culicidae). Acta Tro-pica1,18(1):27-36

LARSON, R.T., J.M. LORCH, J.W. PRIDGEON, J.J. BECNEL, G.G. CLARK, AND Q. LAN. 2010. The biological activity of α-mangostin, a larvicidal botanic mosquito sterol carrier protein-2inhibitor. Journal of Medical Entomology47(2):249-57

LIJA-ESCALINE, J., S. SENTHIL-NATHAN, AND T.A. PRADEEPA. 2015. Physiological and biochemical effects of botanical extract from *Piper nigrum* Linn (Piperaceae) against the dengue vector *Aedes aegypti* Liston (Diptera: Culicidae). Parasitology Research 114: 4239–4249.

LIU, H., L. XIE, P. CHENG, AND J. XU. 2019. Trends in insecticide resistance in *Culex pipiens* pallens over 20 years in Shandong, China. Parasites & Vectors 12(167): 1-9.

MANSOUR, S.A., R.F.A. BAKR, R.I. MOHAMED, AND N.M. HASANEEN. 2011. Larvicidal activity of some botanical extracts, commercial insecticides and their binary mixtures against the housefly, *Musca domestica* L. The Open Toxi-nology Journal 5(1): 1-14.

MAPOSSA, A.B., W.W. FOCKE, R.K. TEWO, R. ANDROSCH, AND T. KRUGER. 2021. Mosquito-repellant controlled release formulations for fighting infectious diseases. Malaria Journal 20(1):165. DOI: 10.1186/s12936-021-03681-7

MASSOUD, A.M., AND I.M. LABB. 2000. Larvicidal activity of *Commiphora molmol* against *Culex pipiens* and *Aedes caspius* larvae. Journal of the Egyptian Society of Parasitology 30 (1):101-15

MASSOUD, A.M., I.M. LABB, AND M. RADY. 2001. Biochemical changes of *Culex pipiens* larvae treated with oil and oleo-resin extracts of Myrrh *Commiphora molmol*. Journal of the Egyp-tian Society of Parasitology 31 (2): 517-529.

MASSOUD, A.M., H.A. SHALABY, R.M. EL KHATEEB, M.S. MAHMOUD, AND M.A. KUTKAT. 2012. Effects of Mirazid® and myrrh volatile oil on adult *Fasciola gigantica* under laboratory conditions. Asian Pacific Journal of Tropical Biomedicine 2(11): 875-884.

MONDAL, R.P., A. GHOSH, AND G. CHANDRA. 2014. Mosquito larvicidal potential of salicylic acid and 3, 5-di nitro salicylic acid against filarial vector *Culex quinquefasciatus*. Journal of Mosquito Research 4 (1): 21-26.

MUTURI, E.J., W.T. HAY, K.M. DOLL, J.L. RAMIREZ, AND G. SELLING. 2020. Insecticidal activity of *Commiphora erythraea* essential oil and its emulsions against larvae of three mosquito species. Journal of Medical Entomology 57(6): 1835–1842.

ONI, M.O., O.C. OGUNGBITE, AND S.O. OGUNTUASE. 2019. Inhibitory effects of oil extract of green Acalypha (*Acalypha wilkesiana*) on antioxidant and neurotransmitter enzymes in *Callosobrucus maculatus***.** Journal of Basic and Applied Zoology 80(1): 1-13

PRAKASH, P., E. GAYATHIRI, R. MANIVASAGAPERUMAL, AND P. KRUTMUANG. 2021. Biological activity of root extract *Decalepis hamiltonii* (Wight & Arn) against three mosquito vectors and their non-toxicity against the mosquito predators. Agronomy11(7), 1267**;** https://doi.org/10.3390/agronomy11071267

REGNAULT-ROGER, C., C. VINCENT, AND J.T. ARNASON. 2012. Essential oils in insect control: low-risk products in a high-stakes world. Annual Review of Entomology 57: 405–424

SALINAS, W.S., T.P. FERIA-ARROYO, AND C.J. VITEK. 2021. Temperatures influence susceptibility to insecticides in *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) mosquitoes. Pathogens 10(8):992. DOI: 10.3390/pathogens-10080992

SAYED, R., R.S. ABDALLA, S. Rizk, AND T.S. EL SAYED. 2018. Control of *Culex pipiens* (Diptera: Culicidae), the vector of lymphatic filariasis, using irradiated and non-irradiated ento-mopathogenic nematode, *Steinernema scapterisci* (Rhabditida: Steinernematidae). Egyptian Journal of Biological Pest Control 28(67): https://doi.org/10.1186/s4-1938-018-0070-z

SELEM, G.S., AND E.A. EL-SHEIKH. 2015. Toxicity and biochemical effects of Neem Azal T/S, willow (*Salix aegyptiaca* L.) and chaste berry (*Vitex agnus-Castus* L.) on house fly, *Musca domestica* L. (Diptra: Muscidae). Journal of Biopesticides 8(1): 37-44.

SENGODAN, K., U. KARTHIC, M. VINOTH-KUMAR, V. MANIGANDAN, C. KAMARAJ, V. PRANHAKARAN, AND K. PATCHARIN. 2020. Larvicidal enzyme inhibition and repellent activity of red mangrove *Rhizophora mucronata* (Lam.) Leaf extracts and their biomolecules against three medically challenging arthropod vectors. Mole-cules 25(17): 3844. DOI:10.3390/molecules-25173844

SHAHAT, M.A., T.M. EL-SHEIKH, K.M. HAMMAD, A.I. HASABALLA, AND A.Z. SHE-HATA. 2020. Effect of some plant extracts on the biochemical parameters, AChE and GST activities of the mosquito, *Culex pipiens* L. (Diptera: Culi-cidae). Egyptian Academic Journal of Biological Sciences, E. Medical Entomology & Parasitology 12(2), 69-80.

SONMEZ, E.**,** AND A. GULEL. 2008. Effects of different temperatures on the total carbohydrate, lipid and protein amounts of the bean beetle, *Acanthoscelides obtectus* Say (Coleoptera: Bru-chidae). Pakistan Journal of Biological Sci-ences 11 (14): 1803-1808.

SWELAM, E.S., H.R. ABDEL-RAHMAN, A.T. MOSSA, AND F.S. AHMED. 2022. Influence of temperature on the toxicity of fipronil to *Spodoptera littoralis* (Boisd.) Lepidoptera: Noctuidae). Bioc-

atalysis and Agricultural Biotechnology, 39, 102277. https://doi.org/10.1016/j.b-cab.2022.102277

TARIGAN, S., I. DADAG, AND S.I. HARAHAP. 2016. Toxicological and physiological effects of essential oils against *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Callosobruchus maculatus* (Coleoptera: Bruchidae). Journal of Biopesticides 9(2): 135–147.

TERRIE, L.C. 1984. Induction of detoxification enzymes in insects. Annual Review of Entomology 29: 71–88.

VAN-ASPEREN, K. I962. A study of house fly esterase by means of sensitive colorimetric method. Journal of Insect Physiology 8: 401-416.

VINOGRADOVA, E.B. 2000. *Culex pipiens* mosquitoes: taxonomy, distribution, ecology, physiology, genetics, applied importance and control. Sofia, Moscow. 250 p.

WANG, Y, P. CHENG, B. JIAO, AND X. SONG. 2020. Investigation of mosquito larval habitats and insecticide resistance in an area with a high incidence of mosquito-borne diseases in Jining, Shandong Province. PLoS One 15(3): e0229764. DOI: 10.1371/journal.pone.0229764

WHO, 2005. Guidelines for laboratory and field testing of mosquito larvicides. World Health Orga-nization: Geneva, Switzerland.

WILSON, A.L., O. COURTENAY, L.A. KELLY-HOPE, AND T.W. SCOTT. 2020. The importance of vector control for the control and elimination of vector-borne diseases. PLoS Neglected Tropical Diseases 14(1):e0007831. https://doi.org/10.137-1/journal.pntd.0007831

ZAYED, A.B., A.A. MOSTAFA, W.A. MOSELHY, H.I. MAHMOUD, AND S.H. HASSAN. 2019. Influence of temperature change on the growth and susceptibility of the common house mosquito, *Culex pipiens* in Egypt to some insecticides. International J. of Ecotoxicology and Ecobiology 4(2): 42-50.

ZORLU, T., Z.U. NURULLAHOGLU, AND H. ALTUNTAS. 2018. Influence of dietary titanium dioxide nanoparticles on the biology and antioxidant system of model insect, *Galleria mellonella* (L.) (Lepidoptera: Pyralidae). Journal of the Entomological Research Society 20(3): 89-103.

تأثير الحرارة علي كفاءة *Commiphora molmol* وحمض اسيتيل ساليسيلك ضد بعوض *Culex* (Diptera: Culicidae) *pipiens*

فاتن ابوالدهب، محمد محمود باز، ياسر عفيفي السيد، رشا محسن، عبلة دسوقي عبدالمجيد

قسم علم الحشرات، كلية العلوم، جامعة بنها، مصر

الملخص العربـــــي

تشير الدراسات البيئية الي ان الحرارة عامل حرج وان لها التأثير الاعظم من بقية العوامل علي بقاء الحشرات. وحيث ان التغير في درجة حرارة البيئة المحيطة قد يؤثر علي سمية المواد للبعوض. اجريت الدراسة بهدف معرفة تأثير الحرارة علي كفاءة كل من صمغ المرة، ميرازيد وحمض اسيتيل ساليسيلك المركب (PASA) والبلوري (CASA) ضد بعوض كيوليكس بيبينز. لهذا الغرض تم اختبار النشاط السمي للمواد المستخدمة علي يرقات العمر الثالث حديثة الانسلاخ تحت الظروف المعملية. أثبتت النتائج كفاءة المواد المستخدمة في قتل يرقات البعوض حيث كانت التركيزات المميتة لنصف عدد اليرقات هي 28.3، 41.6، 570.9 و 799.7 ppm لكل من ميرازيد ، صمغ المرة، PASA و CASA علي التوالي. وتم استخدام LC_{50} في اختبار السمية والفحص الكيميائي الحيوي عند درجات حرارة 15، 26 و 36 ^{o}C . وتبين من النتائج ان سمية المواد قد زادت بزيادة الحرارة وقل المحتوي الكلي للبروتين.كما تباين نشاط انزيمات ازالة السمية (alpha-esterase, beta esterase and glutathione S transferase) حيث قل نشاط كل الانزيمات عند درجة الحرارة 36 ^{0}C وبدت الفروق معنوية في اليرقات التي عولجت بميرازيد. وحيث ان دراسة التغيرات التي تطرأ علي حساسية الحشرة لوسائل المكافحة بسبب انخفاض او ارتفاع درجات الحرارة حتما سيؤثر علي قرار اختيار هذه الوسائل، بحيث يكون الاختيار للمركب الذي يعمل بفاعلية تحت مدي واسع من العوامل المناخية. لذا خلصت الدراسة بأن كفاءة ميرازيد وصمغ المرة تحت مدي واسع من درجات الحرارة جعلت من هذه المركبات مرشح مناسب لمكافحة بعوض كيوليكس بيبينز.