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Efficiency of Insecticides Imidacloprid and Lambada-Cyhalothrin on Two Public Health Pests *Musca domestica* and *Rattus norvegicus* under Laboratory Conditions

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ABSTRACT

In the present study, imidacloprid and lambada-cyhalothrin insecticides were evaluated on second instar larvae of *Musca domestica* including mortality percentage, biological parameters, and histological effects under laboratory conditions. Five different concentrations (4, 2, 1, 0.5 and 0.25%) were used. The mortality data was recorded after 1,2,3,4, and 5 days post-treatment. The highest mortality was induced by imidacloprid and lambada-cyhalothrin (100.0 and 96.6%) after 5 days post-treatment at 4% concentration, respectively. Lethal concentrations (LC_{50}) values in baits were: imidacloprid (0.13%) and lambada-cyhalothrin (0.30%). All concentrations of tested insecticides prolonged the duration of larval and pupal. Also, caused a reduction in the percentage of pupation and adult emergence compared to control. Pupal weight was also, significantly reduced. In general, fecundity decreased with the high concentration of insecticides. Insecticides caused histopathological and cytotoxic changes in the midgut of larvae. The two previous insecticides lambda Cyhalothrin and imidacloprid were also used against *Rattus norvegicus* males under laboratory conditions with different three concentrations (10, 5 and 0.30%) and (10, 5 and 0.13%) respectively. For two tested insecticides, the percentage of mortality reached 20 and 40%, respectively at 10% while these percentages were (10 and 30%) at 5% concentration, respectively. Also, 10% concentration had a great effect on the levels of AST, ALT, ALP, Urea and Creatine in the rat's blood. Histological tests were also conducted at a concentration of 5% on the stomach, liver and heart, it was found that some clear histological changes appeared as a result of treatment with these insecticides. Data suggested that imidacloprid and lambada- cyhalothrin can be used to help to control and eradicate *Musca domestica* and *Rattus norvegicus* especially imidacloprid insecticide had the highest effect in general on two tested public health pests.

INTRODUCTION

The house fly, *Musca domestica*. Linn. (Diptera: Muscidae) is an important perpetual pest of both large farms and homes. It acts as a vector of more than a hundred diseases in humans and animals causing microbes (Fasanella, *et al.*, 2010 and Ugbogu *et al.*, 2006). Insecticides are the main tool for management (Shi *et al*., 2011). Due to their

efficiency and low mammalian toxicity, insecticides with novel modes of action are now used (Korrat *et al.*, 2012; Shi *et al.,* 2011). Physiological effects of insecticides' sub-lethal effects are also possible. Behavioral and developmental aspects that will be impacted the next generation of the insect (Desneux, *et al*., 2007 and Miao, *et al.*, 2014)

Rodents are one of the most important mammalian pests spread in the world, and the importance of these organisms is due to the fact that they are multi-damaging to agricultural crops, orchards, and fruits of all kinds (Abd El-Aleem 2018, and Munawara *et al*., 2024). It also spreads in grain stores and causes much damage (Ognakossan *et al.* 2018 and Amara and Pavan 2022), and Its damage increases when it attacks many economic animals that are important to humans, as it spreads in pens for birds, cows, buffaloes, sheep and other useful animals. It is also one of the most important public health pests that cause the transmission of many dangerous diseases to humans (Petrov and Bileva 2010, Moghaddam *et al*., 2018 and Shrma *et al*., 2019). Because of the severity of the dangers of these pests to humans, animals and plants and their effective role in transmitting many dangerous diseases, humans have resorted over many years to using all available methods to control these pests. Pesticides were among the most used methods over the past years.

Despite the many problems that pesticides cause to the environment and humans, they are still the most widespread in the fight against many types of pests. Currently, the most popular method of controlling arthropods is through the use of pesticides. (Lykogianni, *et al.,* 2021 and Zikankuba, *et al.,* 2019).It has been known for many years that pyrethroid pesticides are less harmful to birds and mammals, and have lower environmental toxicity than other pesticides. On the other hand, it has been used as a highly effective insecticide in many countries around the world, as it disrupts the basic functions of sodium channels. Insecticides are the first choice to manage houseflies in animal sheds and urban vicinities (He, *et al.,* 2013 and Tan, *et al.,* 2012). Lambada-cyhalothrin and Imidacloprid were used to manage public health pests such as organophosphates, carbamates, pyrethroids and neonicotinoids (Tilak, *et al.,* 2010). Lambda Cyhalothrin is one of the pyrethroid insecticides that have been used against many types of insect pests, whether by contact or through the stomach, this pesticide has also been tested to control some public health insect pests (Abd-Rahman and Hend 2017). Besides, Imidacloprid is a chlorinated analogue of nicotine and belongs to the class of nonidentical pesticides; it has moderate toxicity and is classified as a second and third toxic class agent by the United States Environmental Protection Agency. This pesticide has been used for many years as a large-scale insecticide as well as for rat control. On the other hand, it is used to control several chewing insects, such as termites, soil insects, and fleas on pests. In addition to being applied topically to pests, imidacloprid can also be used to treat seeds, crops, buildings, and soil. Individual products containing imidacloprid have a wide range of uses. (Ramos *et a.,l* 2019). Several researchers have indicated that using insecticides at their sub-lethal dosages could lead to pest outbreaks (Cui, *et al.,* 2018; Tran, *et al.,* 2018 and Jimenez-Guri, *et al.,* 2021)

The aim of this research is to determine the efficiency of the aforementioned insecticides against the housefly *Musca domestica* and the brown rat *Rattus norvegicus* and to study the histological effects on them.

MATERIALS AND METHODS

All experiments in this research on *Musca domestica* and *Rattus norvegicus* were carried out under the conditions of animal and insect laboratories, Department of Plant Protection, Faculty of Agriculture, Benha University.

Chemical Compounds: Two insecticides Lambda Cyhalothrin 5% (Ec), and Imidacloprid 35% (Sc) were used; the pesticides were purchased from Kafr El-Zayat Company, Kafr El-

Zayat Center, Gharbia Governorate.

Experimental Insect and Animal:

1. *Musca domestica*: -

1.1. Rearing of *Musca domestica* L.:

The susceptible strain was used for bioassays at 28 ± 2°C temperature and 56.70% R.H. cages of 40cm × 40cm × 40cm size were used for rearing the house fly covered with mesh screen and equipped with a cloth sleeve at the front for handling rearing cage contents. (Faroog and Freed, 2016). A diet for adults that is made up of powdered Macconkey agar (50%), and glucose (50%) in equal parts was used. Every day, food and sugar solutions were given out. To encourage the production of eggs, newly emerged flies were given cotton wool soaked in fresh milk for three days. A mixture of sterilized wheat bran (30g), milk powder (2g), and 60ml water is used to raise larvae. (Pavela, 2008 and Bell, *et al.,* 2010).

1.2. Toxicity Test:

Each insecticide was serially diluted to create different concentrations (4, 2, 1, 0.5, and 0.25%). Each solution was combined with sugar, which was used as a feeding lure for adult *M. domestica*. Twenty larvae during the second instar were subjected to each concentration. The experiment was replicated three times along with the control. Insects and baits were kept in plastic containers ((15 × 6 × 6cm) under the aforementioned conditions. Larval deaths were noted) under, 3, 4 and 5 days (Sultana *et al*., 2016). The corrected mortality percentages have been evaluated through probit analysis to determine the LC_{50} value. according to the method of Finney (1971).

1.3. Biological Experiment:

The duration of the larval and pupal stages, the percentage of pupations, the weight of the pupae, the percentage of the adult's emergence and the adult's fecundity were all determined using different concentrations of each insecticide. Four replicates per treatment and forty insects per replicate, each insecticide concentration was combined with sugar. Adults aged 4-5 days with a sex ratio of 1: 1 were put in plastic containers with the egg-laying substance as previously mentioned. Control was provided with insecticide-free baits. The egg-laying media was examined and counted using a hand lens and still in the medium till eclosion (Fletcher, *et al.,* 1990). By dividing the number of larvae that hatch by the total number of eggs laid, the percentage of eclosion is computed. (Sanil and Shetty, 2012). Neonates were left in the rearing media to calculate the duration of the larva, which was determined as the time from the start of the first instar through pupation (Elkattan *et al.*, 2011). The number of pupae divided by total number of larvae produces the percentage of pupation. Additionally, the pupa was weighted and kept in separate containers until adult emergence. Likewise, % emergence and pupal duration could be measured. (Khazanie, 1979).

1.4. Histological Studies:

Treated and untreated second instar larvae of *M. domestica* reared on fed which incorporated with the LC_{50} of insecticides, after 24 and 48h, only live larvae were fixed in Bouins solution for 24h, and then the larvae were rinsed in a series of ethanol solution. They were transferred first into 50% ethyl alcohol for 2hrs then left for 24 hours. After that passed through a series of alcoholic for two hours starting with 80, 90, 96 and ending with 100% ethyl alcohol. After dehydration, the larvae were placed in a mixture of amyl acetate solution and soft paraffin for 24 hours at 50°C. a mixture of one part of hard paraffin wax was added to the larvae. Serial sections at 5 micros were made by microtome and mounted on clean slides using Mayer's albumin. Sections were mounted on glass slides and stained with haematoxylene and counter-stained in alcoholic solution and prepared for examination and photo microscopy. Also, the midgut of control was done for comparing the effects.

2. *Rattus norvegicus*: -

2.1. Bioassay of *R. norvegicus* under Laboratory Condition:

The individuals of the brown rat *R. norvegicus* were collected from the fields adjacent to the animal laboratory at the Faculty of Agriculture, Benha University, especially the agricultural canals and water drains, the areas of ponds, swamps, and places of agricultural waste, then transfer it to the lab. Adult males weighing 180 ± 30 g were selected to perform the different experiments on them inside the laboratory. The animals were housed in metallic cages, supplied with enough food containing 21% protein, 4.59 %fat and 4.20 % fiber and water, and observed daily for about two weeks before the experiments.

Seventy rats, the healthiest and strongest males, were chosen to conduct experiments. The tested male individuals were divided into three groups. The first group (10 rats) is control which has not been subjected to any transactions. The second and third groups were exposed to different three concentrations of two tested pesticides (Lambda Cyhalothrin and Imidacloprid), for each group 30 individuals of males were used. The three tested concentrations of the two pesticides were 5%, 10% and two sub-lethal concentrations (0.30% for Lambda Cyhalothrin and 0.13% for Imidacloprid) which resulted from the treatment of *M. domestica*, for each concentration, 10 individuals were used. The tested concentrations were mixed with the feed provided to the rats and monitored for four consecutive weeks in the laboratory. Then mortality rates of males were calculated, as well as various biochemical and histological tests were performed on the treated rats and compared to the untreated individuals**.**

2.2. Biochemical Parameters:

All biochemical parameters for *R. norvegicus* were done in Dr. Mahmoud Abou El.makarem laboratory, Toukh, Qalubia Governorate, Egypt. Blood samples were drawn on serum tubes. The serum levels of AST, ALT, ALP, urea and creatine were determined spectrophotometrically, using standard methods.

2.3. Histological Studies:

Specimens from vital organs (Stomach, heart and liver) of treated *R. norvegicus* males were collected 30 days after treatment with only 5% concentration of the two tested pesticides. All histological studies were done at Attar Center for Medical Researches and Histopathology (ACMRH), Zagazig, Sharkia Governorate, Egypt, using the method of **Suvarna *et al*., 2013**.

Statistical Analysis:

The statistical analysis was carried out using one-way ANOVA using SPSS, ver. 22 (IBM Corp. Released 2013). Data were treated as a complete randomization design according to Steel *et al.,* 1997. Multiple comparisons were carried out applying Duncan test the significance level was set at < 0.05

RESULTS AND DISCUSSION

1-The efficiency of Two Insecticides on *Musca domestica*:

1.1. Insecticidal activities of imidacloprid and Lambada cyhalothrin against 2nd instar larvae of *Musca domestica* (L.) in Laboratory:

Data in Table (2) showed the higher potency of tested compounds against the 2nd instar larvae of *M. domestica* (L.). The mortality was increased with an increase in concentration. The highest concentration at 4% showed the highest mean mortality (63.3 and 45.5%) after 1 day of treatment and increased after 5 days post treatments to (100 and 96.6%) for Imidacloprid and Lambada - cyhalothrin, respectively. On the contrary, the lowest concentration of 0.25% showed slight initial efficacy of mortality after 1-day treatment

reaching 25.5 and 23.3%), respectively. The prolongation of post-treatment to 5 days showed a slight increase in larval mortality reaching (72.2 and 65.5%), respectively.

Table 1: Mean mortality of 2nd instar larvae of *M. domestica* (L.) at various concentrations of Imidacloprid.

Concentrations %	%Accumulative mortality after indicated (days)				
	1	2	3	4	5
4	63.3 ± 0.1	62.2 ± 0.2	85.5 ± 0.2	98.8 ± 0.4	100.0 ± 0.0
2	56.6 ± 1.8	66.6 ± 3.6	78.8 ± 5.0	84.4 ± 6.2	94.4 ± 3.4
1	43.3 ± 1.7	57.7 ± 4.3	72.2 ± 4.0	80.0 ± 4.7	88.8 ± 2.8
0.5	38.8 ± 1.6	41.1 ± 1.6	55.5 ± 2.9	77.7 ± 4.4	83.3 ± 5.0
0.25	25.5 ± 4.4	38.8 ± 3.3	53.3 ± 4.4	63.3 ± 5.7	72.2 ± 4.4
Control	0.0	0.0	1.1	1.1	2.2

Table 2: Mean mortality of 2nd instar larvae of *M. domestica* (L.) at various concentrations of Lambada-Cyhalothrin.

Concentrations %	%Accumulative mortality after indicated (days)				
	1	2	3	4	5
4	45.5 ± 1.5	51.1 ± 3.6	63.3 ± 3.5	86.6 ± 2.0	96.6 ± 2.4
2	36.6 ± 1.8	48.8 ± 3.3	57.7 ± 2.9	72.2 ± 3.1	84.4 ± 4.3
1	35.5 ± 2.6	44.4 ± 4.0	60.0 ± 5.2	65.5 ± 5.1	78.8 ± 4.8
0.5	28.8 ± 2.9	37.7 ± 4.1	51.1 ± 4.4	58.8 ± 4.0	70.0 ± 1.7
0.25	23.3 ± 1.5	26.6 ± 2.6	36.6 ± 2.4	46.6 ± 3.3	65.5 ± 2.4
Control	0.0	0.0	0.0	2.2	2.2

Table (3) shows the results of probit analysis obtained by the exposure of 2nd instar larvae of *M. domestica* (L.) of different concentrations of tested compounds. The LC_{50} of Imidacloprid was the most effective with 0.13%. While Lambada-cyhalothrin was the least effective having a value of LC_{50} (0.30%). The same trend occurred at LC_{90} and LC_{95}. significant positive correlation coefficient values between concentrations and mortality % were obtained for tested compounds.

Table 3: Lethal concentrations of tested insecticides against the 2nd instar larvae of *M. domestica* (L.) after 5 days of treatment.

Compounds	Lethal values and their 95% confidence limits %				
	LC_{50}	LC_{90}	LC_{95}	Slope ± SD	R
Imidacloprid	0.13 (0.05-0.33)	6.17 (1.18-32.09)	18.14 (1.89-173.34)	0.77 ± 6.68	0.943
Lambada-Cyhalothrin	0.30 (0.20-0.46)	4.24 (1.57-11.38)	8.93 (0.52-31.87)	1.12 ± 0.072	0.969

1.2. Effect of Tested Insecticides on Some Biological Parameters of *M. domestica* (L.):

1.2.1. Larval Duration:

Data tabulated in Tables (4 & 5) showed a highly significant prolongation in the larval duration at the highest concentration 4% to reach maximum of (9.33 and 8.40 days) with imidacloprid and lambada-Cyhalothria, respectively, compared with (5.33 days) at the

control. On the contrary, the lower concentration of 0.25% caused a reduction in the average larval duration, (7.26 and 6.78 days) for imidacloprid and lambada-cyhalothrin, respectively.

1.2.2. Pupation Percent, Pupal Weight and Pupal Duration:

The data presented in the same Tables (4 &5) indicated a reduction of pupation percent by the highest concentration of 4% to reach (37.0 and 50.0%) for imidacloprid and lambada-cyhalothrin, respectively while it was 97.0% at the control group. The effect of tested compounds on *M. domestica* larvae showed significantly lower pupal average weight. Pupal weights dropped with increased concentration. Also, all concentrations of all tested insecticides show significant prolongation in the pupal duration than the control group.

1.2.3. Adult Emergence Percent and Adult Longevity:

The data presented in the same Tables (4&5**)** indicated that all tested insecticides induced a reduction in the percentage of adults that emerged from treated larvae compared with the emergence percentage resulting from untreated larvae. On the other hand, results indicated highly significant reductions in the longevity of adults in both male and female flies in all tested compounds compared with the control.

1.2.4. Reproductive Aspects:

Results in Tables (4&5) showed a significant decrease in the number of eggs/female. Also, tested insecticides showed a highly significant decrease in the egg-hatching percentage. Meanwhile, the highest number of eggs/female and hatchability percentage was obtained by control treatment.

Table 4: Effect of Imidacloprid on some biological aspects of the 2nd larval instar of *Musca domestica*.

Conc. %	Larval duration (days) ± SE	% pupation	Pupal weight (mg) ± SE	Pupal duration (days) ±SE	% adult emergence	Longevity		Egg/Female		% Hatching
						M	F	Deposit	Hatch	
4	9.33 ±0.33	37.0 ±2.00	7.51 ±2.00	8.91 ±0.33	50.0 ±0.10	8.03 ±0.10	8.66 ±0.27	0.0	0.0	0.0
2	8.66 ±0.33	63.0 ±9.40	9.50 ±2.82	8.63 ±0.18	68.0 ±0.84	11.55 ±0.69	10.85 ±0.43	128.0	40.0	31.25
1	8.00 ±0.58	65.0 3.80	9.90 ±3.63	7.81 ±0.18	70.0 ±0.76	11.25 ±0.25	10.26 ±0.70	145.0	58	40.1
0.5	7.77 ±0.33	70.0 ±6.83	10.90±2.44	7.11 ±0.39	73.3 ±1.37	12.38 ±0.29	12.40 ±0.56	150.0	60	46.6
0.25	7.26 ±0.23	75.0 ±5.02	11.82 ±3.30	6.36 ±0.12	77.7 ±1.38	8.68 ±0.32	9.75 ±0.85	162.0	82.0	50.6
Control	5.33 ±0.30	97.0 ±2.80	14.61 ±3.27	5.56 ± 0.24	83.3 ±0.80	20.60 ±0.24	21.63 ±0.55	227	200	88.1

Table 5: Effect of Lambada-Cyhalothrin on some biological aspects of the 2nd larval instar of *Musca domestica***.**

Conc. %	Larval duration (days) ± SE	% pupation	Pupal weight (mg) ± SE	Pupal duration (days) ± SE	% adult emergence	Longevity		Egg/Female		% Hatching
						M	F	Deposit	Hatch	
4	8.40±0.77	50.0±12.30	7.0±2.78	7.50±1.65	53.0	11.40 ±0.93	13.65 ±1.54	88.0	30	34.0
2	7.47±1.48	59.0±6.83	9.15±1.44	7.08±1.53	70.0	10.63 ±1.10	11.19 ±0.87	133.0	55	41.35
1	7.41±1.30	66.0±6.93	10.30±0.23	6.61±1.72	77.0	9.23 ±1.62	9.63 ±1.39	164.0	74	45.12
0.5	7.11±0.86	73.0±11.40	11.25±0.44	6.40±1.68	83.3	8.32 ±1.65	10.90 ±1.97	191.0	98	51.30
0.25	6.78±0.59	78.0±1.67	11.45±0.52	5.34±1.00	88.8	7.61 ±1.34	8.25 ±0.85227	196.0	120	61.22
Control	5.33±0.30	97.0±2.80	14.61±3.27	5.56±0.24	83.3 ±0.80	20.60 ±0.24	21.63 ±0.55	227	200	88.1

1.3. Morphological malformations:

In the present study, there were different morphological malformations on larvae, pupa and adults after the treatment of 2nd instar larvae of *M. domestica* with Imidacloprid and Lambada-cyhalothrin. Morphological abnormalities include curved larvae, swelling larvae, small-shrunken larvae, darkened larvae and twisted larvae with diffuse brown pigment. Also, darkened pupae, darkened larvae and twisted larvae with diffuse brown pigment. Also, darkened pupae, puparium with abnormal eclosion fissure, small cracked puparium and small distorted puparium. On the other side, many adults couldn't emerge completely and remained concealed in the puparium, with deforme3d wings and legs, crumpled wings and deformed abdomen (Fig. 1).

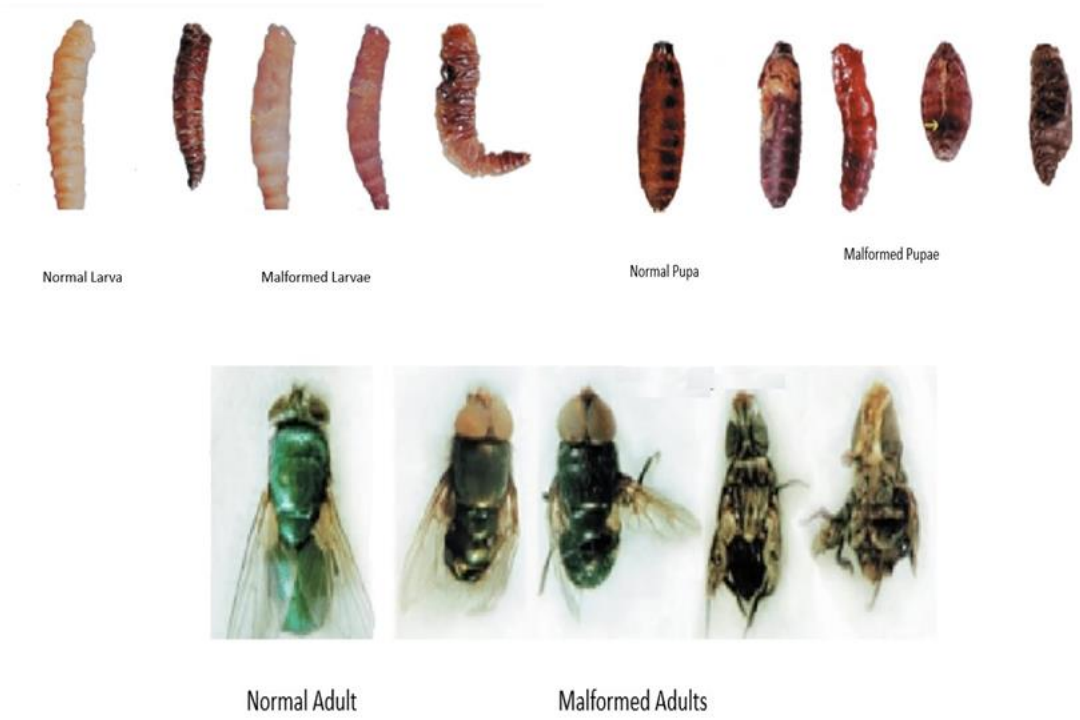

Fig. 1: Morphological deformations which were recorded after treatment with tested insecticides**.**

1.4. Histological Studies:

Untreated *M. domestica* larvae had a cross-section of their midgut that revealed a well-developed outer muscle layer, an inner foundation membrane, a columnar epithelial layer, and a thin peritrophic membrane in the gut lumen. Granular cytoplasm and spherical nuclei could be seen in the well-developed columnar epithelium. On the basement membrane sit these epithelial cells. The space between the different gut wall layers is filled with connective tissue (Fig. 2).

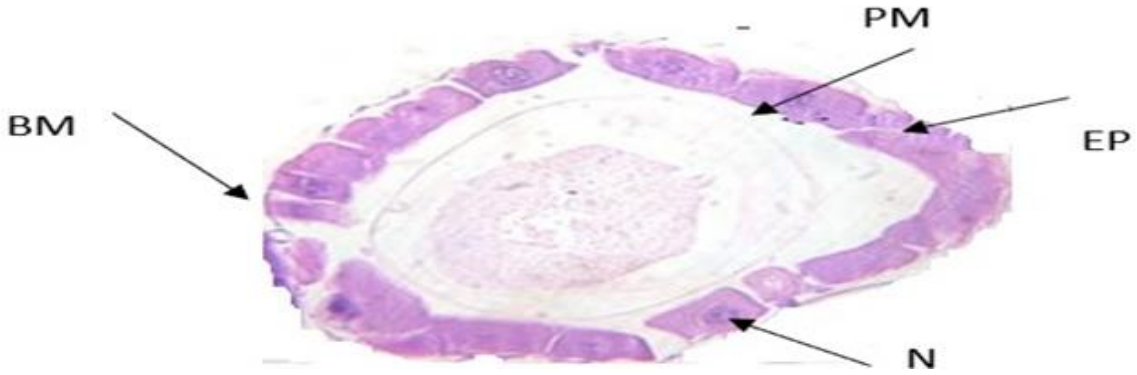

Fig.2: Cross section of normal untreated *M.domestica* 2 nd instar larvae.
EP: epithelial cells, PM: peritrophic membrane, BM: basement membrane, N: nucleus.

1.4.1. Effect of Imidacloprid at 24 and 48 Hours of Treatment on The Midgut of *M. domestica* (Fig. 3&4).

After 24 hours of treatment, the midgut components showed various abnormalities compared to the untreated larvae, including the disintegration of the peritrophic membrane, malformed and enlarged epithelial cells. After 48 hours, the epithelial cells are completely

destroyed and breaking apart from the ruptured basement membrane. At the same time, the peritrophic membrane is unaffected and still intact.

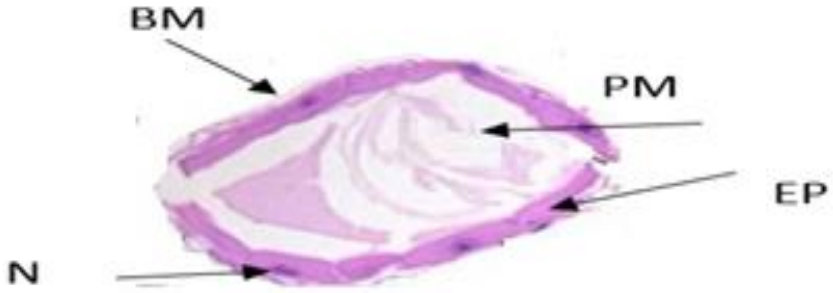

Fig.3: Cross section of the midgut in 2nd *M.domestica* larval instar treated with LC_{50} of imidacloprid after 24 h post-treatment.
EP: epithelial cells, PM: peritrophic membrane, BM: basement membrane, N: nucleus

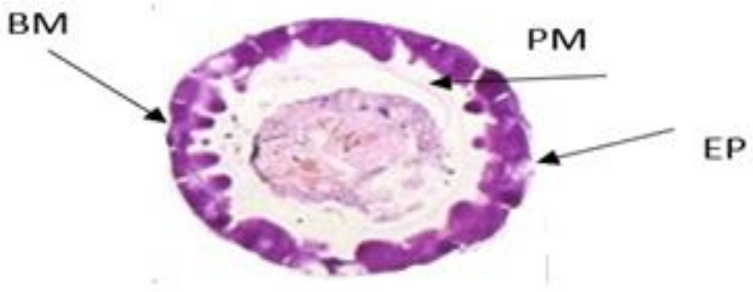

Fig. 4: Cross section of the midgut in 2nd *M.domestica* larval instar treated with LC_{50} of imidacloprid after 48h post-treatment.
EP: epithelial cells, PM: peritrophic membrane, BM: basement membrane.

1.4.2. Effect of Lambada-Cyhalothrin at 24 and 48 hours of treatment on the midgut of *M. domestica*.

After 24 and 48 h of treatments with Lambada-cyhalothrin, certain changes appeared within Figures (5&6) that showed epithelium cells detached from the basement membrane and thickness of epithelial cells in the midgut of larvae. However, after 48h of treatments, degeneration of the midgut epithelial cells and becomes more deformed and lasses columnar structure. While the peritrophic membrane is still intact in many areas.

Fig.5: Cross section of the midgut in 2nd *M.domestica* larval instar treated with LC_{50} of lambada-cyhalothrin after 24 h post-treatment.
EP: epithelial cells, PM: peritrophic membrane, BM: basement membrane, N: nucleus.

Fig.6: Cross section of the midgut in 2nd *M.domestica* larval instar treated with LC_{50} of imidacloprid after 48h post-treatment.
EP: epithelial cells, PM: peritrophic membrane, BM: basement membrane.

2. The Efficiency of Two Insecticides on *Rattus norvegicus*:

Adult males of *R. norvegicus* were subjected to three different concentrations of Lambda Cyhalothrin 5% and Imidacloprid 35% insecticides to test their effect and toxicity on rats under laboratory conditions. These concentrations were (5 and 10%) and two sub-lethal concentrations (LC_{50}) that resulted from the previous control of the second instar larvae of *M. domestica* insect, it was as follows (0.30% for Lambda Cyhalothrin 5% and 0.13% for Imidacloprid 35%). The most important results obtained from the experiments were as follows.

2.1. The Efficiency of Tested Insecticides on The Mortality Percentages:

From the results that were monitored in Table (6), it is clear that there were no mortality cases appeared when *R. norvegicus* males were treated with the LC_{50} concentration of the two tested pesticides. However, death cases began to appear starting from the second week when the individuals were treated with a concentration of 10% of Imidacloprid 35% with 10% mortality rates, while the first death cases appeared at the same concentration of Lambda Cyhalothrin 5% during the third week, with 10% mortality. As for the concentration of 5%, it had the least effect on the tested individuals for Lambda Cyhalothrin 5% and Imidacloprid 35% pesticides together, as the death rates reached 10% only during the fourth and third week, respectively. On the other hand, the highest mortality rates (30 and 40%) occurred during the fourth week with Imidacloprid 35% at concentrations of 5 and 10%, respectively. From the previous results, it is clear that Imidacloprid 35% was somewhat superior to Lambda Cyhalothrin 5% insecticide.

Table 6: Mortality rates of *R. norvegicus* males treated with the Lambda Cyhalothrin and Imidacloprid insecticides**.**

Treatment		The weeks			
		1	2	3	4
Control		0	0	0	0
Lambda Cyhalothrin 5%	0.30	0	0	0	0
	5%	0	0	0	(10%)
	10%	0	0	(10%)	(20%)
Imidacloprid 35%	0.13	0	0	0	0
	5%	0	0	(10%)	(30%)
	10%	0	(10%)	(20%)	(40%)

2.2. Effect of Tested Insecticides on Some Enzymatic Activity and Levels of Creatine and Urea in *R. norvegicus* Male's Blood:

The effect of concentrations (10, 5 and 0.30%) of Lambda Cyhalothrin and (10, 5 and 0.13%) of Imidacloprid on the activity of some enzymes (ALT, AST, ALP), as well as the ratio of Urea and Creatine in the *R. norvegicus* male's blood has been studied. It has been proven from the final results in Table (7) that the concentration of 10 % of the two tested pesticides had the highest effect on the males individuals of *R. norvegicus* under laboratory conditions, as the rate of the three tested enzymes as well as urea (ALT, AST, ALP and Urea) increased from (21.2, 179, 86.3 U/L and 42.4 mg/dl) in the untreated male's blood, and reached (32.1, 280.4, 91.1 U/L and 50.2 mg/dl) and (36.3, 320.6, 97.3 U/L and 56.3 mg/dl) for Lambda Cyhalothrin 5% and Imidacloprid 35% respectively.

As for the percentage of Creatine, it was clear from the results recorded in Table (7) that, it decreased significantly in the male blood of rats treated with concentrations of 5 and 10% of Lambda Cyhalothrin 5%, reaching 0.39 and 0.29 mg/dl compared to the control 0.44 mg/dl. When male rats were treated with the same concentrations of Imidacloprid 35%, the creatine levels in the blood were also decreased by 0.24 and 0.12 mg/dl. The total results shown in Table (7) proved, in general, that Imidacloprid 35% had a slightly higher effect than Lambda Cyhalothrin 5%, and that the concentration of LC_{50} (0.30 and 0.13%) of the two pesticides together did not cause an effect on the tested individuals, as there were no significant differences in the results obtained between this concentration and control.

Table 7: Effect of some insecticides on some biochemical changes of *R. norvegicus* males.

Treatment		ALT(U/L)	AST(U/L)	ALP(U/L)	Urea(mg/dl)	Creatinine(mg/dl)
Control		21.2^{e}	179^{g}	86.3^{g}	42.4^{ef}	0.44^{ab}
Lambda Cyhalothrin 5%	0.30%	21.4^{e}	183.3^{e}	86.6^{f}	42.6^{e}	0.43^{abc}
	5%	26.4^{d}	225.5^{d}	88.2^{d}	48.6^{d}	0.39^{d}
	10%	32.1^{b}	280.4^{b}	91.1^{bc}	50.2^{b}	0.29^{e}
Imidacloprid 35%	0.13%	21.6^{e}	181^{f}	87.2^{e}	41.9^{g}	0.45^{a}
	5%	28.2^{c}	260.4^{c}	91.3^{b}	49.3^{c}	0.24^{f}
	10%	36.3^{a}	320.6^{a}	97.3^{a}	56.3^{a}	0.12^{g}
SX-		**0.074**	**0.135**	**0.086**	**0.107**	**0.011**

Data are presented as means ± standard error. The means in the same column with different superscript letters are significantly different at $P < 0.05$

2.3. The Efficiency of Tested Insecticides on Some Histological Changes in *R. norvegicus* Males:

During this experiment, the toxicity of the lowest concentration (5%) of Lambda Cyhalothrin 5% and Imidacloprid 35% which caused mortality percentages of 10 and 30% respectively during the fourth week were tested to determine the causes of death. Histological sections were taken from the stomach, liver and heart of the treated *R. norvegicus* males and compared with the untreated individuals. The experiment was divided into three groups, the first group (G1), where the rats were untreated (control). The second group (G2) rats were treated with 5% of Lambda Cyhalothrin 5%, and the third group (G3) rats were treated with 5% of Imidacloprid 35%. The most important results obtained were as follows.

2.3.1. Effect of 5% Concentration of Tested Insecticides on The Stomach:

Figure (7) shows the effect of 5% concentration of Lambda Cyhalothrin 5% (G2) and Imidacloprid 35% (G3) pesticides on the occurrence of some histological changes in the stomach of *R. norvegicus* males.

First, it is clear from the figure that the control (G1), shows four normal morpho-anatomical structures of the inner wall of the stomach, which are from the inside to the

outside as follows (the mucous epithelial surface cell layer, with the light blue star, and it contains the gastric glands and the muscular mucosa, which is a circular muscle layer), (The submucosa compose of loose connective and areolar tissues with few fat cells, entangling blood capillaries, venules, lymphatics, nerve cells and a few leucoc ytes, with light green star), (a layer of smooth, longitudinal and circular muscles arranged in fibers with vascular, lymphatic and nervous structures intertwined with the red star) and finally (the layer of connective tissue or the so-called serosa, with the yellow star), (Fig. 7 G1).

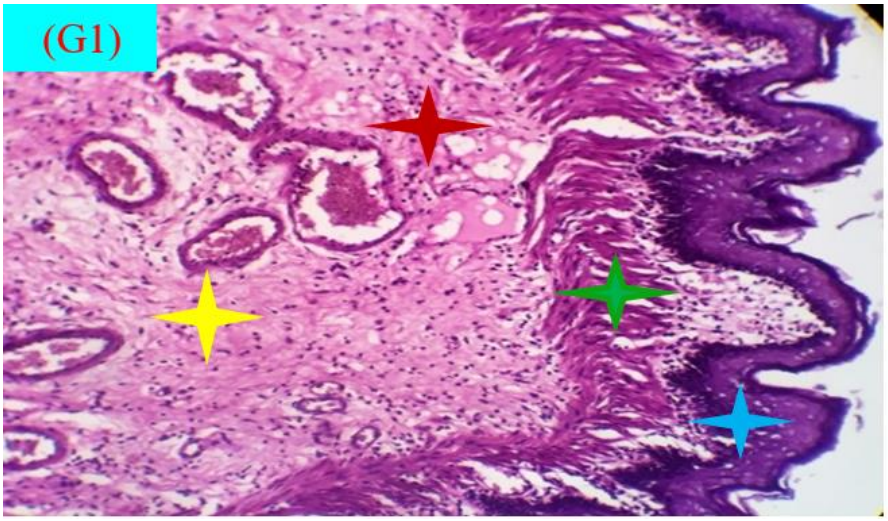

Fig. 7 G1: Cross section of *R. norvegicus* stomach.

As for when the individuals were treated with 5% concentration of Lambda Cyhalothrin 5%, it was observed that some changes occurred in the mucous epithelial layer, and it appeared to some extent congestion of the mucous vessels, in addition to the occurrence of infiltration and light clusters of leukocytes, (Fig. 7 G2 (1). Some lymphatic infections appeared in the stomach with atrophy of the crypt (some ducts) (Fig. 7 G2(2).

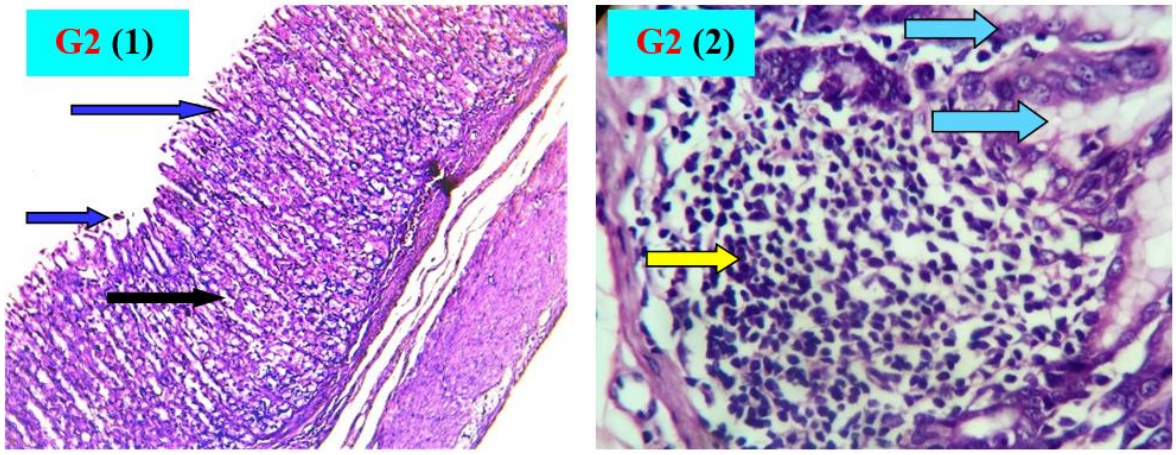

Fig.7: Photomicrograph from the stomach of G2 (1 and 2) showing mucosal vascular dilatation (congestion), leukocytic infiltrate (1), follicular lymphocytic gastritis with crypt atrophy (2), (Dark blue, black, yellow and light blue arrows respectively).

While males treated with 5% concentration of Imidacloprid 35% in (G3) showed clear mucosal hyperemia and diffuse glandular vacuoles in the epithelial mucosal layer, (Fig. 7 G3, (1 and 2). Thus, the effect of the two pesticides at a concentration of 5% on the stomach tissues was somewhat similar.

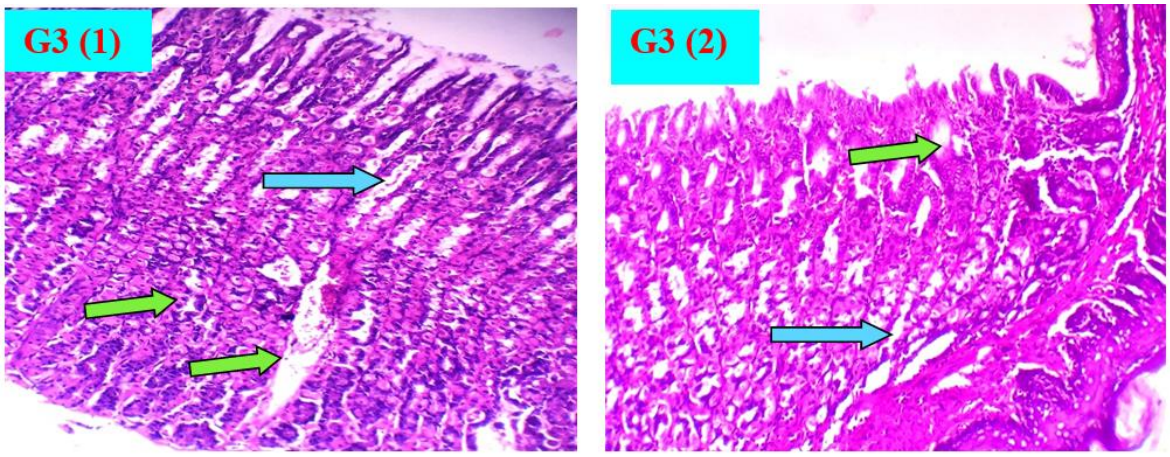

Fig.7 G3, (1 and 2): shows mucosal congestion and glandular epithelial degeneration (vacuole), (dark blue and green arrows respectively).

2.3.2. Effect of 5% Concentration of Tested Insecticides on The Heart:

In the case of normal and untreated rats, serial sections of the myocardium revealed normal vascular structures (coronary vessels, myocardium, and capillaries). The contractile and contractile structures including cardiomyocytes and Purkinje fibers respectively were histologically and morphologically normal. The stromal cells and interstitial tissue were in good histological appearance, (Fig. 8 G1).

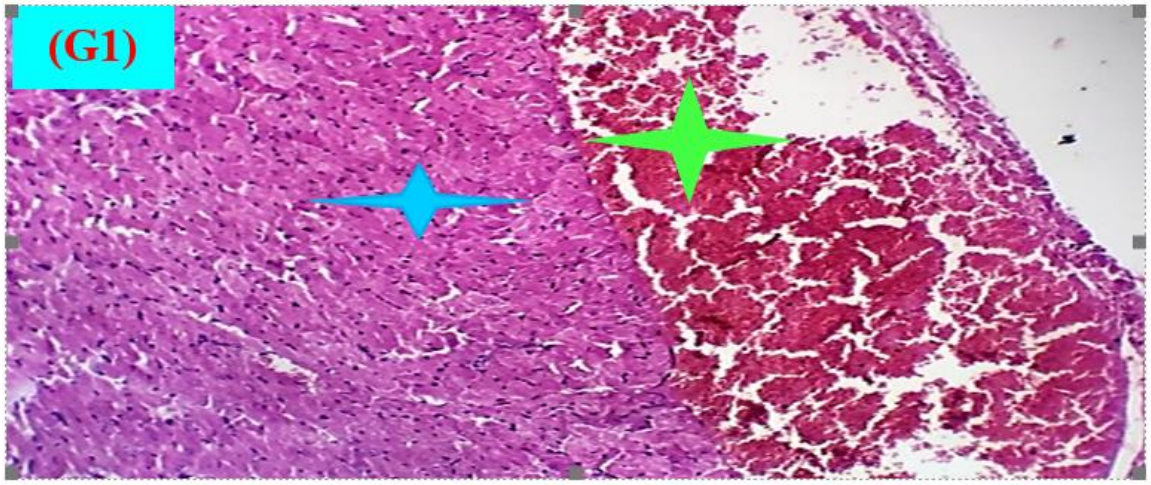

Fig.8(G1). Photomicrograph from the heart of control rats showing normal cardiomyocytes, sarcolemma cells, and intercalated spaces (green and light blue stars) H&E X 100, 200, 400.

After treating male rats from the two groups (G2 and G3) with 5% of the two tested pesticides Lambda Cyhalothrin 5% and Imidacloprid 35% respectively, it was found that some histological changes occurred in the heart, which clearly affected the heart muscle. Cardiac toxicity was identified in both groups with variable severity. Lesions in groups 2 and 3 were represented by multifocal cardiomyocyte degeneration and early necrosis, (Fig. 8), G2 and G3. Notable coronary arterioles, myocardial hypertrophy, congestion, hemorrhage, and interstitial edema were recorded in G2 (Fig. 8 G2). Meanwhile, interstitial edema associated with cardiomyocyte atrophy was seen in G3 (Fig. 8 G3).

It is clear from the results that the higher effect on *R. norvegicus* was for Imidacloprid pesticide.

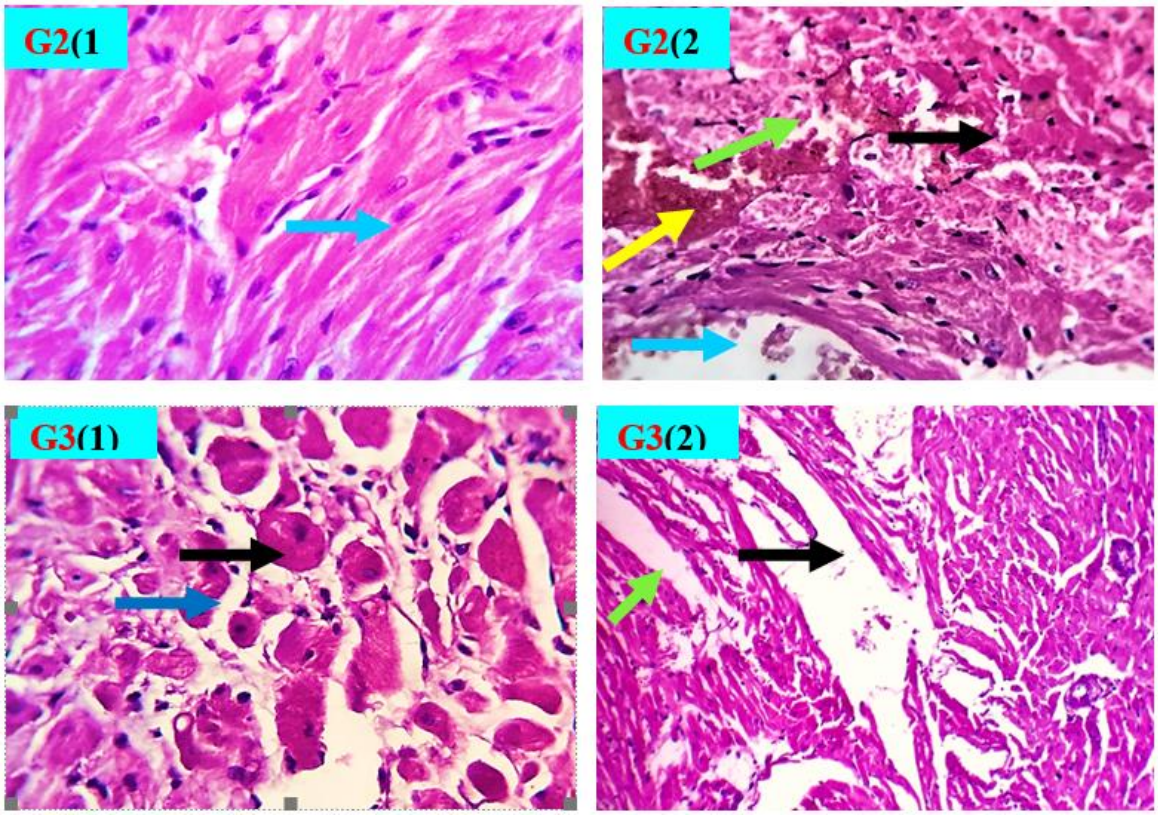

Fig. (8). Micrographs of G2 and G3 hearts showing multifocal myocardial cell degeneration and early necrosis. (black and green arrows). Noticeable coronary arteries, muscular vasodilatation, congestion, and hemorrhage are shown in G2 (light blue and yellow arrows). Interstitial edema associated with cardiomyocyte atrophy is shown in G3 (dark blue arrow). H&EX100, 200, 400.

2.3.3. Effect of 5% Concentration Of Tested Insecticides On The Liver: -

Examined sections from the liver of negative control rats showed preserved hepatic cords, portal triad structures, vascular tributaries, biliary system, sinusoids, Von Kupffer's cells and supporting stroma, (Fig. 9 G1).

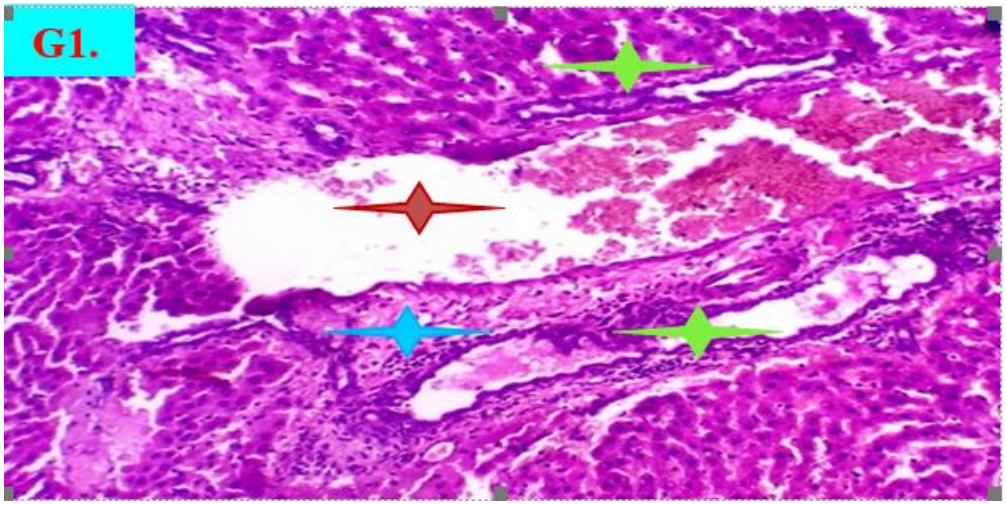

Fig. (9 G1). Photomicrograph from the liver of control rats, shows apparently normal central vein (brown star), portal area and portal blood vessels (green star) beside normal hepatocytes (light blue star), H&EX200, 400.

Whereas, in the case of the treatment of mature individuals from the two groups of male mice with the aforementioned pesticides, significant histological changes occurred in the liver tissues. Vasodilation, congestion and proliferation of bile ducts were seen in G2 and G3, (Fig. 9 G2 and G3) Marked sinusoidal dilatation, associated with atrophy of hepatocytes and Von-Kupffer cells was recorded in G2. (Fig.9 G2). Hepatocellular degeneration (vacuoles and sometimes steatosis) was seen alongside chronic advanced cholangitis in G3. (Fig.9 G3). In general, a slightly higher effect on the rat's liver was recorded in favor of the Imidacloprid pesticide.

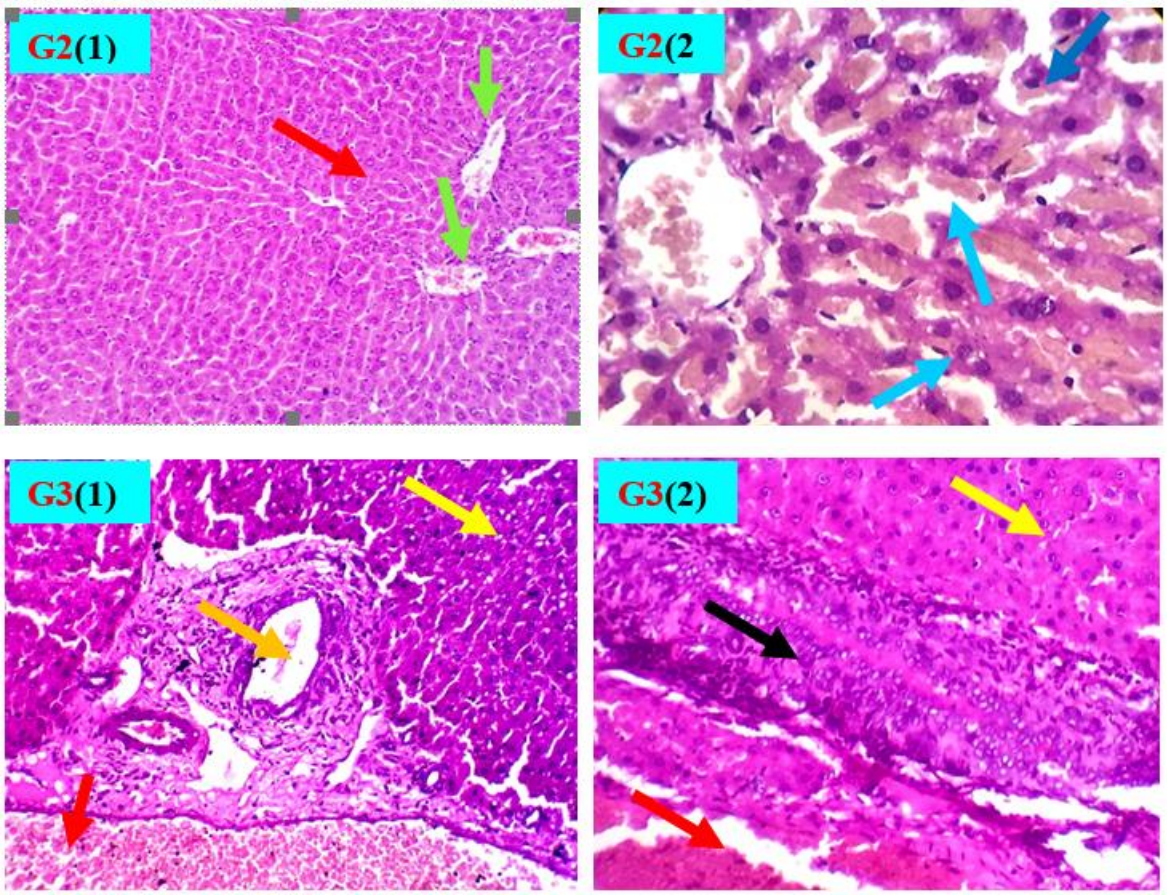

Fig.(9). Micrographs of G2 and G3 livers showing vasodilatation, congestion, and proliferation of bile ducts (green and red arrows), and marked sinusoidal dilatation, associated with atrophy of hepatocytes and Von-Kupffer cells in G2 (light blue and dark blue arrows). In G3, degeneration of hepatocytes (vacuoles and sometimes steatosis) was observed alongside chronic advanced cholangitis. (yellow, orange, and black arrows), H&EX200, 400.

DISCUSSION

Ahmed and Wilkins (2001) found that an insecticide-resistant strain of *M. domestica* has decreased fecundity. Enriquez, *et al.*, (2010) found that the hatching percentage at greater levels of insecticide was found to be lower at the methoxy fenozide LC_{25} concentration compared to lower concentrations and the control. *M. domestica* pupation rates were also lower. However, the duration of the larval stage was not significantly affected by pesticide exposure at all concentrations. Similar results were observed by Miao, *et al.*, (2016) who discovered a decrease in pupal weight and a prolonged pupal period. In addition, *M. domestica* adult emergence was reduced at imidacloprid doses

below the lethal level. On the other hand, our results are in agreement with Sanil and Shetty (2012) after treatment with LC_{30} and LC_{50} concentrations of propoxur, there were observed sex ratio changes in *Anopheles stephensi* (Diptera: Culicidae). Besides, Farooq and Freed (2018) studied nine insecticides against *M. domestica*. Results proved that imidacloprid was the most lethal of the insecticides tested and gave a high mortality percentage. In addition, caused a reduction in pupal weight, percentage pupation and adult emergence while causing prolongation of larval and pupal duration. And Kinareikina and Silivanova (2023) found that the sub-lethal concentration of` insecticide fiproni gave the highest mortality percentage against adults of *M. domestica* compared with chlorfenapyer and control, the mortality percentage reached (40 and 100%) after exposure to chlorfenapyer and fipronil, respectively. Also, Afzal, *et al.,* (2020) showed that imidacloprid and thiacloprid at (5% concentration) were superior in causing mortality in adult houseflies but dependent on syrup. Overall, both insecticides caused more than half the population death of house flies within 48 hours. However, Ghramh, *et al.,* (2022) studied lambada-cyhalothrin for the management of house flies. Also, on life table parameters of the progenitor of adult houseflies exposed to LC_{10}, Lc_{30} and LC_{50} of Lambada-cyhalothrin. Results recorded the lowest progeny of adults exposed to LC_{50} of Lambada-cyhalothrin. While higher fecundity was observed in control. Decreased population parameters suggest that lambada-cyhalothrin can be used successfully in indoor environments to control houseflies. However, Khater (2018) tested the ultrastructural effects of chlorpyrifos and phenthoate on the midgut of the third larval instar of *Chrysomya albiceps.* Results indicated ultrastructural changes after treatment such as; the rough endoplasmic reticulum becoming swallowed. The microvilli clumped and shrunk. The cells of the midgut possess short, shrunk, or atrophied microvilli. As well as Mirza and Amir (2022) examine the histological effects of a fatal dose of the insecticide cypermethrin on the midgut of the meat fly *Sarcophagus ruficornis*. After 24 and 48 hours after treatments, the results revealed histological alterations. At 24 hours after treatment, the midgut epithelial cells showed disruption and expansion. Additionally, the peritrophic membrane deteriorated and the cytoplasm vacuolized after 48 hours of treatment. Additionally, increased disturbance was seen in the outer muscle layer and basement membrane. Yasmen and Amir (2023) determined insecticide, imidacloprid on histopathological midgut of third instar larvae of *Chrysomya megacephala*. Histopathological studies showed deformities and degeneration in the epithelial cells, peritrophic membrane, basement membrane and muscular layer of the larval midgut. While, Fiaz, *et al.,* (2019) assessed the ultrastructural effects of pyriproxy fen on the midgut of *Aedes aegypti* larvae. Histopathological study reveals cytoplasmic vacuolization and damage to the brush border of digestive cells. Also, disorganized microvilli and deformed mitochondria.

For rats, Mostafa *et al*. (2021) indicated that sub-lethal doses LD_{50} of imidacloprid pesticide led to a significant decrease in the levels of ATP, NADH, GST and SOD enzymes, which indicates a significant defect in the liver functions of male albino rats. El-sheikh and Amal (2017) studied the effect of some drugs as a kind of oral poison for rats. Histological results indicated cytotoxicity to Wibster rats when taking chronic oral meloxicam can serve as a source that harms animal organs such as the pancreas and stomach. On the other hand, Mate *et al*. (2010) cleared that the anatomy of treated rat individuals with Lambda-cyhalothrin revealed significant changes in the heart, divergence of muscle fibers occurred, and necrosis and muscle wasting appeared. As well as the occurrence of congestion and bleeding in the heart muscle, on the other hand, a lack of lymphocytes, especially in the spaces surrounding the artery, with the decomposition of the retinal structure. Besides, Tomar *et al* (2015) proved that the treatment of house mice with insecticides had a significant effect on the liver, as congestion appeared in the blood vessels of the liver. Degeneration

also occurs in the liver cells. Degeneration and drainage in the sinuses and the appearance of portal hypertrophy of the central vein.

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ARABIC SUMMARY

كفاءة المبيدات الحشرية ايميداكلوبريد ولمبادا ثيهالوثرين على الذبابة المنزلية والفأر النرويجى كأفتين من أفات الصحة العامة تحت الظروف المعمليه

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أجريت جميع التجارب فى هذه الدراسة على الذبابة المنزلية والفأر النرويجى تحت الظروف المعملية بمعامل الحشرات والحيوان الزراعى بقسم وقاية النبات بكلية الزراعة - جامعة بنها حيث تم قياس مدى استجابة الذبابة المنزلية للمبيدين الحشريين ايميداكلوبريد ولمبادا ثيهالوثرين وكذلك تأثير تلك المبيدات الحشرية على التأثيرات البيولوجية والهستولوجية ليرقات العمر الثانى للذبابة المنزلية تحت ظروف المعمل وتم استخدام خمس تركيزات مختلفة وهي (4، 2، ، 1 ، 5, ،25 ,) وتم حساب نسب الموت بعد اليوم الأول، الثانى، الثالث، الرابع والخامس من المعاملة.

سجل أعلى نسب مئوية للموت عند التركيز 4% بعد اليوم الخامس من المعاملة حيث أعطت (96،100%) بعد المعاملة بمبيدى ايميداكلوبريد ولمبادا ثيهالوثرين على التوالى. تم حساب الجرعة النصف مميتة لمبيد ايميداكلوبريد (13 ,%) بينما كانت (30, %) لمبيد لمبادا ثيهالوثرين . سببت معظم تركيزات المبيدات المختبرة اطالة فى مدة الطورالير قى وطور العذراء كما سببت أيضا انخفاض فى نسبة التعذر ونسبة خروج الفراشات

باللاضافة الى انخفاض وزن العذراء مقارنة بالكنترول. نتج أيضاعن تلك المبيدات حدوث بعض التغيرات الهستولوجية فى المعى الأوسط لليرقات المعاملة. تم استخدام نفس المبيدات الحشرية على ذكور الفأر النرويجى تحت الظروف المعملية باستخدام ثلاث تركيزات مختلفة وهي (10, 5، 30, %) لمبيد لمبادا ثيهالوثرين و(10، 5، 13, %) لمبيد ايميد اكلوبريد حيث أعطى تركيز 10% أعلى نسب مئوية للموت بعد أربع أسابيع من المعاملة حيث كانت (20، 40%) لمب يدى لمبادا ثيهالوثرين و ايميداكلوبريد على التوالى . كان لنفس التركيز تأثير كبيرأيضا على نشاط انزيمات ALT, A ST, ALP, Urea and Creatine فى دم الفئران. لوحظ أيضا بعض التغيرات الهستولوجية على المعدة - القلب والكبد نتيجة المعاملة بتلك المبيدات. لذلك يقترح استخدام مبيدى ايميداكلوبريد ولمبادا ثيهالوثرين فى مكافحة الذبابة المن زلية والفأر النرويجى خاصة مبيد ايميداكلوبريد الذى كان له التأثير الأكبر بصفة عامة .