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Evaluation of the Toxicity and Effectiveness of Some Insecticides on the Climbing Rat, *Rattus rattus* under Laboratory Conditions

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ABSTRACT

The black climbing rat, *Rattus rattus*, is considered one of the rat species that spread in different Egyptian environments. It has great importance in reducing the economic value of food and transmitting diseases. The toxicity of four insecticides (Chlorzan 48% EC, Hachi Hachi 15% EC, Nasr Lathion/Kemenova 57% EC, and Grab 2.5% EC) was tested at three different concentrations (2.5, 5 and 10%) on changes in body weight, mortality rates, and the effect on each of liver and kidney functions. As well as some histological studies in *R. rattus* males. Results showed that Chlorzan 48% recorded the highest effect during the various studies, as the percentage of weekly body weight gain was the lowest (5.68 gm) after one-month post-treatment. The same insecticide also caused the highest rates of mortality, reaching 40% at a concentration of 10%; on the other hand, ALT, AST, ALP and urea rates were significantly increased, while the creatinine level significantly decreased. Nasr Lathion/Cheminova 57% came in second place in terms of its effect on *R. rattus* individuals. The toxicity of the two previous insecticides was tested at a 5% concentration on histological changes in the stomach, liver, heart and kidneys of *R. rattus*; there were clear histological changes in the tissue sections examined as a result of treatment with these two pesticides.

INTRODUCTION

There is no doubt that rats are one of the most important pests belonging to vertebrate mammalian animals and spread throughout the world, they cause many problems at all levels of human living, as they threaten their various types of food, whether in the form of field crops, vegetables, or fruits, as well as food stored in Warehouses and small stores; (Abd El-Aleem; 2018, Kukom *et al* 2018, Venkata and Pavan; 2022 and Munawara *et al*., 2024). The harm of these animals does not stop when they attack food only, but rats also attack human property, causing damage to it, as they spread in homes, companies, and other places where people live. What makes the matter even more dangerous is that rats are one of the most important public health pests and can transmit many dangerous diseases, whether to humans or their domesticated animals, this has been proven by many researchers over the past years, including: (Petrov and Bileva 2010, Vahid Kazemi *et al*., 2018 and Sharma *et al*., 2019). Bennett and David (2019) have proven that the climbing black rat, *Rettus rattus*, is one of the rats that live in a social form and that spread in various human environments and can cause a lot of harm, especially its ability to transmit many diseases to himself and his pets.

Many methods and means have been used to control rats in different environments, whether these methods are mechanical, biological, physical, or chemical to reduce the harm caused by these animals as much as possible.

Over the years, pesticides have been the most widely used means of combating various pests, despite their danger to the environment, humans, soil, and other animals, and the imbalance they cause in the environmental balance. This is because they give quick results and are easy to use. They are also cheap in price compared to other methods used in pest control, (Lykogianni *et al* 2021; Zikankuba, *et al* 2019).

WHO, 1993 explained that nearly 50,000 commercial pesticides have been registered. Many synthetic pesticides are used in rural agricultural communities. About 85% of the pesticides currently used in the world are intended for pests in the agricultural sector, only about 10% are designated for public health pests, and the remainder is applied to specific sites such as buildings, transportation, and housing, with measures taken health against disease vectors.

This study compares the toxicity of four insecticides at various concentrations (Cholorzan 48%, HACHI HACHI 15%, Nasr Lathion / Cheminova, and Grap 2.5) against the black climbing rat *Rattus rattus* under laboratory conditions.

MATERIALS AND METHODS

All experiments were conducted in the Plant Protection Department, Faculty of Agriculture, Benha University, Egypt.

1- Acclimatization of Rats Inside the Laboratory:

One hundred and fifty healthy adult males of the climbing rat *R. rattus* weighted an average of 130 ± 10 g were obtained from nearby villages. The rat's individuals were housed in metal cages and provided with an adequate diet containing protein, fiber and fat. In addition, clean water was provided to animals continuously. The animals were given approximately two weeks to acclimate to the laboratory environments before the start of the experimental investigation.

2- Divide and Conduct Laboratory Experiments:

A group of 130 healthy adult male *R. rattus* were selected to be roughly the same weight. A total of 120 rats were utilized in order to carry out multiple laboratory investigations, while the remaining 10 rats were used as a control group to assess the outcomes. Four insecticides were chosen to test their toxicity on *R. rattus* individuals under laboratory conditions. These insecticides were (Cholorzan 48%, Nasr Lathion / Cheminova 57%, Hachi Hachi 15% and Grap 2.5). From each insecticide, three different concentrations were prepared (2.5, 5 and 10%), for each concentration, 10 rats were used. Thus, laboratory-tested experimental individuals were divided into four groups related to the four pesticides, and within each group, 30 rats were used (10 for each concentration). As for the control individuals, they were not treated with any type of insecticide. The experiments continued in the laboratory for a period of four consecutive weeks from the beginning of the experiments. The various pesticides were mixed after preparing them in different concentrations with the food provided to *R. rattus* male individuals and were observed on a daily basis during the experimental period to record the changes that occurred. During this period, differences in weights were calculated, mortality rates among individuals were recorded, and blood analysis was performed, as well as various histological sections were performed in the treated individuals in the tissues of the stomach, liver, heart, and kidney.

The weight gain percentage of the animal's body was calculated weekly by the following equation:

$$\%\ \textbf{of body weight change} = \frac{\textbf{final body weight} - \textbf{initial body weight}}{\textbf{initial body weight} \times \textbf{number of weeks}} x100$$

3- Tested Insecticides:

All tested insecticides were mixed with rat food. The following Table (1) shows all available information about the tested pesticides; In terms of common name, trade name, chemical group and source of obtaining these pesticides. In addition their mode of action. As well as used formulation and main use of these insecticides.

Table (1): Some information is available about the tested insecticides.

Common Name	Trade Name	Chemical group	Origin	Mode of action	Used formulation	Main use
Chlorpyrifos 48%	Cholorzan 48%	Organophosphate	Kafr El-Zayat Pesticides and Chemicals Company-Egypt	This pesticide works to inhibit acetylcholine (ACh), which directly affects the nervous system of the organism.	EC Emulsifiable Concentrate	Insecticide
Tolfenpyrad %15	HACHI HACHI 15%	Pyrazole	Shoura Chemicals Company-Egypt	This pesticide affects the electron transport chain in cell mitochondria, leading to the cessation of energy production and then death.	EC Emulsifiable Concentrate	Insecticide
Malathion 57%	Nasr Lathion / Cheminova	Organophosphate	El nasr co. for intermediate chemicals	This pesticide works by inhibiting acetylcholinesterase enzyme. Thus, it is permanently bound to the serine residue in the catalytic active site of the cholinesterase enzyme. The resulting phosphoester group binds strongly to the cholinesterase enzyme and permanently inactivates the enzyme, leading to a faster accumulation of acetylcholine in the synapse.	EC Emulsifiable Concentrate	Insecticide
Deltamethrin S-Bioallethrin 2%	Grap 2.5	Pyrethroid	Chema Industry	This pesticide affects the transmission of nerve signals, as pyrethroids interfere with the natural production of nerve signals.	EC Emulsifiable Concentrate	Insecticide

4- Biochemical Parameters:

Parameters of all biochemical were estimated in the laboratory of Dr. Mahmoud Abou El.makarem, Toukh, Qalubia Governorate, Egypt. Serum tubes were used to collect blood samples. Spectrophotometric analysis was used as a standard method to determine the serum levels of AST, ALT, ALP, urea, and creatinine.

5- Histological Studies:

After 30 days of therapy, specimens from the treated *R. rattus* males' vital organs (stomach, liver, heart, and kidney) were taken. Using the Suvarna et al. technique, all histological investigations were carried out at the Attar Center for Medical Research and Histopathology (ACMRH), Zagazig, Sharkia Governorate, Egypt. (2013)

6- Statistical Analysis:

All data were expressed as means and standard error and statistically analyzed using SAS (Statical Analysis Software) SAS (1999). The statistical significance of differences among different study groups was evaluated by one-way analysis of variance (Danken) ($P \leq 0.05$). Duncan's multiple range tests were used to differentiate between means to determine differences between means of treatments at significance rates of ($P \leq 0.05$).

RESULTS AND DISCUSSION

1- The Impact of Tested Insecticides on Body Weight *R. rattus*:

Data in Table (2) show the effect of tested insecticides on treated rats' body weights during the test weeks compared with control. The insecticides that had the most influence on the average weight were Cholorzan 48% and Nasr Lathion / Cheminova 57%, which showed the lowest weights at the end of the experiment, with averages of (153.96, 139.68 and 134.74 gm) and (153.32, 143.70 and 134.64 gm) under (2.5, 5 and 10) concentrations, respectively compared with 155.39 gm in control. When the average weekly weight gain was calculated of the treated rats, Cholorzan 48% and Nasr Lathion / Cheminova 57% insecticides proved to be the most effective, as the average weight gain was the lowest possible with (14.79, 7.89 and 5.64 %) and (15.39, 11.39 and 7.64 %) under (2.5, 5 and 10) concentrations respectively compared with control and the other tested insecticides. The results also demonstrated that concentration (10) had the highest effect with all tested insecticides, as this concentration gave the lowest weights during the different weeks of testing and the lowest averages in the weekly rate of increase compared to the other tested concentrations.

Mansour *et al.*, 2008 studied the extent of the effeteness of five insecticides namely; abamectin, carbosulfan, fenpropathrin, methomyl and profenofos on the change in body weight that occurred in the treated individuals of male albino rats. The results demonstrated the appearance of changes in weight between light and large, and the occurrence of a clear loss of appetite and general wasting of the bodies in the treated individuals. The percentage was for the change in body weights between 7.19% to 13. 95% compared to 15.51% in the control. The chronic effect of imidacloprid pesticide led to a very clear effect on the weekly body weight gain of male rats individuals compared with the control group Najafi *et al.*, (2010).

Table (2): Effect of some insecticides on the body weight changes of *R. rattus* males.

Treatment		Time in weeks					General mean	% of weekly body weight gain change
		0	1	2	3	4		
Control		119.5^{a} ±0.26	132.3^{b}±0.21	154.2^{a}±0.42	175.8^{a}±0.32	195.2^{a}±0.09	155.39	15.85
Cholorzan 48%	2.5%	119.2^{a}±0.26	131.9^{b}±0.21	153.0^{a}±0.42	176.0^{a}±0.32	189.7^{b}±0.09	153.96	14.79
	5%	118.8^{b}±0.26	134.6^{a}±0.21	140.8^{b}±0.42	147.9^{b}±0.32	156.3^{c}±0.09	139.68	7.89
	10%	118.3^{b}±0.26	130.8^{c}±0.21	136.6^{c}±0.42	142.8^{c}±0.32	145.2^{d}±0.09	134.74	5.68
Hachi Hachi 15%	2.5%	119.2^{a}±0.06	130.2^{b}±0.22	154.2^{a}±0.27	174.2^{b}±0.31	190.2^{b}±0.14	153.60	14.79
	5%	119.1^{b}±0.06	130.1^{b}±0.22	147.2^{b}±0.27	167.8^{c}±0.31	182.3^{c}±0.14	149.30	13.26
	10%	118.9^{c}±0.06	128.8^{c}±0.22	143.6^{c}±0.27	155.8^{d}±0.31	166.8^{d}±0.14	142.76	10.10
Nasr Lathion / Cheminova 57%	2.5%	118.6^{c}±0.13	131.6^{a}±0.23	152.8^{b}±0.26	172.0^{b}±0.31	191.6^{b}±0.09	153.32	15.39
	5%	120.3^{a}±0.13	129.3^{b}±0.23	141.2^{c}±0.26	152.6^{c}±0.31	175.1^{c}±0.09	143.70	11.39
	10%	118.2^{c}±0.13	123.3^{c}±0.23	131.2^{d}±0.26	146.2^{d}±0.31	154.3^{d}±0.09	134.64	7.64
Grap 2.5	2.5%	118.5^{b}±0.09	129.9^{c}±0.21	153.1^{b}±0.29	174.5^{b}±0.33	185.6^{b}±0.14	152.32	14.15
	5%	119.2^{a}±0.09	131.2^{b}±0.21	146.8^{c}±0.29	165.8^{c}±0.33	182.6^{c}±0.14	149.12	13.29
	10%	119.3^{a}±0.09	125.6^{d}±0.21	144.2^{d}±0.29	157.6^{d}±0.33	164.8^{d}±0.14	142.3	9.53

Each value (in grams) is a mean of 3 rat's ± SE Value with different letters are significantly different at $p<0.05$(Duncan test)

% of weekly body weight gain = [(final b.wt. - initial b.wt.) / (initial b.w. X no. of weeks)] x 100.

General mean = average reading from 0 time to 4 weeks

2- The Impact of Tested Insecticides on *R. rattus* Mortality Rate:

The effect of tested insecticides on the mortality rates of tested rats individuals is shown in Table (3). The outcomes make this evident that Cholorzan 48% pesticide was the most toxic to the rats, as its effect appeared beginning in the second week with a mortality rate reached 10%, and this percentage continued to rise until the fourth week when the insecticide concentration reached 40% at a concentration of 10%. In addition, a

concentration of 5 % caused 10% and 30% mortality rates during the third and fourth weeks, respectively. On the other hand, Nasr Lathion / Cheminova 57% insecticide ranked second in toxicity. Individual mortality rates increased to 10% and 30% in the third and fourth weeks at 10% and 5% of the insecticide concentration, respectively, while the mortality rate reached 20% at a concentration of 5% during the fourth week. As for HACHI HACHI 15% and Grap 2.5 insecticides, they showed the same lowest degree of toxicity on the tested rats the mortality percentages reached only 10% at a concentration of 10% during the fourth week of the experiment, while no mortality rates were observed for the other concentrations (2.5 and 5 %) of the same pesticides. El-Shewy *et al* 2023 tested the toxicity of insecticides Imidacloprid 35% and Lambda Cyhalothrin 5% on mortality rates of *Rattus norvegicus* males under three different concentrations, the highest death rates were recorded at a concentration of 10% of Imidacloprid 35% insecticide.

Table 3: Mortality rates of *R.rattus* males in all groups.

Treatment		**Time in weeks**			
		1	**2**	**3**	**4**
Control	**Conc.**	**0**	**0**	**0**	**0**
Cholorzan 48%	**2.5%**	**0**	**0**	**0**	**0**
	5%	**0**	**0**	**(10%)**	**(30%)**
	10%	**0**	**(10%)**	**(20%)**	**(40%)**
HACHI HACHI 15%	**2.5%**	**0**	**0**	**0**	**0**
	5%	**0**	**0**	**0**	**0**
	10%	**0**	**0**	**0**	**(10%)**
Nasr Lathion / Cheminova 57%	**2.5%**	**0**	**0**	**0**	**0**
	5%	**0**	**0**	**0**	**(20%)**
	10%	**0**	**0**	**(10%)**	**(30%)**
Grap 2.5	**2.5%**	**0**	**0**	**0**	**0**
	5%	**0**	**0**	**0**	**0**
	10%	**0**	**0**	**0**	**(10%)**

3- The Effeteness Of Tested Insecticides On Some Biochemical Changes of *R.rattus*:

Table (4), shows the effect of tested insecticides on some changes in the blood enzymes of *R.rattus*. The results confirmed that Cholorzan 48% insecticide, at a concentration of 10%, had the highest effect on ALT, AST and ALP enzymes when their levels increased from 20.1, 180.5 and 85.6 U/L for the control and reached 32.9, 310.7 and 96.2 U/L for Cholorzan. With the same 10% concentration, the Nasr Lathion / Cheminova 57% insecticide performed second place in terms of effect, with the rates of the three enzymes rising to 30.8, 296.0, and 94.6 U/L in comparison to the control. It is also clear that the same two insecticides mentioned above had the greatest effect on the level of urea in the blood, especially at a concentration of 10%, where its levels increased to 49.4 and 46.1 mg/dl, for Cholorzan 48% and Nasr Lathion / Cheminova 57%, respectively, compared to 41.7 mg/dl for the control. On the other hand, the results indicated that the same two insecticides at the same concentration led to a significant decrease in the level of Creatinine, as its levels reached their lowest rates (0.15 and 0.27 mg/dl for Cholorzan 48% and Nasr Lathion / Cheminova 57%), respectively compared to the control.

Yasmin *et al* evaluated the toxicity of Chlorantraniliprole insecticide on liver and kidney function in albino rats. The results confirmed that this pesticide has a clear effect on liver and kidney functions when the activity of AST and ALT, urea and creatinine increases, and thus the percentage of albumin, globulin and calcium in the blood decreases.

Table 4: Some biochemical changes of *R.rattus* males in all groups.

Treatment		ALT(U/L)	AST(U/L)	ALP(U/L)	Urea(mg/dl)	Creatinine(mg/dl)
Control		20.1^{j}±0.119	180.5^{i}±0.436	85.6^{h}±0.214	41.7^{h}±0.094	0.45^{a}±0.014
Cholorzan 48%	2.5%	20.9^{h}±0.119	232^{g}±0.436	89.2^{d}±0.214	44.2^{e}±0.094	0.35^{cd}±0.014
	5%	28.2^{d}±0.119	280^{c}±0.436	91.7^{c}±0.214	47.3^{b}±0.094	0.26^{e}±0.014
	10%	32.9^{a}±0.119	310.7^{a}±0.436	96.2^{a}±0.214	49.4^{a}±0.094	0.15^{f}±0.014
HACHI HACHI 15%	2.5%	20.6^{hi}±0.119	190.7^{j}±0.436	86.6^{g}±0.214	42.9^{g}±0.094	0.4^{bc}±0.014
	5%	25.2^{f}±0.119	230.4^{h}±0.436	87.9^{ef}±0.214	43.8^{f}±0.094	0.37^{bc}±0.014
	10%	29.5^{c}±0.119	260.2^{d}±0.436	88.3^{e}±0.214	44.9^{d}±0.094	0.35^{cd}±0.014
NasrLathion / Cheminova 57%	2.5%	20.7^{h}±0.119	210.5^{i}±0.436	88.3^{e}±0.214	42.9^{g}±0.094	0.39^{bc}±0.014
	5%	26.9^{e}±0.119	255^{e}±0.436	91.2^{c}±0.214	44.7^{d}±0.094	0.32^{d}±0.014
	10%	30.8^{b}±0.119	296^{b}±0.436	94.6^{b}±0.214	46.1^{c}±0.094	0.27^{e}±0.014
Grap 2.5	2.5%	20.3^{ij}±0.119	185.2^{k}±0.436	85.9^{h}±0.214	41.9^{h}±0.094	0.42^{ab}±0.014
	5%	23.4^{g}±0.119	210.4^{i}±0.436	86.9^{g}±0.214	43.2^{g}±0.094	0.39^{bc}±0.014
	10%	28.2^{d}±0.119	250.6^{f}±0.436	87.6^{f}±0.214	44.1^{e}±0.094	0.37^{bc}±0.014

Value with different letters are significantly different at p<0.05(Duncan test)

4- The Effectiveness Of Cholorzan And Nasr Lathion / Cheminova Insecticides On Some Histological Changes of *R.rattus*:

From the previous results, it became clear that Cholorzan 48% and Nasr Lathion / Cheminova 57% insecticides had the highest effect on the weights of *R.rattus* as well as the mortality rates at the end of the fourth week of the experiment. The two insecticides together also had the greatest effect on the levels of enzymes, urea, and creatinine in the blood of rats. Therefore, these two insecticides were chosen at a concentration of 5% to study some internal histological changes in some tissues of tested *R.rattus*. Histopathological analyses were performed on the tissues of the stomach, liver, heart, and kidney of *R. rattus* subjects that were treated with a 5% concentration of the two pesticides, and the results were compared with the control group. The experiment was divided into two groups, the first group (G1) was treated with 5% Cholorzan 48% insecticide and the second group (G2) was treated with 5% Nasr Lathion / Cheminova 57% insecticide, the control group didn't receive any pesticide treatment at all, and the histopathological findings were as follows.

4-1- Histopathological Findings In The Stomach:-

Firstly, examined serial sections from different parts of the rat's stomach of the control negative group revealed normal morpho-anatomical structures regarding gastric mucosa, muscularis mucosa, submucosa, muscular coat and serosa (Fig.1).

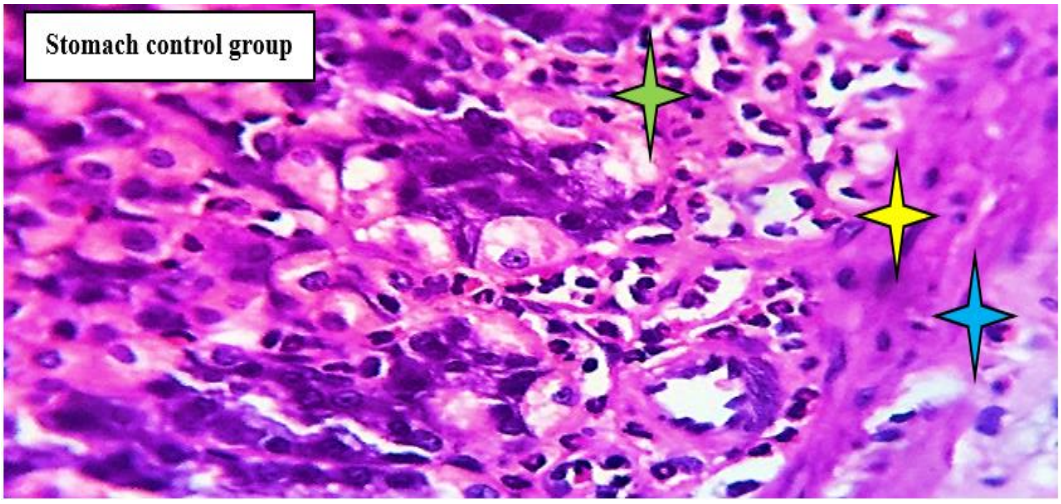

Fig1. Photomicrograph from the stomach of control showing normal mucosa, submucosa and muscular coat (green, yellow and blue stars) .H&E X 100, 200, 400.

When the rats were treated with 5% of Cholorzan 48% insecticide (the first group (G1)), changes and effects appeared in the cells of the three aforementioned gastric layers in the control, where It showed mild submucosal eosinophilia (yellow arrow (G1, 1), along with increased activity of both zymogen (hyperchromatic) and parietal (vacuolated) cells (light blue and black arrows (G1, 2) (Fig. 2).

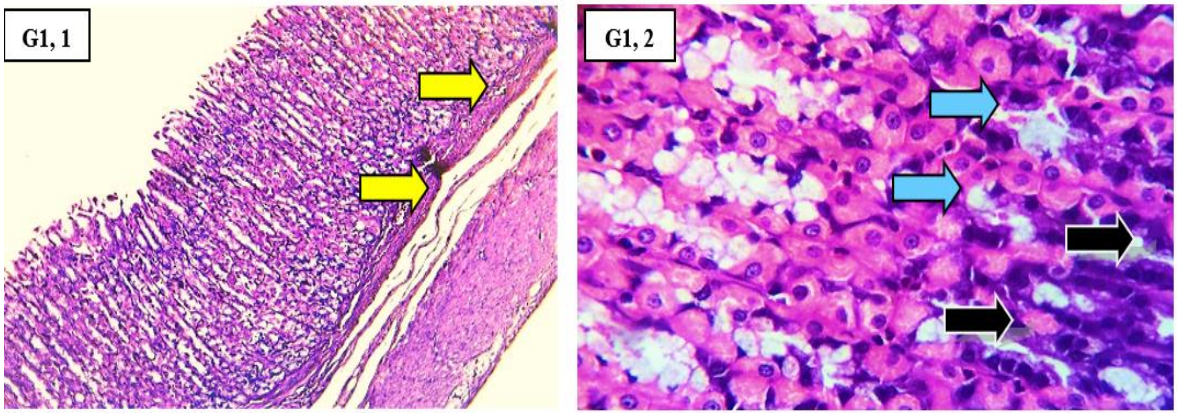

Fig. 2. Photomicrograph from the stomach of G1 showing increased activity of both the zymogene cells (hyperchromatic) and the parietal cells (vacuolated) (light blue and black arrows) beside mild submucosal eosinophilia (yellow arrow). H&EX 100, 200, 400.

Meanwhile, sections from group 2(G2), who were treated with 5% of Nasr Lathion / Cheminova 57% insecticide show glandular proliferation of mucosal lining cells ((G2, 1) green arrows) and proliferation of enzyme cells with cystic changes. (G2, 2) (blue arrows) (Fig.3).

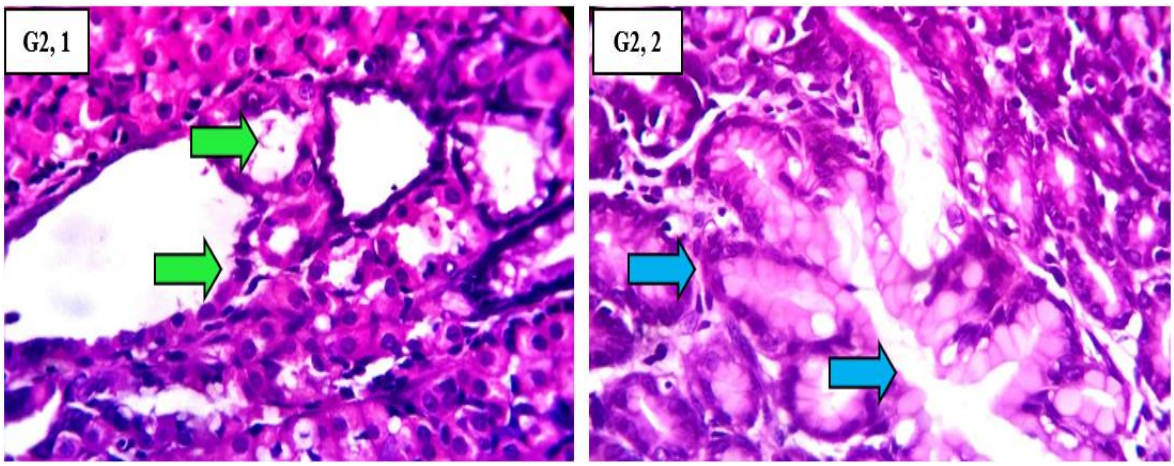

Fig. 3. Photomicrograph from the stomach of G2 showing mucosal lining cells adenomatous proliferation (green arrows) and zymogen cells proliferation with cystic changes. (dark blue arrows). H&EX 100, 200, 400.

El-Shewy *et al*., 2023 indicated that when *Rattus norvegicus* male individuals were treated with 5% of the insecticide Lambda Cyhalothrin, some changes were observed in the mucosal epithelial layer of the stomach, with the appearance of congestion in the mucous vessels, and infiltration in the lymph nodes, and clear inflammation of the stomach also appeared. While males treated with 5% of the insecticide imidacloprid (35%) showed

congestion of the gastric mucosa and glandular vacuoles appeared widespread in the mucous epithelial layer of the stomach.

4-2- Histopathological Findings in the Liver:-

First, anatomical sectioning of normal *R.rattus* male liver tissue shows a normal central vein (brown asterisk), portal zone, and portal blood. Vessels (green star) next to normal liver cells (light blue star) (Fig.4).

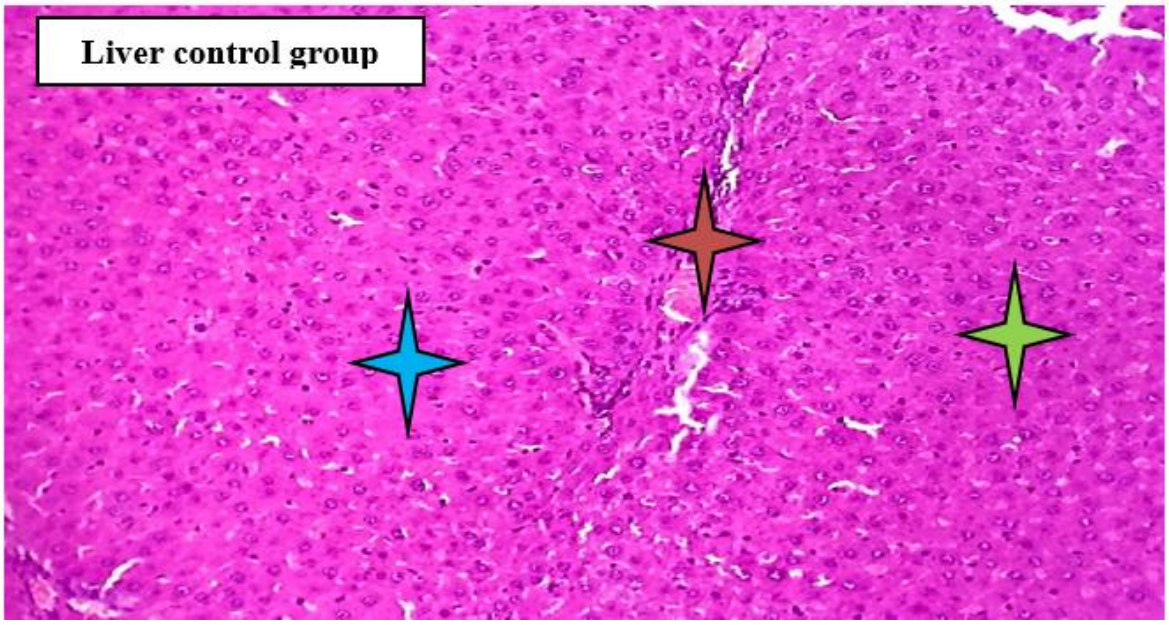

Fig. 4. Normal mouse liver tissue shows a normal central vein (brown asterisk), portal zone, and portal blood vessels (green star) next to normal liver cells (light blue star), H&EX200, 400.

When *R. Rattus* individuals were treated with the insecticide Cholorzan 48% at 5%, some changes appeared in the liver tissue, where bile proliferation occurred ((G1, 1) green arrows), as did obvious hyperplasia of von Kupffer cells ((G1, 2) light blue arrows) (**Fig.5**).

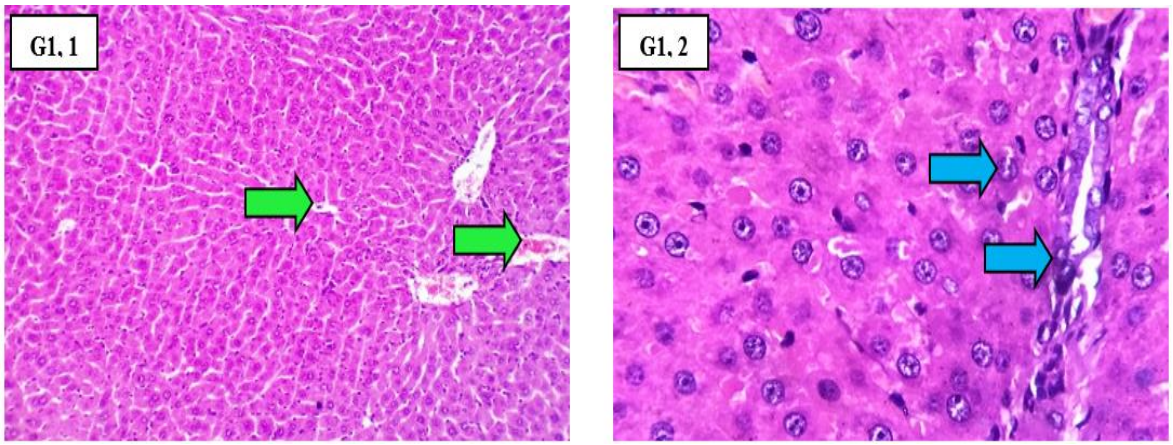

Fig. 5. Bile proliferation occurred (G1, 1) (green arrows), as did obvious hyperplasia of von Kupffer cells (G1, 2) (light blue arrows), H&EX200, 400**.**

There were also significant changes in the liver in the second group (G2) when it appeared in the livers of individuals treated with Nasr Lathion / Cheminova 57% insecticide at a concentration of 5%. Dilatation of blood vessels (red arrows) was seen, as well as congestion and chronic lymphocytic cholangitis (green arrows) (G2, 1). Mild sinusoidal

dilatation, associated with von Kupffer cell atrophy (dark blue arrow), hepatocyte degeneration (yellow arrow), and early necrosis (black arrow) is also seen (G2, 2) **(Fig.6**).

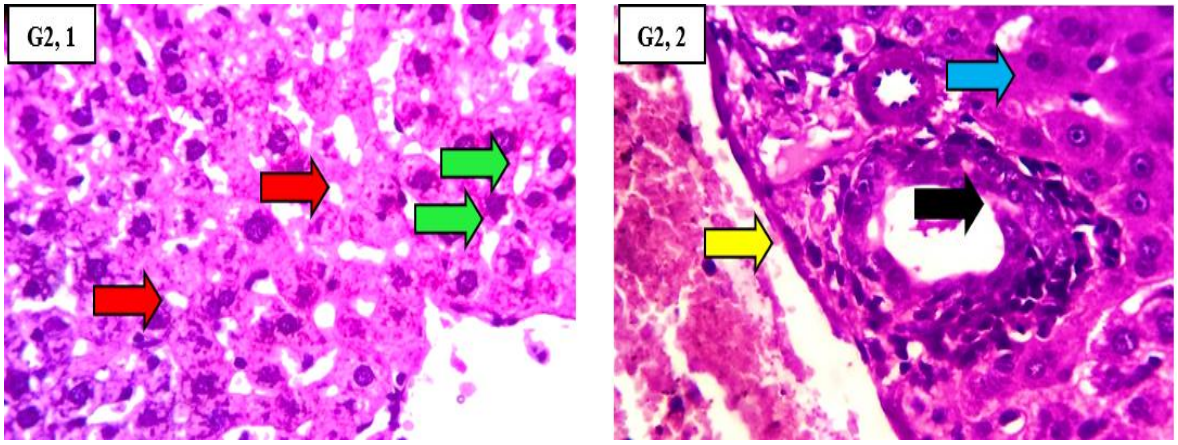

Fig. 6. Shows moderate neovascularization, congestion, and chronic lymphocytic cholangitis (red and green arrows). Mild sinusoidal dilatation, associated with von Kupffer cell atrophy, hepatocyte degeneration, and early necrosis is also seen (dark blue, yellow, and black arrows) H&EX200, 400**.**

The toxicity of five insecticides (abamectin, carbosulfan, fenpropathrin, methomyl and profenofos) was tested on the occurrence of tissue changes in the liver of individuals of male albino rats by Mansour *et al* 2008, and the most important results obtained were that pesticides abamectin and methomyl had the highest effects on the liver tissue of the treated individuals, as abamectin caused dilatation and congestion of the blood vessels of the liver, in addition to degenerative changes Liver cells and the appearance of granules in them, as for the pesticide methomyl, it led to the appearance of areas of necrosis in the liver parenchyma when a mixture of the five pesticides was used, this led to the appearance of proliferation in bile duct cells, degeneration of liver cells, activation of Kupffer cells, and an increase in granules in liver cells.

4-3- Histopathological Findings in the Heart:-

Heart muscle serial sections of the control group revealed apparently normal vascular structures (coronary and intramuscular blood vessels and capillaries), and green stars. The contractile and conducting structures of the heart including the cardiomyocytes and the Purkinje fibers respectively were histo-morphologically normal (blue star). The sarcolemmal cells and the interstitial tissue were in a good histological appearance (Fig.7).

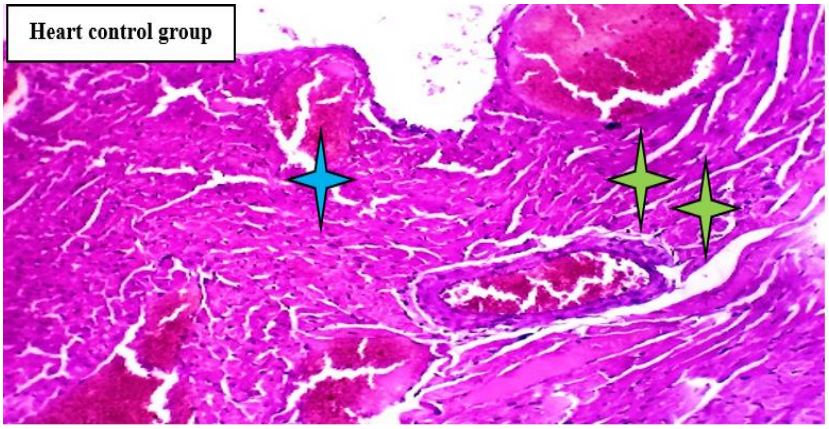

Fig.7. Heart of the control group, showing normal cardiomyocytes, sarcolemma cells, and intercalated spaces (green and light blue stars) H&E X 100, 200, 400.

Figure 8, Confirms the occurrence of myocardial changes in the first group of *R. rattus* treated with 5% Cholorzan and 48% insecticide. The microscopic image (G1- 1 and 2) shows the presence of multifocal myocardial degeneration and early necrosis. (black and green arrows). Signs appear in the coronary arteries, muscular vasodilation, congestion, and bleeding (blue and yellow arrows).

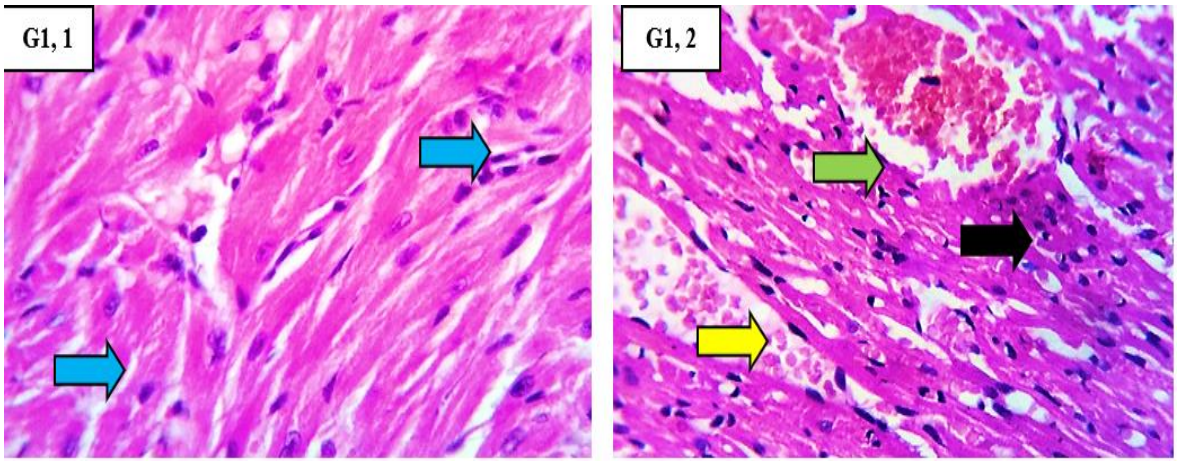

Fig. 8. Photomicrograph from the heart of G1 showing multifocal cardiomyocyte degeneration and early necrosis. (black and green arrows). Marked coronaries and intramuscular vascular dilatation, congestion and hemorrhages are seen (light blue and yellow arrows). H&E X 100, 200, 400.

In the second group (G2) of *R. rattus* who were treated with 5% Nasr Lathion / Cheminova 57%, serious changes were also seen in the heart muscle, such as marked myocardial degeneration (black arrow) and necrosis (green arrow) associated with myosheath proliferation, lymphocytic infiltration and the presence of annischko-like cells. Activated macrophages (yellow arrows) with occasional fibrous proliferation (red arrow). Interstitial edema and atrophy of cardiomyocytes are also seen (blue arrow) G2(1,2) (Fig.9).

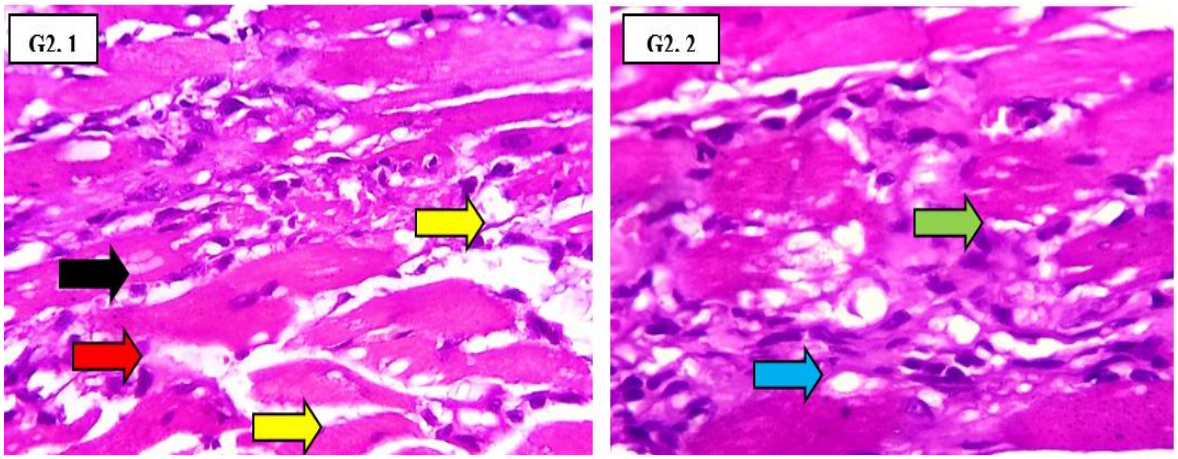

Fig. 9. Moderate to marked myocardial degeneration (black arrow) and necroses (green arrow) associated with sarcolemal proliferation, lymphocytic infiltration and presence of anitschkow-like cells (activated macrophages) (yellow arrows) with occasional fibroblastic proliferation (red arrow) are seen in G1. Interstitial edema and cardiomyocyte atrophy (blue arrow) are also seen. H&E X 100, 200, 400.

Mate *et al* 2010; explained that changes occurred in the heart muscle of the male albino rats treated with the insecticide Lambda Cyhalothrin, as the autopsy of the patients revealed noticeable cardiac changes in rats exposed to 80 mg/kg of this insecticide, as necrosis and degeneration appeared in the heart muscle, spacing between muscle fibers, congestion and obvious bleeding in the heart muscle, and lack of lymphocytes in the spaces surrounding the arteries.

4-4- Histopathological Findings in The Kidney:-

Renal parenchyma and stroma of control negative *R. rattus* rats were normal with keeping features of the nephron units (green star), collecting tubules, papillary and pelvic structures (red star) (Fig.10).

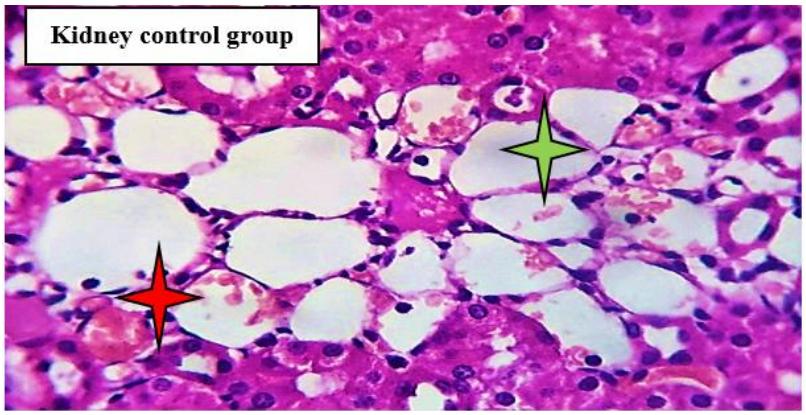

Fig10. Control rat kidneys, glomeruli, and renal tubules (green and red stars) appear normal. H&E X 200, 400**.**

Photomicrograph of G1 (1 and 2) kidney showing mid-glomerular atrophy, shrinkage, and lobulation (green arrow), and degeneration of the tubular epithelium (cloudy swelling and vacuolar degeneration (yellow arrow) along with midglomerular atrophy, telangiectasia, and hemorrhage (red and light blue arrows). This occurred in *R. rattus* individuals treated with 5% Chlorzan and 48% insecticide (**Fig. 11**). On the other hand, the individuals of G2 who were treated with 5% Nasr Lathion / Cheminova 57%, also had histological changes in the kidneys in terms of, glomerulonephropathy (shrinkage and lobulation) (green arrows), tubular epithelial degeneration (cloudy swelling and vacuolar degeneration) (yellow arrow), along with proximal and distal collecting tubular dilatation (red arrows) and mild lymphocytic interstitial nephritis. Also shown (black arrows),(**Fig.12**) (G2- 1 and 2).

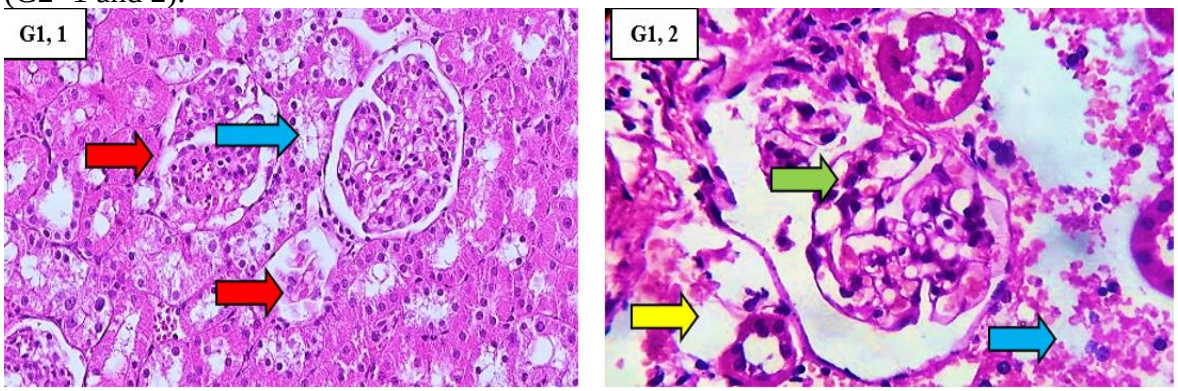

Fig. 11. Photomicrograph from the kidney of G1 showing Moderate glomerular atrophy, shrinkage and lobulation (green arrow), tubular epithelial degeneration (cloudy swelling and vacuolar degeneration (yellow arrow) beside medullary moderate collecting tubular dilatation, capillary dilation and hemorrhages. (red and light blue arrows). H&E X 200, 400.

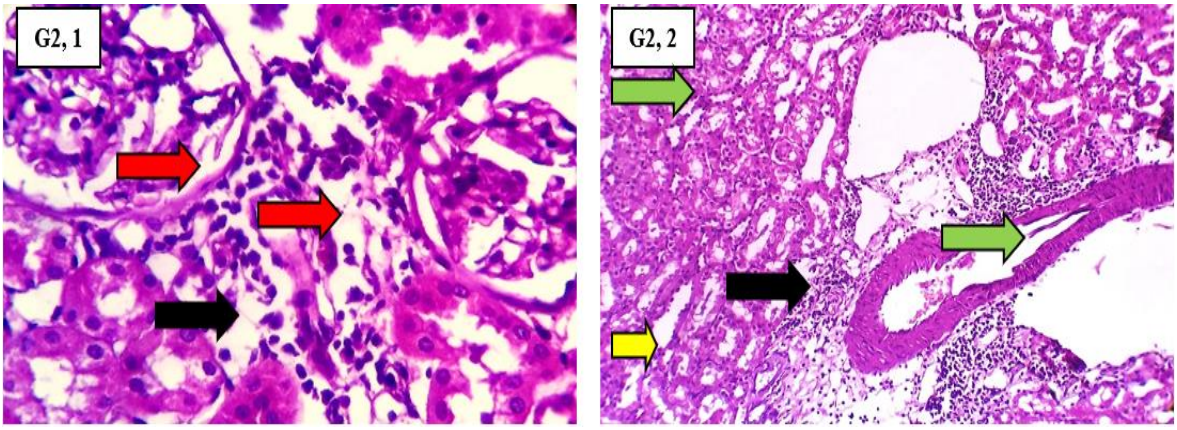

Fig12. Marked glomerulopathy (shrinkage and lobulation) (green arrows), tubular epithelial degeneration (cloudy swelling and vacuolar degeneration) (yellow arrow) beside mild proximal and distal collecting tubular dilatation (red arrows). Additionally, moderate interstitial lymphocytic nephritis is also seen (black arrows) .H&E X 200, 400**.**

Mansour et al 2008 demonstrated the appearance of changes in the kidneys of the individuals of albino rats when it was treated with a mixture of insecticides (abamectin, carbosulfan, fenpropathrin, methomyl and profenofos), as shrinkage occurred in Bowman's capsule and degeneration in the epithelium lining the renal tubules due to obstruction of the lumen. When the pesticides were tested separately, the effect of the pesticide fenpropathrin was very clear, where necrotic changes appeared associated with the desquamation of the tubules lining the renal epithelium. In addition, Rania M. Waheed et al (2011), found that the use of lambda-cyhalothrin as a toxin against male albino rats for four weeks led to some changes histological in the kidneys, where there was cystic dilation of renal tubules, the appearance of lysis by the loss of some renal tubules, a decrease in the number of inflammatory cells, acidic substances and the influx of red blood cells mixed with cellular debris.

Conclusion:

The pesticides Cholorzan (48%), Nasr Lathion (57%), and Cheminova (57%), according to this study, had a toxic effect on *R. rattus*. The observed decrease in body weights and mortality rates was a direct result of these changes in blood chemistry and their evident effects on the liver and kidneys, as well as the obvious histological changes in the tissues of the stomach, liver, heart muscle, and kidneys. Noting that Chlorzan 48% had the highest death rate and the lowest rate of body weight rise, indicating that it had the greatest toxic effect on *R. rattus*.

Declarations:

Ethical Approval: Not available

Competing interests: The authors declare that there are no conflicts of interest.

Authors Contributions: Moamen, A. Elbath; Ghada, R. Mohamed. constructed the experiments, visualized and analyzed the data, and wrote the manuscript; Maha S. Khalil and Hadeer S. A. Rashed edited and revised the manuscript; Moamen, A. Elbath; Ghada, R. Mohamed; Maha S. Khalil and Hadeer S. A. Rashed prepared the methodology and revised the results. All authors have read and agreed to the published version of the manuscript.

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Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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ARABIC SUMMARY

تقييم سمية وفعالية بعض المبيدات الحشرية على الفأر المتسلق *Rattus rattus* تحت ظروف المعمل

مؤمن أحمد البطح - غادة رفعت يوسف - مها سعيد خليل - هدير شوقى عبدالله
قسم وقاية النبات، كلية الزراعة، جامعة بنها، مصر

يعتبر الفأر الأسود المتسلق *Rattus rattus* أحد أنواع الفئران التي تنتشر في البيئات المصرية المختلفة. وله أهمية كبيرة في تقليل القيمة الاقتصادية للغذاء ونقل الأمراض. تم اختبار سمية أربعة مبيدات حشرية (Cholorzan 48% EC، Hachi Hachi 15% EC، نصر لاثيون/كيمينوفا 57% EC وGrab 2.5% EC) بثلاثة تراكيز مختلفة (2.5، 5، 10%) على التغيرات في وزن الجسم ، معدلات الوفيات، وتأثيرها على كل من وظائف الكبد والكلى. وكذلك تم تقييم بعض الدراسات النسيجية في ذكور *R. rattus* . أظهرت النتائج أن الكلورزان 48% سجل أعلى تأثير خلال الدراسات المختلفة، حيث كانت نسبة الزيادة الأسبوعية في وزن الجسم هي الأدنى (5.68 جرام) بعد شهر واحد من المعامله، كما تسبب نفس المبيد الحشري في أعلى معدلات الوفيات حيث وصلت إلى 40% عند التركيز 10%؛ من ناحية أخرى، ارتفعت معدلات ALT، AST، ALP واليوريا بشكل ملحوظ، في حين انخفض مستوى الكرياتينين بشكل ملحوظ. وجاء نصر لاثيون / كيمينوفا 57% في المركز الثاني من حيث تأثيره على أفراد الفئران. تم اختبار سمية المبيدين السابقين بتركيز 5% على التغيرات النسيجية في المعدة والكبد والقلب والكلى في الفار المتسلق؛ كما ظهرت تغيرات نسجية واضحة في المقاطع النسيجية المفحوصة نتيجة المعاملة بهذين المبيدين.