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Behavioral and Histopathological Alterations in (Oreochromis Niloticus) Caused by Cypermethrin Pesticide Exposure

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Abstract:

This study aimed to investigate the effects and toxicity of short term exposes of insecticide Cypermethrin on (Oreochromis niloticus) fish tissues (liver and gills), and fish behavior. Oreochromis niloticus fish were obtained from the fish Hatchery of the department of fisheries and wildlife science. (30) Fish of both sexes were used in this experiment. average weight was (50 -100 g.) fish were divided in to five groups and subjected to Cypermethrin insecticide solution in 4 dosages The first group was exposed to 0.0001ppm, the total amount of solution was 3 ml Cypermethrin insecticide / 30 liter water (D) , second group was exposed to 0.0002ppm, by 6 ml / 30 liter water (B), third group was exposed to 0.0003ppm by 9 ml / 30 liter water(E), The fourth group was exposed to 0.0004ppm, by 12ml/ 30 liter water (A) Results of histology indicates several kinds of damages in all studied organs, in liver showed Focal areas of necrosis, dilation and thrombosis formation in central vain and ruptured hepatocytes and vacuolation, pyknosis and hemorrhages, gills shows sloughing of secondary lamellae and proliferation and damage in the epithelium of gill filaments and congestion in blood vessels of gills filaments and atrophy of secondary lamella Many behavioral observation were notice, rapid swimming and lose of balance were observed in different dosages.

Keywords:

Water Pollution, Insecticide, Fish, Behavior, Health, Risk, Environment

1. Introduction

Contamination of fresh water with a wide range of pollutants has become a matter of concern over the last few decades; information about the biological effects of pollution on the aquatic organism is lacking and show many gaps [1]. Pollution may be defined is the introduction of contaminants into the natural environment that cause

adverse change [12]. Water pollution is the contamination of water bodies. Water pollution affects organisms living there [7]. Water pollution is one of the most serious environmental problems. And it's a major problem in the global context [22]. It is the major source of water born disease and other health problems [16]. Aquatic toxicology is the study of the effects of environmental contaminants on aquatic organisms, such as the effect of pesticides on the health of fish or other aquatic organisms. A pesticide's capacity to harm fish and aquatic animals is largely a function of its toxicity, exposure time, dose rate, and persistence in the environment [11].

Insecticide residues pose a severe threat to our ecosystem because of their greater stability [9]. Although the fact that majority of the US and EU states have posed a ban on their use, Insecticides are still extensively used in developing countries [2]. Since behavior serves as the link between physiological and ecological processes, it may be ideal for studying environmental pollutant effects. Fish are an excellent model in this regard, since many ecologically relevant fish behaviors are easily observed and quantified in a controlled setting [8].The studies on fish behaviors provide a lots of knowledge and information because, any behavior alteration can be related to physiological biomarker in aquatic species [18]. After ingestion through intestine the insecticide is taken into the liver through the portal blood where it is reported to induce number of changes [10,14]. The aims of this research were to study the effects of short term exposes of insecticide Cypermethrin on (Oreochromis niloticus) tissues including: the liver and gills, and to study the effects of insecticide Cypermethrin on the fish behavior and to estimate the experimented fish mortality rate.

2. Materials and Methods

2.1. Samples Collection and Experiments

Adult freshwater fish (Oreochromis niloticus) were obtained from the fish Hatchery of the department of fisheries and wildlife science. Total of (30) adult fish of both sexes were used in this experiment. The average weight of the fish was (50-100 g.) the fish were divided in to five groups and placed in large tanks (30 liter water) with aerated tap water and were fed with commercially pellets. Fish were acclimatized for (15) days. Water temperature was measured using aquarium thermometer and pH values were measured using portable pH meter and Water phosphate was measured using liquid water quality kits. After that fish were subjected to Cypermethrin insecticide solution in 4 dosages as follow:

The first group was exposed to 0.0001ppm (D) The second group was exposed to 0.0002ppm (B) The third group was exposed to 0.0003ppm.(E) The fourth group was exposed to 0.0004ppm (A), the fifth was the control group (C) Any dead fish was dissected for its liver and gills preserved on formalin 10% for histological analysis using normal histological techniques and examined under light microscope.

2.2. Behavioral Manifestation

The observations of the fish behavior were recorded during the experiment.

2.3. Statistical Analysis

The data obtained were analyzed using SPSS software (ANOVA test).

3. Results

3.1. Mortality Rate

No mortality was observed in the control group however, mortality speed increased with the increase of the concentration of Cypermethrin. The concentration at which there the highest percent mortality was 12ml/ 30 liter water, aquarium (A) however the lowest percent was 3 ml Cypermethrin / 30 liter water (D), 100% mortality were caused in the all concentrations during different time.

Table 1. *The number of dead fish in different concentration of the pesticide.*

Concentrations of Cypermethrin ppm	Cumulative mortality				
	Time of exposition				
	15 hours	30 hours	45 hours	55 hours	65 hours
0.0 (control group)	0	0	0	0	0
0.0001ppm			1	1	3
0.0002ppm		1	1	1	2
0.0003ppm		1	1	1	2
0.0004ppm		1	2	2	

Table 2. *The water quality parameters in experiment aquariums M±SD.*

Aquariums/Water parameters	A	B	C Control	D	E
pH	7.1	7.1	7.0	7.1	6.8
Temperature	28.3^0C	26.4^0 C	27.8^0 C	29.4^0 C	28^0 C
Phosphate	0. 5 mg/l	0.25 mg/l	0.25 mg/l	0.25 mg/l	0.5 mg/l

3.2 Behavioral Manifestation

The behavior and condition of the fishes in all aquariums, control and test solutions was noted all the time up to mortality was complete (Figure 1 and Figure 2). Fishes showed marked changes in their behavior when exposed to Cypermethrin in different concentrations. Fishes in the different aquariums showed rapid swimming than in control aquarium. Hyperactivity, loss of balance, rapid swimming, and increased surfacing activity were noted.

Figure 1. *Fish showed loss of balance.*

Figure 2. *Fish showed surfacing activity.*

3.3. Histopathological Results

Liver showed: normal tissues Figure 3, Focal areas of necrosis (FN) as shown in Figure 4, Dilation and thrombosis formation in central vain (CV) as shown in Figure 5 and Figure 6, ruptured hepatocytes (RH) and vacuolation (V) as shown in Figure 7, pyknosis (PY) and hemorrhages Figure 8

Gills showed normal tissues Figure 9 sloughing of secondary lamellae as shown in Figure 10, proliferation and damage in the epithelium of gill filaments as shown in Figure 11 congestion in blood vessels of gill filaments and atrophy of secondary lamella as shown in Figure 12 and Figure 13.

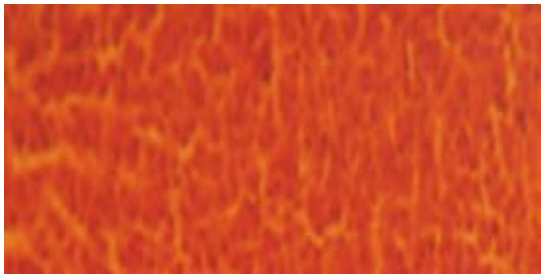

Figure 3. *Normal tissues of liver.*

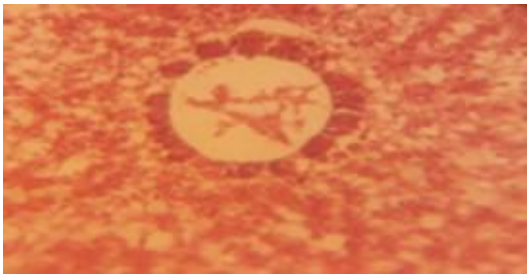

Figure 4. *Focal areas of necrosis.*

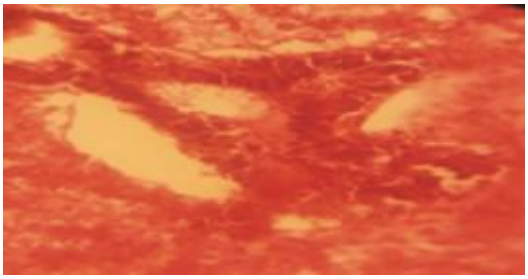

Figure 5. *Dilation and thrombosis formation in central vain.*

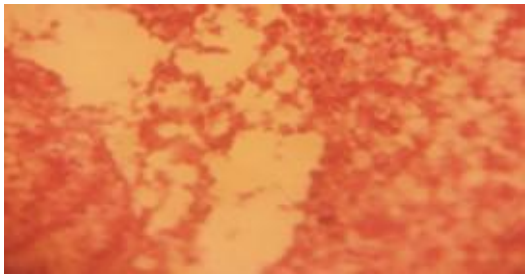

Figure 6. *Dilation and thrombosis formation in central vain.*

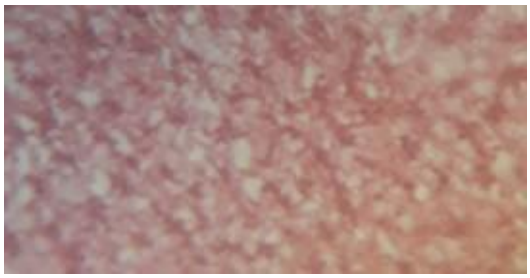

Figure 7. *Ruptured hepatocytes and vacuolation.*

Figure 8. *Pyknosis and hemorrhages.*

Figure 9. *Normal Gills tissues.*

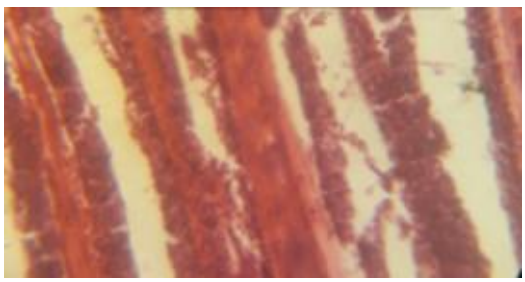

Figure 10. *Sloughing of secondary lamellae.*

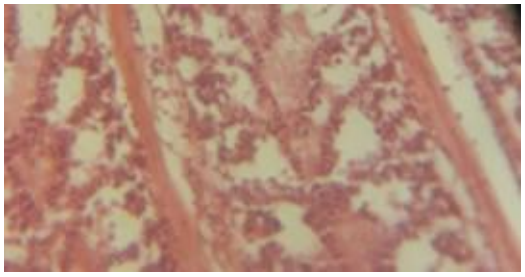

Figure 11. *Proliferation and damage in the epithelium of gill filaments.*

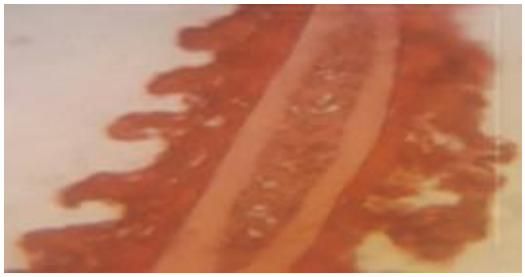

Figure 12. *Congestion in blood vessels of gills filaments and atrophy of secondary lamella.*

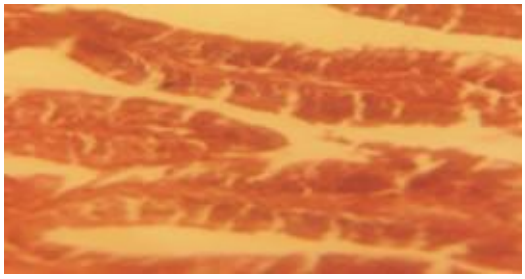

Figure 13. *Congestion in blood vessels of gills filaments and atrophy of secondary lamella.*

4. Discussion

According to the results of the present work, the observations of fish behaviors provide information of toxic effects of Cypermethrin, Swimming performance is considered as behavior parameters to assess the physiological status of fish, behavior alteration can be related to physiological biomarker and water pollutants in aquatic species [18]. In this side the study agreed with [21]. Who study the effects of copper exposure on fish behavior, his result clearly showed that the dependence on the concentration of toxic causes the loss of resistance in the fish swims.

Histopathological alterations consider as important measurement to study the water pollution and toxic effects of pollutants. Histopathological results indicated that gill was the primary target tissue affected by Cypermethrin.

The liver is the main organ for detoxification that suffers serious morphological alterations in fish exposed to pesticides, Alterations in the liver may be useful as markers that indicate prior exposure to environmental stressors. This result was agreed with the observed histopathological alteration like cloudy swelling, focal necrosis, atrophy and vacuolization in the *Corydoras paleatus* exposed to methyl parathion [3]. The effect of pesticides in general on fish liver was described for different species by [17,19]. One of the most important functions of liver is to clean pollutants from the blood coming from the intestine, so it is considered as indicator of aquatic environmental pollution [20]. Similar results were obtained by [4].

Gills are generally considered good indicator of water quality, being models for studies of environmental impact, since the gills are the primary way for the entry of pesticide. In fish, gills are critical organs for their respiratory, osmoregulatory and excretory functions [3]. Gills remain in close contact with the external environment and particularly sensitive to changes in water quality also they are considered the primary target organ of the contaminant [13].The cellular damages observed in the gills in term of sloughing of secondary lamellae as shown in Figure 10, proliferation

and damage in the epithelium of gill filaments as shown in Figure 11 and congestion in blood vessels of gill filaments and atrophy of secondary lamella can adversely affect the respiratory process and osmoregulation process [13], and [15] Alterations like proliferation and damage in the epithelium of gill filaments are examples of defense mechanisms, since; in general, these result in the increase of the distance between the contact environment and the blood and this serve as a barrier to the entrance of pollutants [5,6]. Several studies have indicates similar effects of pesticides on fish gills, the histopathological changes in gills of different fish species exposed to pesticides. For example mucus extrusion, lamellar swelling reduces were shown in blue gill sunfish, *Lepomis macrochirus* exposed to different sub lethal concentrations of diazinon [3].

5. Conclusions

a. Chlorine in water affects Oreochromis niloticus behavior clearly

b. Chlorine in water cause Oreochromis niloticus mortality

c. Many histological impacts were found in the liver and gills of Oreochromis niloticus exposed to different dosage of chlorine.

d. The analysis of observations and tissues from the present investigation evidenced that chlorine is highly toxic and had profound impact on behavior and respiration in Oreochromis niloticus

e. Tap water may contains small amount of chlorine to safeguard our health, which can be harmful to your fish

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

Conceptualization: H.H.A.B.; Formal analysis: H.H.A.B.; Investigation: H.H.A.B.; Data Curation: A.E.; E.A.; K.Y.; Writing – review and editing: H.H.A.B.; Visualization: H.H.A.B.

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