Original Article

Oxidative Stress Evaluation of Lambda-Cyhalothrin and Antioxidant (Vitamin E) on Male Rats

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Abstract

Background: Lambda-cyhalothrin (LCT) is a widely used pyrethroid to control insect pests in agriculture, public health, and homes. **Objectives:** The aim of this study was to evaluate the oxidative stress evaluation of LCT pesticides and and antioxidants (vitamin E) in male rats. **Materials and Methods:** Thirty adult male rats were separated evenly into three groups after 3 weeks of acclimatization as follows: For 12 weeks, group-normal C's feed and water were given to 10 rats. Group T was given LCT at a dose of 0.5 mL per 100 g of body weight for 12 weeks (n = 10 rats) and group E was given (LC + vitamin E) at a dose of 0.5 mL per 100 g of body weight. **Results:** At a results significant increase in malondialdehyde (MDA) level in the T group compared with the E group and C group. Significant decrease of glutathione (GSH) levels in the T group compared with the E group and C group. Macroscopic and microscopic lesions demonstrated atrophy of the kidney in the T group and congestion in the G group while the C group was normal the microscopic lesion of the kidney in the T group multiplied the area of the renal cast at renal tubules with degenerative changes and multiply the area of hemorrhage at the interstitial area but E group show mild degenerative changes in the structure of the renal tubule. It is interesting to note that every modification showed how detrimental LTC is to the kidneys and how vitamin E's antioxidant capacity benefits them. **Conclusions:** Exposure to pesticides continuously creates a health concern, particularly in the agricultural working environment where animal and human life are intertwined. Thus, the study findings demonstrate the impact of LCT on oxidative stress and renal function as well as the antioxidant role of vitamin E.

Keywords: Kidney, lambda-cyhalothrin, rats, vitamin E

Introduction

An imbalance between oxidants and antioxidants causes oxidative stress, which impairs redox signaling and causes target molecules to be modified by oxidation.[1] Increased synthesis of oxidizing species or a considerable decline in the efficiency of antioxidant defenses, including glutathione (GSH), are both linked to oxidative stress.[2] The reactive oxygen species (ROS)-involved (non)-radicals react with cellular macromolecules such as DNA, RNA, proteins, and lipids to cause cellular damage and cell death, according to the oxidative stress hypothesis of disease.[3] The ability of the tissue to protect against oxidative stress like ROS which is caused by free radicals (FR) heavily influences the maintenance of normal cell functioning in the presence of oxygen.[4]

Lambda-cyhalothrin (LCT), a pyrethroid insecticide, is effective against a number of pests. Pyrethroids are now favored over organochlorines and organophosphates due to their great efficacy, low toxicity to species other than the target, and simplicity of biodegradation.[5] They function by interfering with the normal functioning of an organism's neurological system, which can result in paralysis or even death. To combat vectors like mosquitoes, LCT, a stomach and contact pesticide, is sprayed directly over bodies of water[6] and cancer.[7] The defense system's capacity to successfully detoxify and neutralize the surplus ROS oxidative stress is brought on by an imbalance in the physiology of many bodily organs.[8]

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The production, storage, and human health of food were significantly impacted by pesticides.[9] Although pesticides offer advantages, some of them also have disadvantages, such as the potential to be harmful to humans and other desirable species.[10] In society, pesticide residues are often viewed as a substantial danger factor.[11] Pyrethroid insecticides are a subclass of lipophilic esters that include both an alcohol and an acid moiety.[12] Human-made pyrethrins take the form of pyrethroid, which is toxic, adhesive, and incapable of dissolving in water.[13] The body has antioxidant defense systems that are always under attack from damage brought on by FR and ROS.[14] Four tocopherols and four tocotrienols are among the eight fat-soluble components that make up vitamin E.[15] Antioxidant vitamin E, which is fat-soluble, may help shield cell membranes from ROS.[16] Therefore, the main goal of the study must be the effects of vitamin E supplementation as an antioxidant on livestock performance and animal products.[17] The purpose of the current study was to evaluate the long-term toxicity of LCT and the antioxidant capacity of vitamin E in laboratory animals (albino rats).

Materials and Methods

Experimental animals

Thirty male albino rats, aged 3 months or so, were used for the study. The research was carried out at the University of Baghdad's College of Veterinary Medicine, where the animals, whose body weight ranged from 250 to 300 g, were created and nurtured. The animals were kept in cages ($20 \times 30 \times 50 cm^3$) that had a 12-h light/dark cycle, a temperature of 23°C, and a relative humidity range of 45% to 55%. Water and food were available without restriction. After the LCT was dissolved in deionized water, rats were gavaged with either water or the LCT and (LCT + vitamin E). Throughout the study, commercial feed pellets and water were offered; the dosages were selected in agreement with other studies.[18,19]

Experimental design

Thirty male adult rats were employed in this study. Following 3 weeks of acclimatization, they were equally split into two groups. Adult rats were given LTC diluted in distilled water (DW) and vitamin E + LTC orally by gavage needle as follows:

Group-T: administered LCT 0.**5** mL/100 gm body weight (BW) (1/1**5** LD50) orally for 12 weeks (10 rats).

Group E: administered LTC + vitamin E 0.**5** mL/100 gm BW orally for 12 weeks (10 rats).

Group-C: for DW orally for 12 weeks (10 rats).

Preparation of the dose of LCT and vitamin E

LCT is considered moderately toxic via the oral route in tested animals. reports revealed that oral 1/15 LD_{50} values are 81.5 mg/kg for male rats,[20] while the dose of vitamin E used in this study was 40 mg/kg BW.

Malondialdehyde and glutathione analysis

The concentration of MDA in serum was determined according to the Buege and Aust method.[21] For GSH analysis, the serum thiol concentration was measured according to the method described by Erel and Neselioglu.[22]

Histological study of kidney

Samples of the kidney were collected, washed in saline, preserved in 10% neutral buffered formalin, and then handled for the creation of microscopic slices for histological analysis that were 5–6 μm thick.[23]

Statistical analysis

To find the impact of various conditions on research parameters, a program was employed. To statistically compare between means, the least significant difference (LSD) test (analysis of variation) was employed.[24]

Results

Malondialdehyde

MDA concentration in the control and treatment groups. The highest mean value was found in the T group (1.831 ± 0.02), followed by the E group (1.340 ± 0.02), and the C group (1.102 ± 0.01) for 12 weeks shown in Table 1. LTC's impact on MDA was significantly different.

Glutathione

Table 2 shows the GSH concentrations in the control and treatment groups. The lowest mean value was found in the T group (137.60 ± 1.90), followed by the E (194.00 ± 1.12) and the C group (322.20 ± 9.42) for 12 weeks shown in

Table 1: Comparison between different groups in antioxidant level (pg/mL) of rats

Group	Mean ± SE
	MDA (μmol/L)
C	1.102 ± 0.01c
T	1.831 ± 0.02a
E	1.340 ± 0.02b
LSD value	0.048

Means having with different letters in the same column differed significantly. ** $P \leq 0.01$

Table 2: Comparison between difference groups in antioxidant level (pg/mL) of rats

Group	Mean ± SE
	GSH (μmol/L)
C	322.20 ± 9.42a
T	137.60 ± 1.90c
E	194.00 ± 1.12b
LSD value	14.86**

Means having with different letters in the same column differed significantly. ** $P \leq 0.01$

Table 2. LTC influence on GSH showed a difference that was significant.

Histopathology changes

The pathological observation between the three groups is shown in Figures 1–3. The histopathological examination of the treated with LTC shows multiple areas of renal cast at renal tubules with degenerative changes of the kidney shown in Figure 4. Figure 5 shows a histopathological section of the kidney treated with LTC and reveals multiple areas of hemorrhage at the interstitial area of the kidney. Figure 6 shows a histopathological section of the kidney treated with vitamin E shows mild degenerative changes in the structure of the renal tubule.

Discussion

A popular ingredient in pesticides, LCT is a synthetic pyrethroid insecticide that affects a variety of organs.[25] The kidneys in the LCT-treated group had many areas of bleeding in the interstitial area of the kidney, multiple areas of the renal cast in the renal tubules, as well as enlarged glomeruli and degenerative alterations. These findings concur with those of Khaldoun Oularbi[26] who showed that LCT injured the kidneys of mice, rabbits, and rats in a manner similar to what the current findings show. For xenobiotic substances, the kidney is a crucial target organ because these substances cause a range of toxic renal effects on tubular cells and the glomerulus.[27] The majority of pesticides have been demonstrated to cause cell infiltration and inflammation.[28]

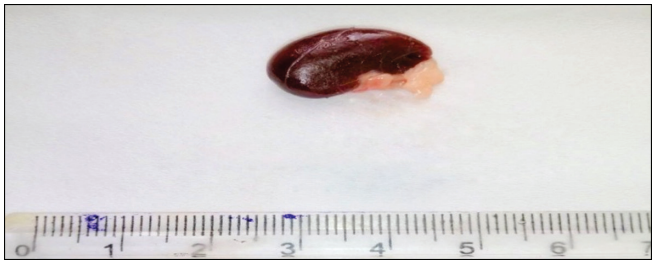

Figure 1: Show normal kidney C group

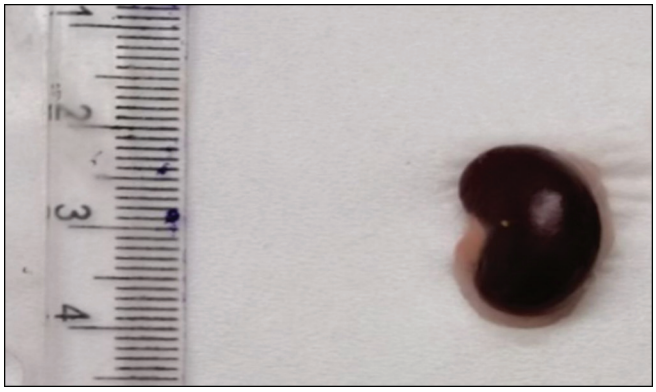

Figure 2: Show mild atrophy and congestion of the kidney in the T group

Tissue damage is assumed to be a probable result of ROS, which induces oxidative damage by damaging proteins, lipids, and DNA.[29] LCT doesn't directly create FR, but it does so indirectly by creating other radicals such as

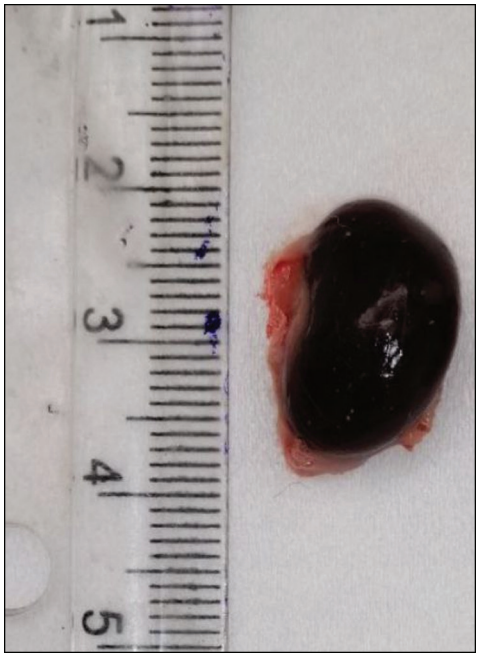

Figure 3: Show dark congested kidney in the G group

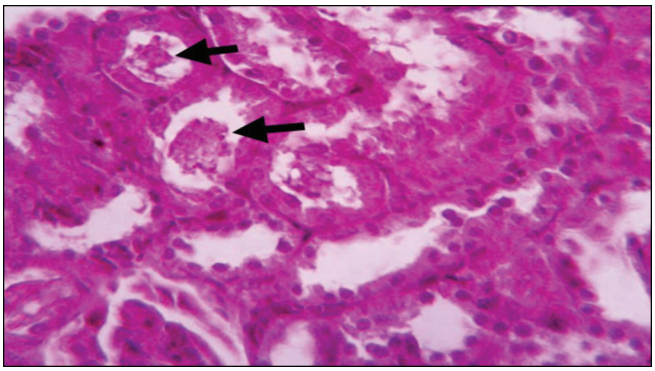

Figure 4: Histopathological section of kidney treated with LTC shows multiple areas of the renal cast at renal tubules with degenerative changes (H&E stain, 40×)

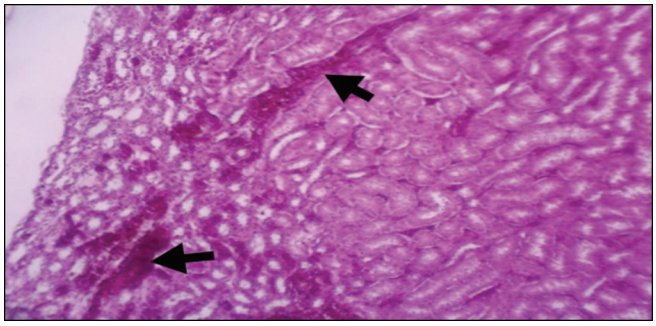

Figure 5: Histopathological section of kidney treated with LTC shows multiple areas of hemorrhage at the interstitial area of the kidney (H&E stain, 40×)

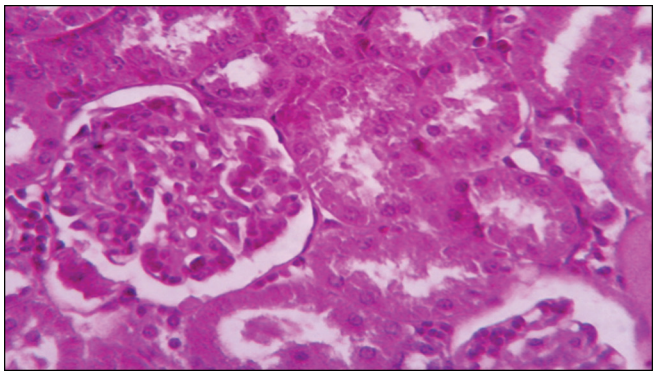

Figure 6: Histopathological section of kidney treated with vitamin E shows mild degenerative changes in the structure of the renal tubule (H&E stain 40×)

superoxide, nitric oxide, hydroxyl, and nitrogen species like peroxynitrite.[30] Damage that is consistent with oxidative stress is the outcome of this. These radicals attack the cell membrane as a result of lipid peroxidation, making it unstable and prone to disintegration.[31,32] This is in line with several studies showing the antioxidant properties of vitamin E, which are crucial to the intracellular defense system. Because of the oxidative stress induced by vitamin deficiency, tissue damage is rising.[33]

Oxidative stress and changes in the antioxidant status system have been linked to pesticides.[34] The mismatch between the formation of ROS and the antioxidative mechanism of radical production led to oxidative stress.[35] In line with this observation, the much lower GSH level in the LTC-treated group may have enhanced the renal tissue's vulnerability to free radical damage. They can produce superoxide anions and hydrogen peroxide during their "redox-cycling" activity, which can lead to oxidative stress, or they can produce ROS by altering the normal antioxidant homeostasis, which depletes the body's supply of antioxidants.[36]

GSH concentrations may have dropped because of inadequate synthesis or non-enzymatic oxidation of GSH to glutathione disulfide (GSSH) in the pesticide-treated rats' livers.[37] The increase in lipid peroxidation products, which can be used to evaluate oxidative stress, in intoxicated rat livers supported the earlier claim.[38]

As FR are hazardous consequence of several metabolic processes in biological membranes, vitamin E, a lipid-soluble antioxidant, protects against oxidative stress and inhibits the generation of lipid peroxides.[39] Vitamin E may have a protective impact against LCT's negative effects on the quality of semen by acting as an antioxidant and lowering LPO potential.[40]

Conclusion

Exposure to pesticides continuously creates a health concern, particularly in the agricultural working environment where animal and human life are intertwined. Thus, the study findings demonstrate the impact of LCT on oxidative stress and renal function as well as the antioxidant role of vitamin E.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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