Vol 5 No 2 June 2024 Pages 30-34 e-ISSN 2708-5694

Journal of Agriculture, Food and Environment (JAFE)

Journal Homepage: https://journal.safebd.org/index.php/jafe

https://doi.org/10.47440/JAFE.2024.5206

Research Article

Histological alterations in the kidney of Nile tilapia (*Oreochromis niloticus*), exposed to Celecron 50EC

Sultana Z[1*], Rahman MH[2*], Rahman UO[3], Aziz MA[4], Mahruf B[2], Mukta SP[5], Romjan AS[5]

[1]Department of Fishery Biology & Genetics, Khulna Agricultural University, Khulna
[2]Department of Aquaculture, Bangladesh Agricultural University, Mymensingh
[3]Department of Marine Fisheries Science, Bangladesh Agricultural University, Mymensingh
[4]Project Co-ordinator of RHL, Ad-din Welfare Centre
[5]Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Araihazar, Narayanganj.

ABSTRACT

Tilapia is widely cultured and most demandable fish species in Bangladesh as well as in the world. The current experiment was undertaken to investigate the histopathological conditions of the kidney of Nile Tilapia, *Oreochromis niloticus* after exposure to the pesticide Celecron 50EC. To determine the impact of histo-architectural changes in the kidney of the studied fish, the fishes were exposed to different sublethal concentrations of Celecron 50EC for 24, 48, 72, and 96 h. The kidneys of the treated groups showed highly deteriorated bowman's capsule, necrosis, impaired renal tubules, pyknosis, vacuolization, damaged hematopoietic tissue, and necrosis. The current study demonstrated that Celecron 50EC harms fish organs.

Article history

Received: 25 March 2024

Revised: 16 May 2024

Accepted: 29 May 2024

Published online: 30 June 2024

***Corresponding author**

Sultana Z, Rahman MH
E-mail: zakiasultana@kau.ac.bd; hamidur.aq@bau.edu.bd

Keywords
Celecron, *Oreochromis niloticus*, Sublethal, Histopathology

How to cite: Sultana Z, Rahman MH, Rahman UO, Aziz MA, Mahruf B, Mukta SP, Romjan AS (2024). Histological alterations in the kidney of Nile tilapia (*Oreochromis niloticus*), exposed to Celecron 50EC. J. Agric. Food Environ. 5(2): 30-34.

INTRODUCTION

Bangladesh is a state bordered by rivers with strong potential for both aquaculture and capture fishing, each of which offers an abundance of resources to increase fishing potential. Bangladesh has a wide variety of aquatic species and a wealth of fishery resources. The proverb "Bengali food is made of fish and rice" (Maache-Bhate Bangali) originated from the fact that fish is a well-known addition to rice in the national diet. The world's fastest-growing food production industry is aquaculture. It supplies half of the world's fish. As the second most farmed fish in the world, tilapia has played a crucial role in the expansion of aquaculture and is able to maintain density. The popular fish that is widely distributed throughout many of the world's nations is tilapia. The Nile tilapia (*Oreochromis niloticus*), Mozambique tilapia (Oreochromis mossambicus), and blue tilapia (Oreochromis aureus) are the three main categories of tilapia species. Out of these three species, O niloticus has been in charge of the substantial rise in tilapia output from freshwater aquaculture globally for many years, accounting for over 83% of all tilapias produced globally (Nasrin *et al*., 2021). Fish and fishery products hold significant nutritional value within the human diet, contributing to approximately 60% of daily animal protein intake (Majumdar *et al*., 2024). Aquaculture has sustained a global growth at present and is expected to increasingly fill the shortfall in aquatic food products (Islam *et al*., 2020). Bangladesh is the biggest deltaic country in the world (Mahmuda *et al*., 2020; Rahman *et al*., 2021; Tandra *et al*., 2019, Rasel *et al*., 2022). Furthermore, the fisheries and aquaculture subsector plays a critical role in reducing the negative impacts of protein shortfall (Baroi *et al*., 2019; Islam *et al*., 2020; Mahmuda *et al*., 2020). Aquaculture is becoming a more significant method of producing fish because of Bangladesh's diminishing natural fisheries resources and expanding human population (Mahmud *et al*., 2021; Nasrin *et al*., 2021; Rahman *et al*., 2021 & Noor *et al*., 2024). As per Mou *et al*. (2023), the fisheries sub-sector contributes 1.24% of the nation's total export earnings, 26.50% of its agricultural GDP, and 3.57% of its overall GDP. A substantial amount of foreign exchange is produced by this enormous output (Biswas *et al*., 2021, Murshed *et al*., 2023). The expansion of aquaculture in Bangladesh has coincided with a rise in the usage of different algae and chemicals (Uddin *et al*., 2020; Rahman *et al*., 2022). Bangladesh is a beloved child of Mother Nature. But pesticides are widely used in agricultural lands to ensure high crop yields by controlling undesired organisms such as weeds, fungi, and insects. Pesticides are biologically active substances that have inherent toxicity based on their components. They are regarded as substantial contributors to diffuse pollution, which may have long-term health consequences in humans (Claeys *et al*., 2011). Pesticides can easily target aquatic organisms like fish, polluting aquatic habitats (Pandey and Singh, 2010). Pesticide residues can easily pollute aquatic habitats via rainfall runoff and air deposition, as well as urban and industrial discharges. Most insecticides end up in rivers, lakes, and ponds (Werimo *et al*., 2009). These chemicals are particularly hazardous to non-target animals in natural habitats near agricultural areas, causing fish death (Rahman *et al*., 2002). Profenofos (PRO) is an organophosphate insecticide used in agriculture to control insects. It was extensively used for selective mite control on cotton, maize, and other vegetables (Sharafeldin *et al*., 2015). The Environment Centre of National Toxicology declared profenofos is a harsh pesticide that has raised concerns due to its potential and dangerous effects (Khan, 2019). Fish have direct contact with pollutants in the water through their gills and body surface. Previously, ultrastructure or histology of the gill and liver were utilized as indicators to determine environmental risk (Gernhöfer *et al*., 2001). Histological research on fish tissues like liver and kidney are a useful tool for toxicological studies (Thophon *et al*., 2003). One of the most popular aquaculture fish in Bangladesh, GIFT (Genetically Improved Farm Tilapia) outgrows commercial strains of tilapia by 60% and exhibits superior survival rates (McAndrew and Majumdar, 1989). Because of its extremely quick development and less expensive source of animal protein, it has become a fish of density. For small-scale producers and customers with limited resources, faster-developing, tougher, and more disease-resistant fish provide numerous advantages. They give farmers a higher return on their investment, and in other nations, tilapia that has been genetically modified has increased national tilapia production costs and lowered buyer prices. The present study intends to assess the toxic effects of profenofos on important organ such as the kidney in *Oreochromis niloticus*.

MATERIALS AND METHODS

The science of histology involves creating stained, microscope-ready sections of preserved tissue on glass slides. These preserved tissues contain bacteria, fungus, and parasites in addition to degenerative processes and anomalies. Hospitals where pathologists and doctors analyze tissue utilize similar techniques to the one used in the histology lab. For many research initiatives, including those in the fields of fish biology, aquatic health, endangered and threatened species, and shellfish biology, histology is a crucial research tool. Numerous plant and animal species have had tissue samples processed by the histology Lab. Our tissue slides are utilized for the assessment of diseases and parasites, the general health of marine species that are significant, and a deeper understanding of the reproductive dynamics of fisheries. A total of 100 healthy and fresh quality Nile Tilapia (*O. niloticus*) with a body weight of an average of 5.7±3.56g and standard length of 7.11±1.32 cm were collected from the local fish farms and reared in the cemented tank. Fish were allowed to acclimatize to the laboratory conditions for two weeks to remove the suspected unhealthy subjects at 23.0-26.0^{0}C. Commercial dry pellets (Krishibid Feed Ltd.) were provided with 38% protein and were fed to the fish twice daily at 8.00 AM and 6.0 PM. Celecron 50EC, an organophosphorus pesticde, was obtained from an authorized pesticide dealer in Mymensingh, Bangladesh, in its original sealed container. The fishes were treated with concentrations of Celecron 50EC to observe the LC_{50} value for 96 h. Based on the result, the LC_{50} value of Celecron pesticide was 3.50 ppm. Each replication had a control group without Celecron treatment. Celecron was added directly to the aquarium water. The aerator was used in the aquarium for 2 h to obtain a homogeneous concentration. Ten fish were transferred into each aquarium. Mortality was recorded 24, 48, 72, and 96 h after exposure to Celecron concentration. Dead fishes were immediately removed.

An experiment was conducted to investigate the impact of sub-lethal Celecron dosages on the kidney of Nile tilapia. Before starting the experiment, all aquaria were cleaned and filled with dechlorinated tap water. The experiment included three treatments, each with three replications. Three groups of fish were treated to a tenth of the pesticide Celecron for 24, 48, 72, and 96 hours. Celecron was not used in the control aquarium. Ten fish were moved to each aquarium and kept for 7 days. Water and pesticides were changed at 24-hour intervals daily. Before sampling, the fish were carefully collected and anesthetized with clove oil (5 mg/L). The liver and kidney were taken immediately after decapitation and stored in 10% formalin. The samples were fixed and embedded in paraffin wax, cut with a microtome machine, and stained with hematoxylin and eosin.

RESULTS AND DISCUSSION

The normal structure of kidney cells was seen in the case of controlled fish (Fig 1). The kidney helps to maintain body homeostasis. The nephron is the functional unit of the kidney which consists of a Renal Corpuscle (RC) and a Renal Tubule (RT). The renal corpuscle of nephron consists of the glomerulus (G) and Bowman's capsule (BC). The renal tubule also includes proximal, distal, and collecting tubules. Hematopoietic Tissue (HT) in tubule interstices consists of round to polygonal cells with hyperchromatic nuclei (Iqbal *et* *al*., 2004). In this study, fish kidneys showed changes such as pyknosis (p), necrosis (N), impaired renal tubules (IRT), vacuolation (V), damaged bowman's capsule (DBC), damaged glomerulus (DG) and damaged haematopoietic tissue (DHT) following exposure to celecron after 24, 48, and 72 h (Fig. 1, 2, 3, 4 and 5). The abnormalities increased with the increasing concentrations of Celecron. Similar findings have been found in common carp (*Cyprinus carpio*) after exposure to sub lethal dose of malathion (Sharmin *et al*., 2015). When the fish were exposed to quinalphos for 24 hours, the kidney developed degenerative alterations, including dilated glomeruli and Bowman's capsule. After 48 hours of exposure, hemopoietic tissues showed significant degenerative alterations infresh water fish, Anabas testudineus (Aswin *et al*., 2016). Sub-lethal Quinalphos 25EC exposed kidney sections showed several alterations such as degeneration of renal corpuscles, vacuolization, highly degenerated and distended kidney tubules and hematopoietic tissue, changes in the nucleus structure, mild to severe necrosis and hemorrhage in Silver barb (*Barbonymus gonionotus*) (Mostakim *et al*., 2014). Gross changes included irregular diameters of renal tubules, glomerular expansion, renal corpuscle damage, severe degeneration in the tubules cells, in addition to the infiltration of edematous fluid between the tubules, hemorrhage, and diffusion of the erythrocytes in the interstitial fluid was found in *Tilapia zilli* after exposure to aluminum (Hadi and Alwan 2012).

Histopathology of the kidney of *Oreochromis niloticus*

Histology allows for the comparison of healthy tissue shape or structures with those of diseased fish, making it a valuable diagnostic tool for fish diseases. However, appropriate specimen processing and a certain level of histopathological competence are necessary for accurate identification and confirmation of alterations linked to illnesses. The four main categories of tissues are neural, muscular, connective, and epithelial. Typically, an organ is a mix of these four tissue types. It is crucial to keep in mind that an organ's structure or histology is always connected to the function it serves.

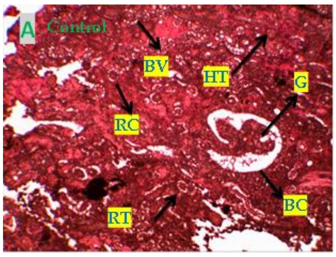

Figure 1. Kidney section of *Oreochromis niloticus* (Control); Arrowheads are indicating Blood vessel (BV), Renal tubules (RT), Renal corpuscle (RC), Glomerulus (G), Bowman's capsule (BC), Haematopoitic tissue (HT).

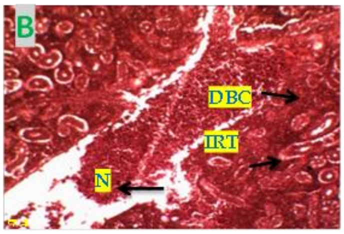

Figure 2. Kidney section of *Oreochromis niloticus* after 24 h exposed to Celecron 50EC; Arrowheads are indicating Necrosis (N), Impaired kidney tubules (IRT), Damaged Bowman's capsule (DBC).

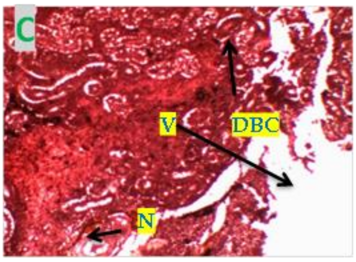

Figure 3. Kidney section of *Oreochromis niloticus* after 48 h exposed to Celecron 50EC; Arrowheads are indicating Necrosis (N), Vacuolation (V), Damaged Bowman's capsule (DBC).

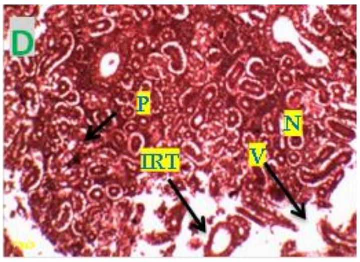

Figure 4. Kidney section of *Oreochromis niloticus* after 72 h exposed to Celecron 50EC; Arrowheads are indicating Pyknosis (P), Necrosis (N), Impaired kidney tubules (IRT), Vacuolation (V).

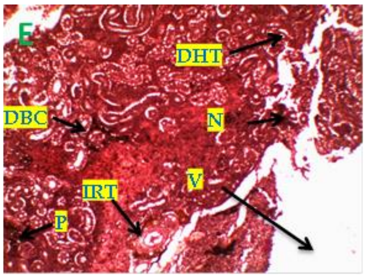

Figure 5. Kidney section of *Oreochromis niloticus* after 96 h exposed to Celecron 50EC; Arrowheads are indicating Pyknosis (P), Necrosis (N), Impaired kidney tubules (IRT), Vacuolation (V), Damaged Bowman's capsule (DBC), Damaged Haematopoietic Tissue (DHT).

CONCLUSION

Tilapia is one of the most significant freshwater fish species in our nation and has a bright future ahead of it in terms of commercial development. One very remarkable source of protein is tilapia. The present study has indicated the histology of kidney in the Nile Tilapia, *Oreochromis niloticus* on exposed to Celecron 50EC for short term period. It is concluded that proper care should be taken to minimize the dose of the pesticide. We should be careful about using the pesticide on agricultural lands. Using pesticides indiscriminately can cause bioaccumulation and magnification in humans and other vertebrates, resulting in significant alterations in histology and physiology. By using this research findings the fish farmers and hatchery owner can identify the disease and abnormalities of fish easily.

Acknowledgements

The authors thank the Department of Fisheries Biology and Genetics, Department of Aquaculture, Bangladesh Agricultural University for their technical support for conducting this research. The authors also grateful to Khulna Agricultural University for supporting this research.

REFERENCES

Aswin B, Binu Kumari S, Ravisankar S, Mohan Kumar M, Ambikadevi AP and Drishya MK 2016: The effect of quinalphos on histopathological changes in the Kidney of fresh water fish, *Anabas testudineus*.

Baroi B, Rahman MH, Rohani MF, Hossain MS 2019: Effect of dietary vitamin C on growth and survival of GIFT Tilapia. *Journal of Agriculture & Rural Development* **11**(2):37-42.

Biswas C, Soma SS, Rohani MF, Rahman, MH, Bashar A, & Hossain MS 2021: Assessment of heavy metals in farmed shrimp, *Penaeus mono*don sampled from Khulna, Bangladesh: An inimical to food safety aspects *Heliyon*. 7e06587

Claeys WL, Schmit JF, Bragard C, Maghuin-Rogister G, Pussemier L and Schiffers B 2011: Several Belgian consumer groups were exposed to pesticide residues through fresh fruit and vegetable consumption. Food Control, **22**(3-4), 508-516.

Gernhöfer M, Pawert M, Schramm M, Müller E and Triebskorn R 2001: Ultrastructural biomarkers as tools to characterize the health status of fish in contaminated streams. *Journal of Aquatic Ecosystem Stress and Recovery*, **8**, 241-260.

Hadi A and Alwan SF 2012: Histopathological changes in gills, liver and kidney of fresh water fish, *Tilapia zillii*, exposed to aluminum. *International Journal of Pharmacy & Life Sciences*, **3**:11.

Iqbal F, Qureshi I Z and Ali M 2004: Histopathological changes in the kidney of common carp, Cyprinus carpio following nitrate exposure. *J. res. Sci*, **15**(4), 411-418.

Islam MM, Rohani MF, Rahman MH, Tandra TS, Alam M, Hossain MS 2020: Suitability and efficacy of potato as prebiotic compound on the growth performance of rohu (*Labeo rohita*). *Journal of Agriculture, Food and Environment (JAFE)* **1**(1) 20-25.

Khan MP 2019: Effects of profenofos, an organophosphate pesticide, on the hematological parameters of nile tilapia (*Oreochromis niloticus*).

McAndrew BJ, Majumdar KC 1989: Growth studies on juvenile tilapia using pure species, hormone-treated and nine inter specific hybrids. *Aquaculture of Fisheries Management* **20**:35-47.

Mahmuda M, Rahman MH, Bashar A, Rohani MF, & Hossain MS 2020: Heavy metal contamination in tilapia, *Oreochromis niloti*cus collected from different fish markets of Mymensingh District. *Journal of Agriculture, Food and Environment (JAFE)* **1**(4) 1-5.

Mahmud MT, Rahman MM, Shathi AA, Rahman MH & Islam MS 2021: Growth variation of tilapia (*Oreochromis niloticus*) with variation of environmental parameters. *Journal of Agriculture, Food and Environment (JAFE)* **2**(2) 75-79.

Majumdara BC, Chowdhury A, Ahammad B, Rasul MG, Rabbi RHM, Rahman MH, Anny F, Rahman MZ, Mia R 2024: Effects of ice storage on post-mortem quality changes and shelf life of Hilsa, *Tenualosa ilisha* (Hamilton, 1822) in Bangladesh. *Journal of Stored Products Research* **107** (102344) 1-8

Mou AT, Uddin MT, Rahman MH 2023: Empirical assessment of species vulnerability for biodiversity conservation: A case study on Chalan beel of Bangladesh. Heliyon. 9 e15251

Mostakim GM, Mishu MM, Rahman MK and Islam MS 2014: Chronic toxicity of organophosphorous pesticide Quinalphos 25EC and its effects on the morphological alterations in the kidney and livers of Silver barb (*Barbonymus gonionotus*). In *Proceedings of 5th International Conference on Environmental Aspects of Bangladesh [ICEAB 2014]*.

Murshed S, Rahman MH, Mahruf B, Najmunnahar, Mostakima S, Hossain MS 2023: Impact of silica nanoparticles on the digestibility and growth efficiency of rohu (*Labeo rohita*). *Journal of Agriculture, Food and Environment (JAFE)* **4**(4) 24-30.

Nasrin S, Rahman MH, Awal MR, Das M, Hossain MS & Sarker F 2021: Effect of feeding frequency on the growth of GIFT (*Oreochromis niloticus*). *International Journal of Fisheries and Aquatic Studies* **9**(2) 98-107.

Noor MNJ, Romjan AS, Hossain MS, Habib MAB, Mahruf B, Rahman MH 2024: Low-cost spirulina manufacturing technique by using supernatant of digested rotten ladies finger (*Abelmoschus esculentus*). *Journal of Agriculture, Food and Environment (JAFE)* **5**(1) 30-36.

Pandey VC and Singh N 2010: Impact of fly ash incorporation in soil systems. Agriculture, ecosystems & environment, **136**(1-2), 16-27.

Rahman MZ, Hossain Z, Mollah MFA and Ahmed GU 2002: Effect of Diazinon 60 EC on *Anabas testudineus*, *Channa punctatus* and *Barbodes gonionotus*.

Rahman MH, Rahman UO, Akter F, Baten MA, Uddin MA, Bhuiyan ANMRK and Mou AT 2021: Physico-chemical properties of digested rotten potato (*Solanum tuberosum*) used as a production medium of spirulina (*Spirulina platensis*). *Journal of Agriculture, Food and Environment (JAFE)* **2**(4):52-58.

Rahman MH, Mahmud MT, Hossain MS, Mou AT, Sarker F and Rahman UO 2021: Variation of production performance of Gulsha (*Mystus cavasius*) monoculture with variation of water and soil quality parameters. *Journal of Agriculture, Food and Environment (JAFE)*, **2**(4):59-64

Rahman MH, Khan ANMAI, Habib MAB, Hossain MS 2022: Evaluation of Sugar Mill By-product Molasses as a Low Cost Culture Media for Microalgae. *Aquaculture Studies*, **22**(4) AQUAST776.

Rasel S, Rahman MH, Akter R, Jinia MN, Habib MAB, Ferdous Z 2022: Assessment of growth parameters of spirulina (*Spirulina platensis*) using digested rotten mango (*Mangifera indica*) supernatant as a cost-effective culture media. *Malaysian Journal of Sustainable Agriculture* **6**(2) 117-123.

Sharafeldin KM, Abdel-Gawad HA, Ramzy EM, Sweilum MA and Mossad MN 2015: Bioaccumulation of profenofos and its impact on hematological parameters of Nile tilapia, *Oreochromis niloticus* (Linnaeus, 1758). Int J Aquatic Sci., **6**(2):48–59.

Sharmin S, Shahjahan M, Hossain MA, Haque MA and Rashid H 2015: Histopathological changes in liver and kidney of common carp exposed to sub-lethal doses of malathion. *Pakistan Journal of Zoology*, **47**(5).

Tandra TS, Rohani MF, Rahman MH, Islam MM, and Hossain MS 2019: Suitability and efficacy of potato as prebiotic on the growth performance of catla (*catla catla*). *Bangladesh. Journal of Fisheries* **31**(2) 221-227.

Thophon S, Kruatrachue M, Upatham E S, Pokethitiyook P, Sahaphong S and Jaritkhuan S 2003: Histopathological alterations of white seabass, Lates calcarifer, in acute and subchronic cadmium exposure. *Environmental pollution.*, **121**(3), 307-320.

Uddin MA, Hassan R, Halim KMA, Aktar MNAS, Yeasmin MF, Rahman MH, Ahmed MU & Ahmed GU 2020: Effects of aqua drugs and chemicals on the farmed shrimp (*Penaeus monodon*) in southern coastal region of Bangladesh. *Asian Journal of Medical and Biological Research* **6**(3) 491-498.

Werimo K, Bergwerff AA and Seinen W 2009: Aquat. Ecosys. Hlth. Manage., **12**:337-341.