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Histological Alterations of Gill, Liver and Kidney of Black-Chinned Tilapia *Sarotherodon melanotheron* Contaminated by Heavy Metals from Bietri Bay in Ebrie Lagoon, Cote d'Ivoire

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Abstract: ***Histological changes in gills, liver and kidney were used to evaluate the health of Black-Chinned Tilapia Sarotherodon melanotheron obtained from Bietri Bay in Ebrie Lagoon during February 2008 and January 2009. Several histological alterations were observed in the gills, including proliferation in the epithelium of gill filaments and secondary lamellae, proliferation of mucous cells, cyst at the top of secondary lamellae, dilation and congestion in gill filaments blood vessel, atrophy of secondary lamellae, lamellar disorganization with focal fusion and hyperplasia of the epithelial cells and between secondary lamellae. The liver showed dilation in cells hepatic, focal areas of necrosis, cells hepatic degeneration, vacuolar degeneration with infiltration of lipid, blood vessels degeneration, hemorrhage and severe dilation in liver cells. In the kidney, the pathological alterations included vacuolization, dilation in renal cells, severe dilation with renal cells degeneration, hemorrhage, parasitic cyst, vacuolar degeneration in the epithelium of renal tubules, parasites, dilation in renal blood vessels and cyst. It was concluded that the environmental contamination of Bietri Bay induced several histopathological alterations in the tissues of Sarotherodon melanotheron.***

Keywords: *Sarotherodon melanotheron*, Histopathology, Tissues, Bietri Bay.

1. Introduction

Heavy metals are dangerous to aquatic organisms and it can be bioaccumulated in the food chain leading to diseases in humans. Cumulative effects of metals or chronic poisoning may occur as a result of long term expose even to low concentrations [1]. The accumulation of heavy metals conditions depending upon the species, environmental conditions and inhibitory processes [2]. Bietri Bay is one of the principal bays of Ebrie Lagoon. The quality of water and sediment within this ecosystem has been gradually degraded due to the discharges of mostly untreated industrial waste and domestic sewage [3]. Contaminants include heavy metals that can be taken up by fish. The most toxic ones such as Pb, Hg, Cu and Cd have been subjects of ecotoxicological research for a long period of time [4]. Histopathological alterations can be used as indicators for the effects of various anthropogenic pollutants on organisms and are a reflection of the overall health of the entire population in the ecosystem. The ingestion of these contaminants may affect not only the productivity and reproductive success of these organisms, but ultimately affect the health of man that depends on these organisms as a major source of protein. Black-chinned Tilapia *Sarotherodon melanotheron* is an important commercial species and is also one of the most consumed fish in Ivory Coast. Considering the human health risk due to the consumption of fish, the concentration of heavy metals (Hg, Cd, Pb, Cu and Zn) are investigated in water, sediments and different tissues of *Sarotherodon melanotheron* collected from the Bietri Bay [3]. The fish was examined for metal constituents are the basis on the human nutrition in the study area. This study provides an insight into the potential impact of increased levels of metals in the environmental as well as estimated of the contaminated of fish tissues.
The aim of the present study was to determine histological changes in gills, liver and kidney of commercially important fish, Black-Chinned Tilapia *Sarotherodon melanotheron* obtained from Bietri Bay in Ebrie Lagoon.

2. Materials and Method

All samples of fish were collected monthly in Bietri Bay (05°16 N–03°58 W, Figure1.0) from February 2008 until January 2009. The Bietri Bay which is one of the principal bays of Ebrie Lagoon draining an important discharge from industrial factories. Moreover, due to heavy industrial activities and some other small factories in the region, the Bietri Bay receives large quantities of untreated industrial and domestic sewage. Therefore, it is one of the most polluted coastal waters of Ivory Coast. Meanwhile the Bietri Bay has an economical importance for fishery. Thus, contamination in the Bay is an important issue regarding the health of the aquatic animals

A total of 300 fish specimens (5 samples from each square, roughly about 25 samples collected monthly) were caught with a gill net by professional fishermen and transferred alive in a cooled ice box (4°C) to the laboratory. Various attributes, species, weight, length, and sex of each fish were recorded. Pieces of gills, liver and kidney were excised, rinsed in physiological saline and fixed in aqueous Bouin´s fluid for 24 hours. The tissues were dehydrated in an ethyl alcohol series of ascending concentrations, embedded in paraffin and sectioned at 5 mm. Sections were deparaffinized in xylene, hydrated in ethanol and stained

with hematoxylin – eosin (HE) method and approximately 2 – 3 sections of each individual fish were analyzed by light microscope.

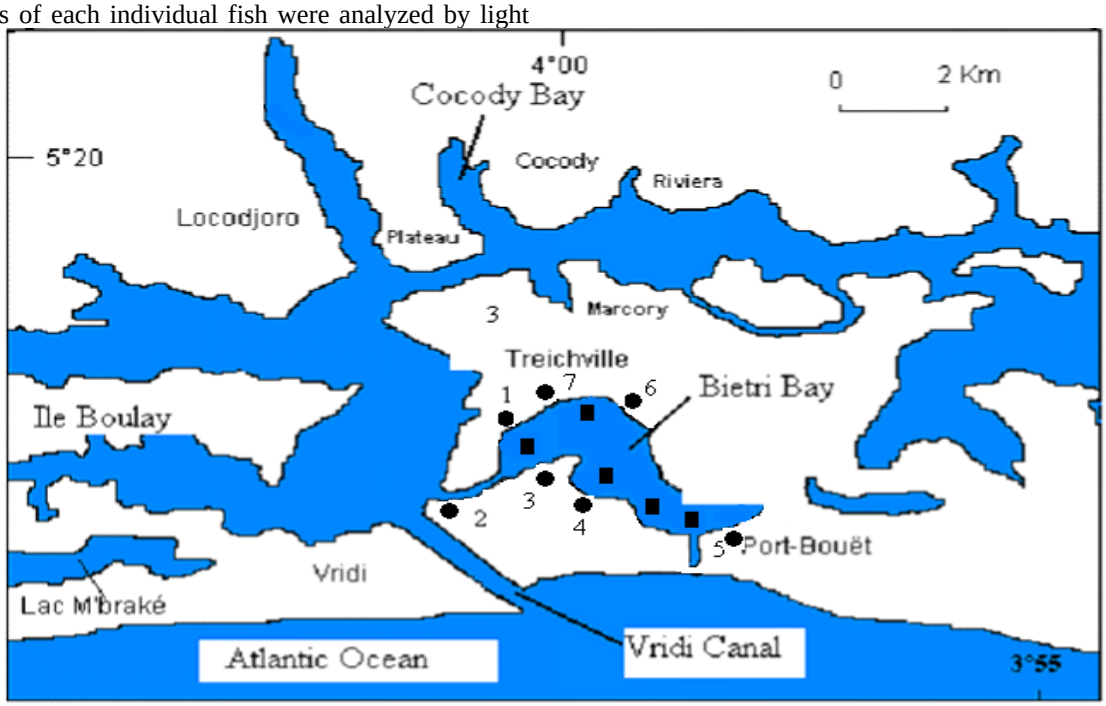
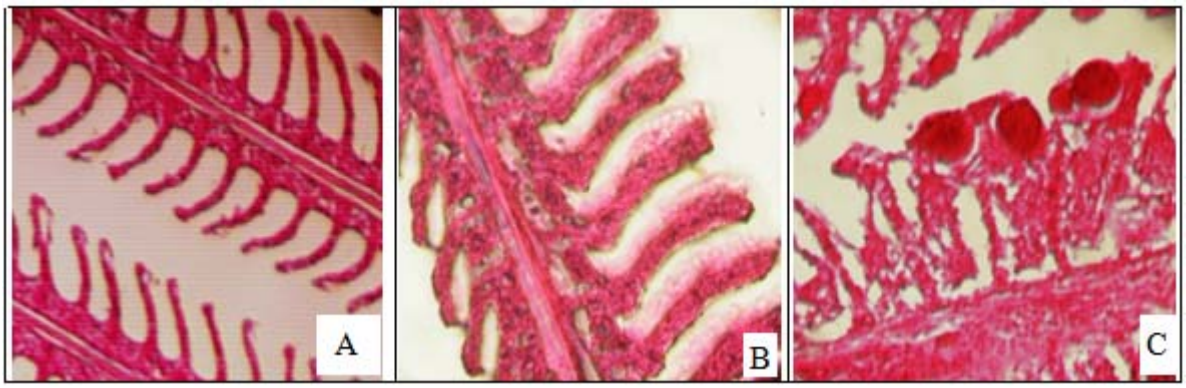


Figure 1: Location of sampling sites (■) in Biétri Bay, Ebrié Lagoon, Ivory Coast
Industrial factories: 1 Unilever; 2 SHELL; 3 Village of fishermen; 4 SIR; 5 Slaughterhouse; 6 SIVOA; 7 Marina.

3. Results and Discussion

3.1. Gills

Figure 2.A shows the normal histological structures of the gills. In all the gills samples, 98% present deteriorations. Several histological alterations were observed in the gills. The commonest anomalies were included proliferation in the epithelium of gill filaments and secondary lamellae (Figure 2.B). Cyst at the top of secondary lamellae, dilation and congestion in gill filaments blood vessel were observed (Figure 2.C). Atrophy of secondary lamellae was seen (Figure 2D). Also, gill alterations included proliferation in the epithelium of gill filaments and secondary lamellae, resulting in lamellar disorganization with focal fusion and hyperplasia of the epithelial cells and between secondary lamellae (Figure 2.E, F).



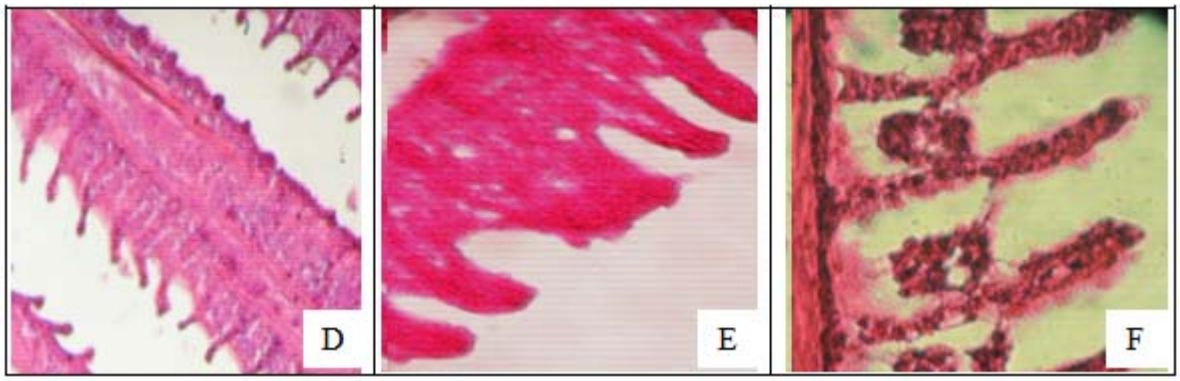


Figure 2: Gill histopathology of *Sarotherodon melanotheron* from Bietri Bay in Ebrie Lagoon. A normal gill (HE, 150×); B proliferation in the epithelium of gill filaments and secondary lamellae (HE, 150×); C Cyst at the top of secondary lamellae, dilation and congestion in gill filaments blood vessel (HE, 200×); D Atrophy of secondary lamellae (HE, 150×); E lamellar disorganization with focal fusion (HE, 200×); F hyperplasia of the epithelial cells and between secondary lamellae (HE, 150×).

3.2. Liver

Figure 3.A shows the normal histological structures of the liver. In all the liver samples, 80% present deteriorations. The most common lesions in the liver of *Sarotherodon melanotheron* were dilation in cells hepatic, focal areas of necrosis and cells hepatic degeneration (Figure 3.B, C). Also, vacuolar degeneration with infiltration of lipid (Figure 3.0D), blood vessels degeneration (Figure 3.E) were observed. Moreover, hemorrhage and severe dilation in liver cells were noticed (Figure 3.F).

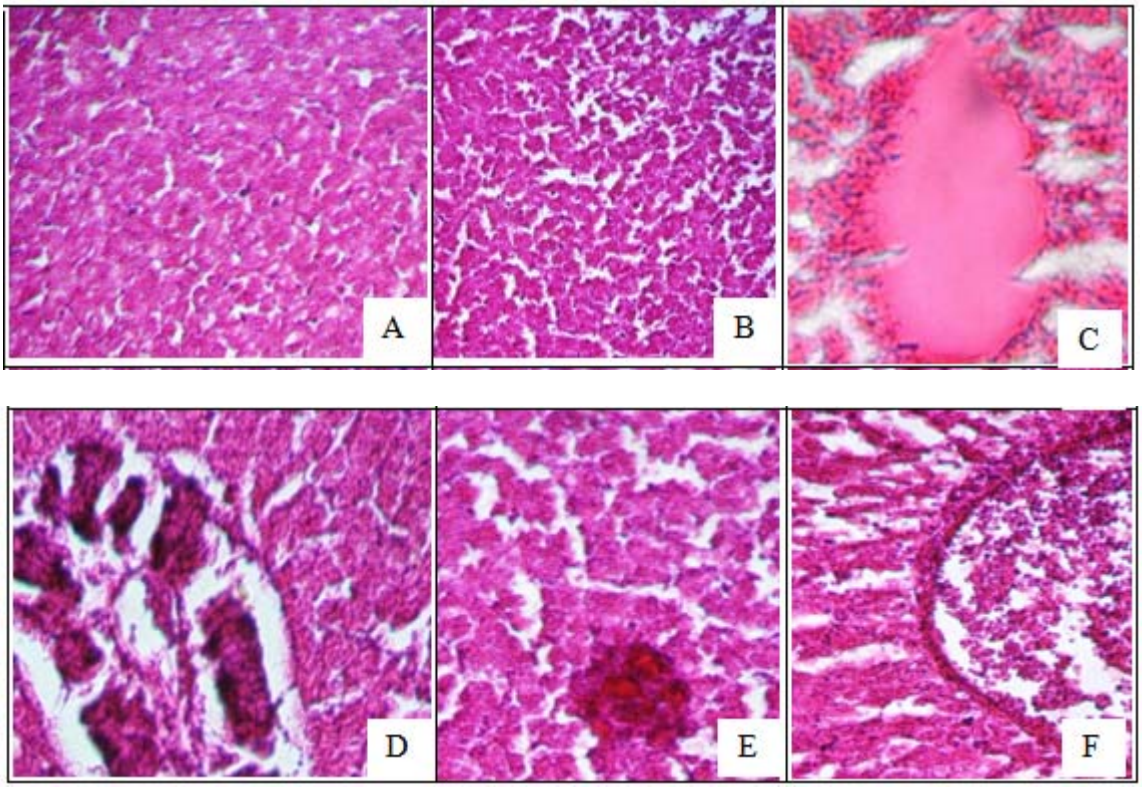


Figure 3: Liver histopathology of *Sarotherodon melanotheron* from Bietri Bay in Ebrie Lagoon. A normal Liver (HE, 150×); B dilation in cells hepatic (HE, 150×); C focal areas of necrosis and cells hepatic degeneration (HE, 200×); D vacuolar degeneration with infiltration of lipid(HE, 200×); E blood vessels degeneration (HE, 150×); F hemorrhage and severe dilation in liver cells (HE, 200×).

3.3. Kidneys

Figure 4.A shows the normal histological structures of the Kidneys. In all renal samples 74% of renal samples, vacuolization, dilation in renal cells, severe dilation with renal cells degeneration, hemorrhage, parasitic cyst, vacuolar degeneration in the epithelium of renal tubules, parasites, dilation in renal blood vessels and cyst were observed (Figure 4.0). Among these pathologies, the dilation of the cells and the cysts are most frequently observed (Figure 4.0).

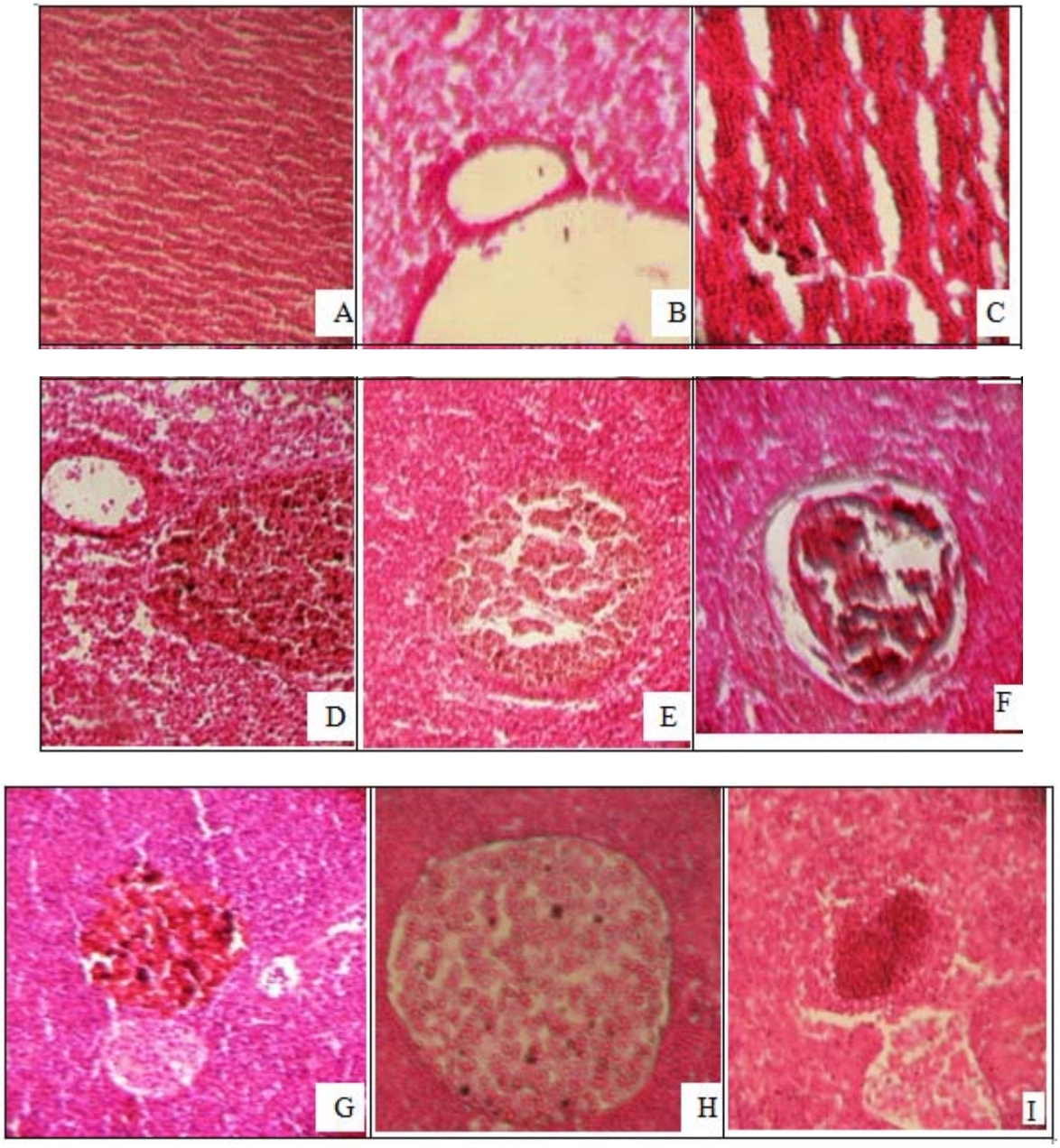


Figure 4.0: Kidney histopathology of *Sarotherodon melanotheron* from Bietri Bay in Ebrie Lagoon. A normal Kidney (HE, 150×); B vacuolization(HE, 200×); C severe dilation with renal cells degeneration (HE, 200×); D hemorrhage (HE, 200×); E parasitic cyst (HE, 200×);F vacuolar degeneration in the epithelium of renal tubules (HE, 200×);G hemorrhage (HE, 200×); H parasites (HE, 200×); I dilation in renal blood vessels and cyst (HE, 200×).

3.4. Discussion

Histopathological changes have been widely used as biomarkers in the evaluation of the health of fish exposed to contaminants, both in the laboratory and field studies. These histopathological biomarkers are closely related to other biomarkers of stress since many pollutants have to undergo metabolic activation in order to be able to provoke cellular change in the affected organism. Previous studies reported that the exposure of fish to pollutants resulted in several pathological alterations in different tissues (gills, liver, Kidneys, muscle and gonads) of fish [5] [6] [7] [8]. In our study, the tissues sections whose metal rates are inferior with 0, 01µgkg $^{-1}$ exhibit a normal structure with no abnormalities in the tissues sections. Results of the present study revealed that *Sarotherodon melanotheron* obtained from Bietri Bay in Ebrie Lagoon during February 2008 and January 2009 manifest histopathological changes in gills, liver and kidney. It is possible that the pathological alterations in the tissues of studied fish could be a direct result of the heavy metals, which are entered to constantly into the lagoon in a general way and in particular into bay of Biétri with the drainage water.

Our study reveals that the gills are the most faded bodies (98% of the sample observed are faded). The gills, which participate in many important functions in fish, such as respiration, osmoregulation and excretion, remain in close contact with the external environment, and particularly sensitive to changes in the quality of the water, are

considered the primary target of the contaminants [6] [9]. Proliferation in the epithelium of gill filaments and secondary lamellae, proliferation of mucous cells, cyst at the top of secondary lamellae, dilation and congestion in gill filaments blood vessel, atrophy of secondary lamellae, lamellar disorganization with focal fusion and hyperplasia of the epithelial cells and between secondary lamellae were observed in *Sarotherodon melanotheron* gills. These pathological changes may be attributed to a reaction to toxicants intake or an adaptive response to prevent the entry of the pollutants thorough the gill surface [10]. That can cause the increased distance between water and blood due to epithelial lifting, the oxygen uptake is impaired and as a consequence caused hypoxia or anoxia of the tissue [6]. In addition, gills are immediately exposed to the environment external to the body and are the first organs exposed to pollutants, such as heavy metals [11]. Similar alterations in the gills have been reported by [12] in *Tilapia zillii* and *Solen vulgaris* from Lake Qarun, Egypt exposed to metals. Similar alterations were detected by [13] in *Liza saliens* from Esmoriz-Paramos lagoon, Portugal contaminated by copper and zinc and by [11] in *Litopenaeus vannamei* gills after acute exposure to cadmium and zinc from coastal areas, China.

In our study, several histological alterations were observed in *Sarotherodon melanotheron* liver (80% of the sample observed). These pathological alterations included dilation in cells hepatic, focal areas of necrosis, cells hepatic degeneration, vacuolar degeneration with infiltration of lipid, blood vessels degeneration, hemorrhage and severe dilation in liver cells. That is explained by the fact why the liver plays an important role in vital function, basic metabolism and accumulation, transformation and excretion of contaminants [14] [15]. Moreover, the liver, as the major organ of metabolism, comes into close contact with xenobiotics absorbed from the environment and liver lesions are often associated with aquatic pollution. Deteriorations of the liver can be due to the storage of heavy metals in this body [16]. [17] were noted similar histopathological alterations in the liver of *Gymnocephalus cernua* collected from Elbe Estuary contaminated by domestic, industrial and agricultural pollutants. The liver anomalies in this work are similar to those observed in laboratory exposures, such as *Clarias gariepinus* after exposure to lead [18]. These authors observed cells hepatic degeneration after 3 days and necrosis after 2 weeks exposure to lead. The present results are in agreement with those observed in other fish species under the influence of different pollutants [19] [20] [21].

In addition, our results showed that the kidney presents also serious lesions (74% of the sample observed are faded). The kidney pathological alterations included vacuolization, dilation in renal cells, severe dilation with renal cells degeneration, hemorrhage, parasitic cyst, vacuolar degeneration in the epithelium of renal tubules, parasites, dilation in renal blood vessels and cyst. These changes may be attributed to direct toxic effects of pollutants on renal, since the kidney is the site of detoxification of all types of toxins such as heavy metals.

Also, the kidney is a vital organ of body and proper kidney function is to maintain the homeostasis [22]. According to [23], the kidney is one of the first organs to be affected by contaminants in the water. The same type of damage has been reported in kidneys of pole *Lates calcarier* due to exposure to cadmium [23]. In the same way, [24] reported severe lesions in kidneys of tilapia (*Oreochromis mossambicus*) after exposure to mercuric chloride.

4. Conclusion

It could be concluded that the environmental contamination of Bietri bay induced several Histopathological alterations in the tissues of *Sarotherodon melanotheron*. This study showed thus that heavy metal contamination not only directly affects fish health.

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