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Histopathology of *Clarias Gariepinus* fingerlings exposed to Kaduna Textile Limited (KTL) effluents

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Abstract
The static bioassays to determine the toxicological effects of Kaduna Textiles Limited (KTL) effluents on *Clarias gariepinus* fingerlings were conducted. The acute bioassay showed that the opercula ventilation rates initially increased but later dropped as both the concentrations of the effluent and days of exposure increased. Histopathology of the gills and liver of the fish showed that there was oedema and mutilation of the gill rakers leading to impaired oxygen uptake as well as liver necrosis and dilation of liver sinusoids.

Keywords: Kaduna Textiles Limited, effluents, Toxicity, *Clarias gariepinus.*

1. Introduction

With the present increase in the use of chemicals for many purposes and with increasing concern over the presence of chemical pollutants in our food, water, air and other parts of the environment, safety of elements of basic human consumption becomes a concern [1]. Among the problems of our valued environment, pollution arouses the most interest. This is because pollution impacts on people directly through effects on their health, on their food supply and other items of cultural heritage as well as overt effects on forests, rivers, coast lines and ecosystems that they are familiar with [2]. Presently no portion of the earth's surface is entirely free from chemical signs of human activity [3]. Today some environmental balances have been so stressed as to be in danger of irreversible change. In the environment short term or chronic exposure to pollutants may lead to impairment of species ability to survive. According to Filipic and Toman [4] water pollution by inorganic micro pollutants is one of the most critical problems concerning resources of drinking water and protection of the water ecosystem as a whole. Water must be adequately managed since most waste materials eventually find their way into some phase of the hydrologic cycle [5].

Some effects of pollutants in effluents from industrial wastes on fish have been reviewed by the European Inland Fisheries Advisory Commission [6]. According to FAO [7] African fisheries resources are only slightly contaminated by heavy metals and are presently safe for human consumption. Several investigations had been carried out on the deleterious effect of heavy metals on the tissues of fish especially in Africa [8, 9, 10, 11]. In Nigeria, though a number of workers has studied the effect of pollutants on the physiology and biochemistry of fishes [12] studies on the effects of pollutants on the histopathology of fishes include the works of Oladimeji and Ologunmeta [13] on the toxicity of water borne lead to *Tilapia niloticus*. Beecroft *et al* [14] monitored pollution in Kaduna River while Omoregie and Ufodike [15] studied the histopathology of *Oreochromis niloticus, niloticus* (L) exposed to Actellic 25EC Anune *et al* [16] studied acute toxicity of zinc to the fingerlings of *Clarias lazera* and *Oreochromis niloticus* while Omoregie [17] studied petroleum toxicity on the Nile tilapia. According to CIFA [18] organic pollution of inland waters in Africa is as a result of poverty and economic and social underdevelopment. There is therefore the need for studies on the occurrence and effects of pollutants on fish in the various water bodies in Africa. This work therefore aims at studying the effects or toxicity of Kaduna textiles limited effluents on the fingerlings of *Clarias gareipinus*.

2. Materials and Methods

Fingerlings of *Clarias gariepinus* used for this experiment were obtained from artisanal fishermen at Ahmadu Bello University, Zaria Dam and were transported in ice-cooled containers to the laboratory. The Industrial effluents of Kaduna Textiles Limited (KTL) was used for this experiment and was transported in 50L capacity plastic cans to the laboratory where they were used immediately. The experimental fish were acclimated to laboratory conditions for two weeks by holding them in 160L capacity holding tanks containing dechlorinated tap water at a temperature range of between 24.5 to 26.5 ^{o}C before using them. The fingerlings were fed daily at 2.5% body mass with formulated diet at prevailing natural photoperiods. The water was changed daily in order to remove any feaeal materials. Chemical analysis of the test water was performed using analytical methods of APHA [19]. 96 h Static bioassays were conducted on the fingerlings of *Clarias gariepinus* to determine the toxicity of KTL effluents. The fingerlings (mean total length 12.35^{+} - 0.6+0.2 mean and weight 10.8^{+} - 0.2 gm) were exposed to four concentrations of the effluents (10%, 15%, 20%, 40% and a control) The fingerlings were randomly distributed into each of the effluent concentration as well as the control containing only de-chlorinated water. The test was repeated once. During the bioassay opercular ventilation and tail fin movements were recorded. Mortality was recorded after exposure periods of 15 mins, 30 mins, I hr, 2, 4, 6, 12, 24, 48, 72 and 96 hours. The LC_{50} was determined using the method of Sprague [20] and the 95% confidence limit was determined using the Probit method [21] Histopathology of the gills and liver were observed. The gills and liver samples from the test fish in each effluent concentration were removed and fixed in 10% normal saline. Sections were stained in Haematoxylin and eosin [22].

3. Results

The physico-chemical parameters of the test water are shown in Table 1. There was no significant difference (p>0.05) in the parameters during the experiment. Symptoms of toxicosis in fish exposed to Kaduna Textile effluents show that the effluents caused subacute effects on the fish behaviour which included agitated swimming, loss of balance, hitting against the edges of the tank, air gulping, quiescence and death.

Table 1: Physico-Chemical Parameters of dilution water

Parameter	Range	Mean	Std. Deviation
Temperature (^{o}C)	235 – 265	25.18	± 0.62
DO (mg/l)	6.10 – 9.44	7.35	± 1.018
pH	7.45 – 8.15	7.78	± 0.219
Hardness (mg/l Caco$_3$)	93.012 – 98.584	96.198	± 1.789
Total Alkalinity (mg/l Caco$_3$)	34 – 36	34.3	± 0.814

The results of the mortality plotted against the log dose of the effluent gave a linear relationship (fig 1).

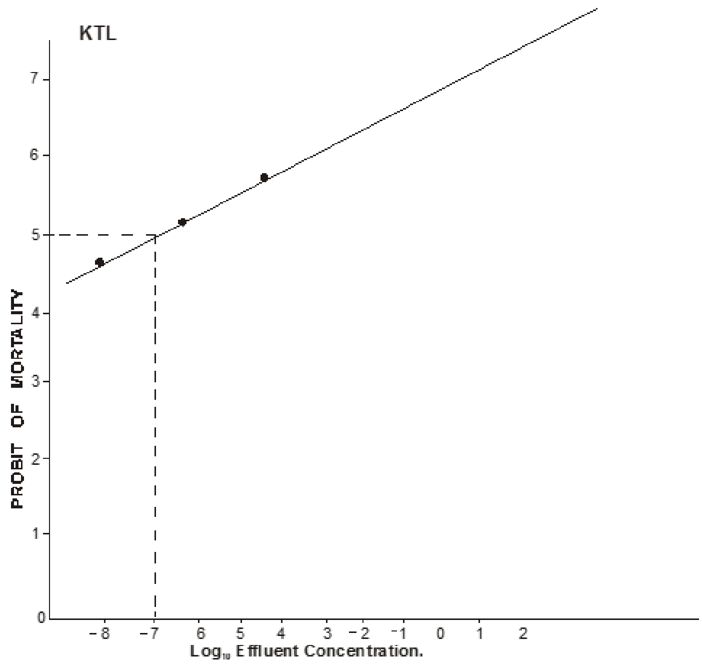

Fig 1: Probit of Mortality versus LOG Dose KTL Effluents

The opercular ventilation of *C. gariepinus* exposed to different toxicant concentrations are graphically presented in fig 1. The beats were seen to increase initially as the concentrations increased but after 72 hours of exposure the beats dropped. There was no change in the control. Histological sections of the gills and the liver exposed to the different concentrations of the effluents are shown in Plates 1(a-e) and plates 2(a-d) respectively.

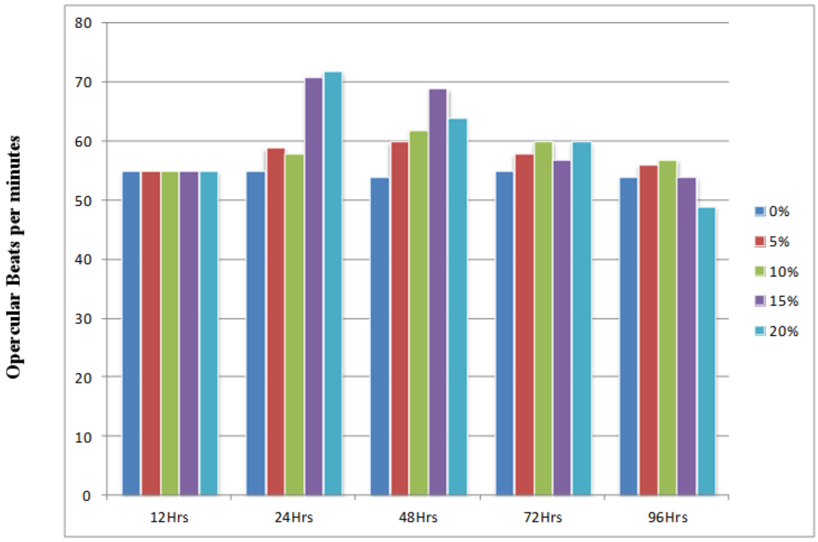

Fig 2: Opercular beats of *Clarias gariepinus* exposed to acute concentration of KTL effluents

The results revealed that the effects of the effluents were most severe on the gills. There was copious accumulation of mucus on the gill filaments and body surfaces of the dead fish as well as the peeling off of the skin and swollen abdomen. The onset and duration of stress symptoms on the fish were dose dependent. At concentrations of between 0.1% -0.15% the damages caused by the effluents were less severe compared with damages caused by the effluents to the fish at higher concentrations of 0.4%. At higher concentrations also there was oedema, evidence of proliferative lesions in the gill epithelium and mutilation of the gill rakers, (Plate 1). Also traces of blood were found around the gill covering of the dead fish. Many changes were noticed in the liver. At lower effluent concentrations there were few vacuolation of the liver cells (Plates 2b) but at higher concentrations of the effluents the liver had liver necrosis and oedema leading to dilation of the liver sinusoids (Plates 2c - d).

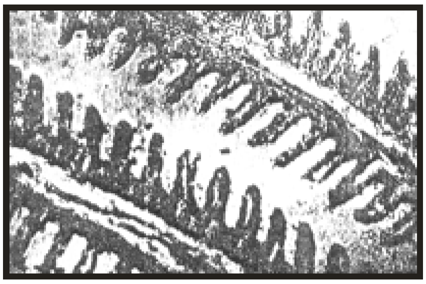

Plate 1a: Control

Plate 1b: 10% Concentration

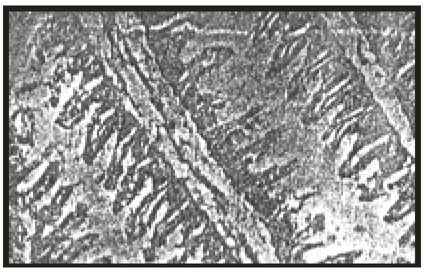

Plate 1c: 15% Concentration

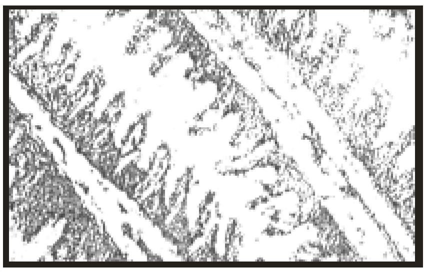

Plate 1d: 20% Concentration

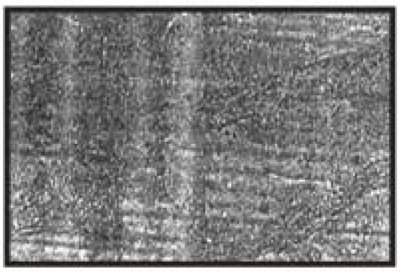

Plate 1e: 40% Concentration

Plates 1 (a – e): Effects of Acute Concentrations of Kaduna Textiles Limited Elements on the Liver of *C. Gariepinus*

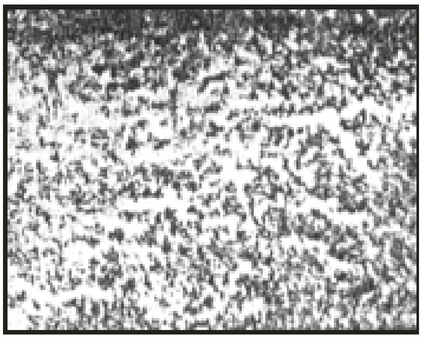

Plate 2a: Control

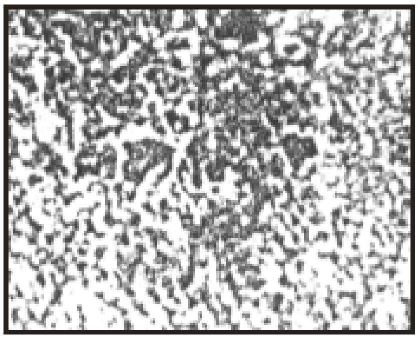

Plate 2b: 10% Concentration

Plate 2c: 20% Concentration

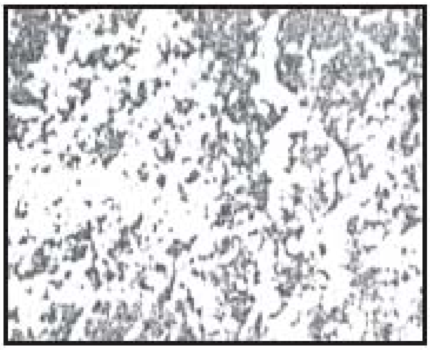

Plate 2d: 40% Concentration

Plates 2(a – d): Effects of acute concentrations of Kaduna Textiles Limited elements on the liver of *C. gariepinus*

4. Discussion

Toxicity tests with various aquatic organisms are frequently applied worldwide in order to determine the toxicity of pure substances and waste waters [23]. Presence of pollutants in water has been shown to produce undesirable consequences [24]. The gills were seen to be effected most by the toxicants. Toxicants mostly enter the body of fishes through the gills. This unique organ for aquatic vertebrates is a susceptible structure since it is in intimate and continuous contact with the ambient water and the dissolved toxicants. According to Wester and Vos [25] its surface is extremely large and its function is exchange of water and plasma constituents which is essential for life and highly dependent on the quality of the water-blood barrier. Lovegrove and Eddy [26] and Anunne and lyaniwura [27] have all reported that the gill is one of the main sites of heavy metal uptake in fish. The fish gills were affected by the effluents probably due to high accumulation of metals. A relationship between metal concentration in fish and the amount in water, food and sediments had been suggested by Duobun [28] and Smith *et al* [29]. Nemesok *et al* [30] had found zinc to be highly accumulated by gills of dogfish. The opercular ventilation increased as the concentration of effluent increased within the first 24 hours introduction of the pollutant. The effects of the pollutant were more in higher concentrations of effluents. There was a marked decrease in the opercular ventilation after 48 hours. Indices of opercular ventilation is a strong indicator of stress in unfavourable conditions. Buttler [31] has reported that stress on the gills led to initial increase in the opecular ventilation because of demand for more oxygen until the fish was exhausted and hence the fall in the opercular ventilation during the later hours.

Similar observations of gill conditions had been made by Ufodike and Onusirinka [32] in *C. gariepinus* exposed to inorganic fertilizers. The result showed that there were evidence of proliferative lesions of the secondary lamella and mutilation of gill rakers, lamella disarray and epithelial detachment. Wester and Vos [25] observed common gill lesions such as hyperplasia of the epithelium and fusion of the lamellae in gills exposed to acute concentrations of toxicants. Also mucus was observed to accumulate on gills. Accumulation of mucus on the body may be as a result of increase in the activity of the mucus cells which result in the production of copious amount of mucus all over the body [16] Structural damages were noticed in the liver which according to Wester and Vos [25] is a well known target organ in toxicology regarding its function in biotransformation. Structural damages in the liver included necrotic hepatocytes, fibrosis (precipitating cytoplasm), hepatic vacuolation and liver oedema. This probably was caused by accumulated of metals from the pollutants. Gbem *et al* [33] have reported that the liver accumulated metals much more than tissues in *C. gariepinus* exposed to tannery effluents. Anunne and lyaniwura [27] had reported that the livers of *C. gariepinus* and *O. niloticus* accumulated more Zinc and Cadmium than other tissues.

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