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SHORT COMMUNICATION

Evaluation of the haematology and biochemistry of the silver catfish, *Chrysichthys nigrodigitatus* as biomarker of environmental pollution in a tropical lagoon

Ugwu George Chukwudi, Soyinka Olufemi Olukolajo*
Department of Marine Sciences, University of Lagos, Nigeria. *Corresponding email: soyinka.olufemi@gmail.com

ABSTRACT

The objective of the present study was to examine the haematological and biochemical parameters of the silver catfish, *Chrysichthys nigrodigitatus*, from the Makoko area of a polluted tropical lagoon such as Lagos Lagoon, to serve as a baseline data for the assessment of the health status of the fish and as reference point for future studies. The mean values of the haematological parameters analyzed were: blood haemoglobin, Hb (97.29±4.35g/L); pack cell volume, PCV (29.28±1.23%); red blood cell/total erythrocyte count, RBC (2.97±0.12T/L); white blood cell count, WBC (10.69±0.37g/L); mean cell volume, MCV (95.19±2.28fl); mean corpuscular haemoglobin, MCH (30.53±0.67pg), mean corpuscular haemoglobin concentration, MCHC (33.32±0.38g/dl), and the differential leucocytes. While the mean values of the biochemical parameters were: aspartate transaminase, AST (66.06±6.12 IU/L); alanine transaminase, ALT (12.98±1.10 IU/L), and alkaline phosphatase, ALP (88.01±8.60 IU/L). The findings from this study gave an indication of stress on the health status of the fishes in this lagoon and there is need for proper management strategies to be adopted in monitoring the conditions of the faunal communities in the lagoon. The lagoon indeed showed signs of environmental stress, which eventually pose devastating effect on the health status of the fishes. These have an indirect effect on the coastal communities. There is therefore the need for periodic monitoring and enforcement of environmental laws by respective organisations to ensure health safety of the people especially in the coastal communities.
Keywords: Haematological parameters; *Chrysichthys nigrodigitatus*; Makoko; Lagos Lagoon; baseline

INTRODUCTION

Many of the developing countries of the world, such as Nigeria, aim at attaining the status of the developed nations in the nearest future. This goal is being achieved through massive industrialization and urbanization, which is leading to the continual pollution of the coastal waters. Akpata (1986) also emphasized that although aquatic pollution could be attributed to inadequate consideration given to environmental impact analysis of various projects; it is majorly due to increasing urbanization and industrialization of the country's coastal cities. According to Babalola and Agbebi (2013), water pollution is a major problem in the global context, but Lagoon pollution has been increasingly significant over the recent years and this has been found to contribute significantly to environmental problems in many developing countries where, through man's exploitation of the water resources, the normal dynamic balance in the aquatic ecosystem is continuously disturbed, and often results in each dramatic response as depletion of fauna and flora, fish kill, and change in physico-chemical character. The Makoko area of Lagos Lagoon is being used as the cheapest and convenient refuse disposal system. The indiscriminate discharge of wastes into the coastal waters has resulted in excessive loading of these aquatic systems, beyond their capacity of self-purification.

C. nigrodigitatus was selected for this particular study because of its relative availability and abundance of the fish species throughout the year in the Lagos Lagoon, and widely consumed by the coastal communities and sold in several markets in the area (Fagade and Olaniyan, 1973; 1974). It is a mainstay of the artisanal fisheries in coastal communities in the area. It has great aquaculture potentials (Oribhabor and Ezenwa, 2005), and thus several studies have been carried out on the species (Ekanem, 2000; Offem *et al*., 2008; Nwafili *et al.,* 2012).

The natural environment of fish is water. They live in direct contact with water. Changes in the physico-chemistry of water do induce physiological stress to the fish. In order to survive in its environment, the fish would have to either overcome the stress or adapt to it. The physiological stress response, although initiated as an adaptive response to destabilizing factors, could have damaging effects if prolonged. Jobling and Reinsnes (1986) established that continuous stress affects the behaviour and normal development of fish. Gerking 1980) observed that these stressors caused growth reduction, while Schreck and Bradford (1990) stated that the stressors were responsible for suppression of reproduction and an increase in susceptibility to infections, through immune depression, which caused mortality. Therefore, there has been a greater understanding of the need to establish reference haematological and biochemical values in fish in order to assess health status and the subsequent diagnosis of disease. A similar study was carried out for fish species reared in ponds by other researchers, for example by Etim *et al.* (1999), Sowunmi (2003). Erondu *et al.* (1993); Adedeji *et al.* (2000), and Gabriel *et al.* (2004).

Haematological parameters such as RBC (red blood cells), Hb (haemoglobin), Haematocrit/packed cell volume (HCT/PCV), MCV (mean corpuscular volume), MCH (mean corpuscular haemoglobin), and MCHC (mean corpuscular haemoglobin concentration); and biochemical parameters such as AST (aspartate aminotransferase), ALT (alanine aminotransferase) and ALP (alkaline phosphatase), are the most common criteria used in the toxicity studies on fish, and the present study was to examine these parameters in the catfish, *C. nigrodigitatus* from a contaminated tropical water body as Lagos Lagoon. Hence, the objective of the present study was to examine the haematology and biochemical parameters of the silver catfish, *C. nigrodigitatus* from a tropical polluted Lagos Lagoon, as a biomarker of the health status of the species.

MATERIALS AND METHODS

Study Site

Makoko is a slum neighbourhood community located on the eastern part of Lagos, Nigeria (Figure 1). According to Ayeni (2014), Makoko had an estimated population of about 85,000 people in 2009. Majority of these people engage in fishing as means of livelihood. Over a thousand fishing boats (paddled and motorized) could be located at a time.

Fish Species

Silver catfish, *Chrysichthys nigrodigitatus* (Lacépède: 1803),of the family Claroteidae plays a pivotal role in the ecology and fisheries of Nigeria in particular, and West Africa at large (Ayotunde and Ada, 2013).*C. nigrodigitatus* is an important commercial fish because of its high protein content and hardy flesh, thus forming a very important component in the diet of many Nigerians. According to Ezenwa *et al.* (1990), *C. nigrodigitatus* accounts for the second highest production of fish that can be obtained from the wild in the four geomorphological regions of the Nigerian coastline, and is highly recommended as a culturable species. In the Makoko area, *C. nigrodigitatus* is the second most landed fish species, after the various tilapia species. The fishes were landed through the help of the local fishermen using cast nets of various mesh sizes. The weight ranged between 1000 – 1420 g, while the length ranged from 31 – 51cm.

Figure 1. Map of Lagos Lagoon showing the Makoko Slum Area

Blood Sampling

A bi-monthly collection of blood from 18 live fish specimen was carried out between May and July, 2013. The bloods were collected between 08:00 and 10:00 hour on each of the sampling day, stored in ice chest and transported to the laboratory for analyses. The blood collection was done using 2ml sterile plastic disposable syringes fitted with 0.8×38-mm hypodermic needles. The blood samples were expressed into ethylene diamine tetra acetic acid (ETA) and lithium heparinized bottles for the haematology and serum enzyme biochemical analyses respectively.

Haematological and Biochemical Procedures

Haemoglobin (Hb) concentration was determined with the cyanomethaemoglobin method. Packed Cell Volume (PCV) by micro haematocrit method, Red blood cell (RBC) and total white blood cell (WBC) were done using the Neubauer haemocytometer. Differential counts (neutrophils, monocytes and lymphocytes) were done on blood film stained with May Grumwald-Giensa stain. The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated from the data using standard formulae.

Serum was separated from the cellular blood components by centrifugation for 5 min at 14,000 rev/min. Blood alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (AP) were determined using a portable automated chemical analyzer following the procedure and using the reagents recommended and as described by the manufacturer (RANDOX Laboratories Ltd, UK; AST/ALT (Cat. No. Sc 2643) and ALP multi-sera level 2 (Cat. No. 1530) and level 3 (Cat. No. 1532)), assay kits. All blood analyses were carried out within 48 hours of collection.

Statistical Analyses of Data

Haematological parameters and biochemical indices were analysed using one-way analysis of variance (ANOVA) at 5% level of significance. While post-hoc comparison of significance of variance result gotten from ANOVA was done using Duncan Multiple Range Test (DMRT).

RESULTS

The analysis of variance (ANOVA) of the haematological parameters showed that only Hb, PCV and WBC are significant (P<0.05) while Post-Hoc analysis using DMRT (Duncan Multiple Range Test) showed that Hb, PCV, WBC and MCV are significant (P<0.05). But analysis of variance of the biochemical parameters showed that there was significant difference (P<0.05) in all of them, while Post-Hoc analysis using DMRT showed that there was significant difference in AST in weeks 2, 3 and 6; ALT in weeks 2, 3, 4 and 5; ALP in weeks 2, 3, 4 and 5. The results of the haematological and biochemical analyses are shown in Tables 1 and Table 2, respectively.

Table 1. Mean and S.E for Haematology of *Chrysichthys nigrodigitatus*

Parameters	Week-1	Week-2	Week-3	Week-4	Week-5	Week-6	Grand Mean
Hb(g/L)	101.7±0.98^{b}	99.23±5.15^{b}	63.37±5.56^{a}	101.83±8.15^{b}	104.83±6.64^{b}	112.8±7.2^{b}	97.29±4.35
PCV (%)	29.67±0.88^{b}	30±0.58^{b}	19.67±2.19^{b}	31.67±2.40^{b}	31.33±1.76^{b}	33.33±1.45^{b}	29.28±1.23
RBC(T/L)	3.13±0.07^{a}	3.23±0.15^{a}	2.37±0.32^{a}	3.27±0.44^{a}	3.13±0.24^{a}	2.67±0.29^{a}	2.97±0.12
WB(g/L)	12.79±0.66^{b}	11.51±0.44^{ab}	10.11±1.06^{a}	9.31±0.50^{a}	10.59±0.62^{ab}	9.83±0.66^{a}	10.69±0.37
MCV(fl)	92.94±0.46^{ab}	90.26±0.87^{a}	92.37±7.40^{ab}	91.20±3.10^{a}	95.72±5.04^{ab}	108.67±7.5^{b}	95.19±2.28
MCH(pg)	32.13±0.13^{b}	30.54±0.60^{b}	31.54±3.37^{b}	29.24±0.56^{b}	31.48±0.74^{b}	28.27±2.21^{b}	30.53±0.67
MCHC(g/dl)	33.60±1.84^{a}	33.25±1.80^{a}	33.10±0.20^{a}	33.40±0.32^{a}	33.62±0.47^{a}	32.97±0.19^{a}	33.32±0.38
NEUT(%)	13.67±2.19^{a}	18.67±4.67^{a}	19.00±5.29^{a}	20.67±1.45^{a}	17.33±1.20^{a}	21.67±1.20^{a}	18.50±1.25
LYMP(%)	86.33±3.18^{a}	74.33±7.22^{a}	84.67±2.19^{a}	81.67±2.60^{a}	82.67±1.45^{a}	78.33±2.84^{a}	81.33±1.61
MONO(%)	0.67±0.67^{a}	1.00±1.00^{a}	0.00±0.00	0.00±0.00	0.33±0.33^{a}	0.00±0.00	0.33±0.20
EOS(%)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
BAS(%)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Mean frequencies (mean ± S.E, Standard Error) with different superscript letters in a row are significantly different in the DMRT (p<0.05). NEUT (neutrophile granulocytes); LYMP (lymphocytes); MONO (monocytes); EOS (eosinophile granulocytes); BAS (basophile granulocytes)

Table 2. Biochemical Parameter of *Chrysichthys nigrodigitatus*

Parameters	Week-1	Week-2	Week-3	Week-4	Week-5	Week-6	Grand Mean
AST(IU/L)	36.07±5.85^{a}	91.09±0.80^{b}	81.86±10.87^{b}	53.33±3.48^{a}	39.43±3.79^{a}	94.59±0.63^{b}	66.06±6.12
ALT(IU/L)	8.96±1.60^{a}	14.51±1.21^{b}	21.06±0.44^{c}	12.56±1.20^{b}	13.07±0.05^{b}	7.73±0.14^{a}	12.98±1.10
ALP(IU/L)	33.12±4.22^{a}	125.12±6.63^{d}	119.6±3.68^{cd}	103.04±13.55^{bc}	95.68±2.43^{b}	51.52±1.84^{a}	88.01±8.60

Mean frequencies (mean ± S.E, Standard Error) with different superscript letters in a row are significantly different in the DMRT (p<0.05)

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DISCUSSION

This present study sought to provide haematological indices and aspects of biochemical indices for *C. nigrodigitatus* in Makoko area of a tropical and polluted Lagos Lagoon, a brackish water environment. Okafor and Chukwu, (2010) also confirmed the need to establish normal haematological characteristics of a particular species of fish which would serve as reference for further comparative studies. This is very necessary, as emphasized by Moiseenko (1998), and Adhikari *et al.* (2004) that haematological assessment is a pathophysiological reflector of the whole body and, therefore, blood parameters are important in diagnosing the structural and functional status of fish exposed to contaminants. From the report by Adedeji and Adegbile (2011), on the haematology of *C. nigrodigitatus* from a freshwater Asejire Dam in Nigeria, all the blood parameters such as PCV, Hb, RBC, WBC and Lymphocytes were lower than those in the present study. According to Hassan *et al.,* (2016), increase in salinity gradient was noted to have an increasing effect on the value of the blood parameters in the common carp, *Cyprinus carpio.* These values are in line with those of Okafor and Chukwu (2010) who recorded mean Haematocrit values of 27.7%, 28.1%, 28.8% and 29.2% for the fingerlings, juveniles, intermediates and large sizes, respectively, for the African Lungfish (*Protopterus annectens*) from Anambra River. The values recorded in this study are also within the minimum, intermediate and maximum values of 20%, 35% and 50% respectively, in various reports (Clarks *et al.*, 1979; Etim *et al.*, 1999). According to Adedeji and Adegbile (2011), anaemic condition is determined by haematocrit or PCV (Blaxhall and Daisley, 1973); increased Hb concentration depict higher activity; increased RBC also depicted more effective O_2 and CO_2 to lung tissue; while WBC and Lymphocytes increase is an indication of ability to fight infections from the environment. However, it is surprising that a fish in a polluted environment as the Lagos Lagoon would have increased blood parameters as should be in a healthy fish. This could possibly be as an internal homeostatic response in the *C. nigrodigitatus* to counteract the stresses posed both by a saline gradient and the pollutants in the Lagoon.

Toxic effects of different pollutants are frequently determined by the use of Plasma enzymes, AST, ALT, and LDH (Li *et al.,* 2010). The biochemical parameter in the present study, AST, was higher than the mean value of 48.26±77.54 reported for *C. nigrodigitatus* by Adedeji and Adegbile (2011). However, ALT value in this study was lesser than that reported (21.79±13.49) by Ayoola *et al.* (2014). Increase in AST occurred due to disruption in mitochondria brought about as a result of heavy hepatitis; in the same way, elevated level of ALT in the blood is indicative of damage to the integrity of hepatocyte membranes (Ayoola *et al.,* 2014).

The comparable levels of haematological parameters in this study could also be attributed to the various stressors present in the Lagoon. Various authors, such as Gabriel *et al.* (2007), have established that pollutants, such as herbicides, pesticide and industrial effluents, alter the haematological indices of fish. Makoko Area of Lagos Lagoon is organically polluted, especially with sewage from the floating shanties, wood wastes from logging and sawmills activities and Refuse discharges from the nearby Better-life fish market. There was disparity in the colour of fish species; while some of the *C. nigrodigitatus* were silver-white; others were silver-grey, which could also be an evidence of pollution. Sarkar and Bhavna (2011) also reported that pollution is capable of changing the colour/physical appearance of a fish.

CONCLUSIONS

The lagoon indeed showed signs of environmental stress, which eventually pose devastating effect on the health status of the fishes. These have an indirect effect on the coastal communities. There is therefore the need for periodic monitoring and enforcement of environmental laws by respective organizations to ensure health safety of the people especially in the coastal communities.

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