Original Research Article

A Comparative Study on the Haematological and Biochemical Alterations in Catfish (*Clarias gariepinus*) Under Natural and Artificial Environments in Sokoto Metropolis, Nigeria

ABSTRACT

Aims: The study was conducted to compare the alteration in haematological and biochemical parameters in African catfish (*Clarias gariepinus*) under natural (river) and artificial (ponds) habitats in Sokoto metropolis, Nigeria.

Study design: Whole blood and serum samples harvested from each group of the catfish were used for assessment of the haematological and biochemical parameters, respectively. Data were analyzed to compare changes between the two groups of African catfishes using *T*-test and $P < 0.05$ was considered statistically significant.

Place and Duration of Study: Catfish samples were collected over a period of four weeks from Kwalkwalawa river and commercial fish farms in Sokoto metropolis. Samples for haematological parameters were determined at the Clinical Pathology Laboratory, Veterinary Teaching Hospital, Usmanu Danfodiyo University Sokoto. The serum analyses were performed at the Chemical Pathology Laboratory, Usmanu Danfodiyo University Teaching Hospital Sokoto.

Methodology: A total of fifty (50) whole blood samples were obtained from live African catfishes representing twenty-five (25) samples each from natural and artificial environments.

Results: The results showed significant changes in some haematological parameters, packed cell volume ($P = 0.039$), haemoglobin concentration ($P = 0.001$), white blood cell count ($P = 0.012$), and differential neutrophils ($P = 0.001$) and lymphocytes ($P = 0.001$) counts between the two groups of African catfishes studied. Significant biochemical alterations in the total protein ($P = 0.001$), total bilirubin ($P = 0.028$) and direct bilirubin ($P = 0.019$) were observed in catfishes under natural and artificial environments.

Conclusion: This study shows that aquaculture environment has great influence on the haematological and biochemical parameters in African catfish. These changes were more evident in catfish reared under the natural environment. Hence, the alterations in haemato-biochemical parameters were suggestive of unhealthy state or chronic stressful condition in catfish perhaps due to natural and human caused stresses.

Keywords: African catfish, Biochemistry, Haematology, Ponds, River, Sokoto, Nigeria

INTRODUCTION

African mud catfish is called *Clarias gariepinus*, is one of the most commonly cultured fish species in tropical Africa including Nigeria [1]. It belongs to the family Claridae which exists in the wild and artificially cultured in the ponds, cages, and pens for commercial purposes. Catfish is an omnivorous creature with a preference for a planktonic diet and other types of foods such as insects, insect larvae, pupae, fish, fish remnants and commercially available pelleted feeds [2,3]. People's attraction to catfish farming is linked to some imperative features of high-quality meat, enduring in nature, high tolerance to adverse conditions

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and production performance [1]. Economically, catfish has significant market values in Sokoto state and Nigeria at large.

Fish leaves favorably in aquatic habitat, and their blood profile is an important tool in the development of aquaculture system [4]. Fish blood can inform measurable physiological changes more quickly than any other physiological assessment parameters [5]. Changes in the value of a component of a blood parameter in comparison with the reference values are used in the interpretation of health status of animals [6]. Fish haematology has been used as an index to detect different stressful conditions such as exposure to pollutants, diseases, heavy metals, hypoxia and anaemia [7,8]. Intensive system of fish management has been characterized by high tendency of disease outbreaks. Diseases are part of the limiting factors that reduces fish production [9]. Therefore, haematological evaluation is recommended in fish culture for early detection of diseases and environmental research [8,5]. Similarly, the examination of serum constituents has produced valuable information for detection and diagnosis of metabolic disturbances and diseases in fish [7]. In particular, a number of liver injury biomarkers have often been used to detect unhealthy state in fish [10].

Despite the nutritional and economic benefits of African catfish, yet there is paucity of information on their blood profile under different aquaculture systems. Thus, this study was aimed at investigating the changes in haematological and biochemical parameters of African catfish under natural and artificial environments in Sokoto metropolis Nigeria.

2. MATERIAL AND METHODS

2.1 Study Area

African catfishes were purchased at the Kwalkalawa river Sokoto and some commercial fish farms in Sokoto metropolis Nigeria, representing natural and artificial fish habitats. Sokoto, the capital city of Sokoto state is located at the northwestern part of Nigeria, longitudes 11° 30′ to 13° 50′ East and latitudes 4° to 6° 40′ North. The state shares boundary with Niger Republic to the north, Kebbi state to the southwest and Zamfara state to the southeast [11, 12].

2.2 Fish Samples

A total number of fifty (50) *C. gariepinus* were collected alive at intervals for 4 weeks using cast net, it was immediately transferred into plastic container for transportation to the laboratory for samples collection. Twenty-five (25) each from the wild (Kwalkwalawa River) and cultured (commercial farms) aquatic environments in Sokoto metropolis. Adult and juvenile catfishes of both sexes were used for the study. Catfishes were weighed before collection of blood samples and then individually restrained manually.

2.3 Blood Collection

Blood samples were collected from live *C. gariepinus* (80 - 330g body weight) by puncturing the posterior caudal vein [13] using a heparinized plastic syringe fitted with a 21-gauge hypodermic needle. The samples were immediately transferred into ethylene diamine tetra-acetic acid containing tubes to avoid coagulation of the blood and used for haematological analyses. Serum samples were harvested in plain containers after the whole blood was clotted, centrifuged using bench centrifuge at 10,000rpm for 5 minutes and kept at freezing point until required for biochemical analyses.

2.4 Haematological and Biochemical Analyses

Haematological parameters, red blood cell (RBC), hemoglobin (Hb) concentration, packed cell volume (PCV), white blood cell (WBC), and differential leukocyte counts, namely lymphocytes, neutrophils, monocytes, eosinophils, basophils and band cells were determined at the Clinical Pathology Laboratory, Veterinary Teaching Hospital, Usmanu Danfodiyo University Sokoto. Serum total protein (TP), total bilirubin (TBIL), direct bilirubin (DBIL), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) concentrations were determined according to the standard laboratory procedures at the Chemical Pathology Laboratory, Usmanu Danfodiyo University Teaching Hospital Sokoto.

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2.5. Data Analysis

Data were analyzed using statistical package for social sciences version 22. *T*-test was used to compare the haematological and biochemical changes between the African catfish reared under natural and artificial environments in Sokoto metropolis. $P < 0.05$ was considered statistically significant.

3. RESULTS AND DISCUSSION

Table 1 shows the mean haematological parameters of *C. gariepinus* reared under natural and artificial environments. The mean PCV, Hb, WBC, neutrophils and lymphocytes values were significant ($p<0.05$) between wild and cultured catfishes. However, the mean RBC, monocytes, eosinophils, basophils and band cells were not significant ($p>0.05$) between the two groups. Based on the result, it can be seen that the mean PCV values of catfish from the two research locations were within the normal range of 30.8 - 45.5% [14]. But, Hb concentrations were below the reference range of 10 -14g/dL. Normally, Hb binds to oxygen in order to produce energy. As such, low protein diet could cause the Hb content to be low as well, and inconsequence will predispose fish to an infection [14].

Red blood cell count was not remarkable among the two groups studied. The results were within normal values [15]. Low erythrocyte counts indicate anaemia, while high levels indicate stress induced polycythemia in fish [16]. Anaemia has an impact on growth performance of fish due to the low RBC counts, and by extension reduced food supply to cells, tissues and organs [14]. The WBC counts in both groups of catfishes, their values were below total range of leukocytes in health, suggesting leukopenia perhaps due to unhealthy state or chronic stressful conditions [17, 18]. WBC is the main component of the body's defence system [16]. Mean differential leukocyte counts indicate neutropenia and lymphocytosis [19, 20] in both natural and artificially managed catfishes, thus suggesting extravasation of neutrophils and immunogenic stimulation, respectively [21].

Table 1. Haematological parameters (Mean ± SD) of *Clarias gariepinus* reared under natural and artificial environments

Parameters	Wild catfish	Cultured catfish
PCV (%)	37.08 ± 11.26	31.96 ± 3.77*
RBC ($x10^6$cells/mm^3)	1.68 ± 0.96	2.07 ± 0.49
Hemoglobin (g/dL)	3.52 ± 1.82	7.06 ± 1.98*
WBC ($x10^3$cells/mm^3)	8.34 ± 3.59	11.64 ± 5.13*
Neutrophils (%)	11.32 ± 4.71	18.58 ± 7.42*
Lymphocyte (%)	84.64 ± 6.04	75.33 ± 8.06*
Monocyte (%)	3.88 ± 3.23	5.45 ± 3.22
Eosinophil (%)	0.00 ± 0.00	0.33 ± 1.09
Basophils (%)	0.00 ± 0.00	0.00 ± 0.00
Band cells (%)	0.16 ± 0.62	0.29 ± 0.75

Key; SD = standard deviation. Results were determined using student's *T*-test. $P < 0.05$ was statistically significant. *= $P < 0.05$.

Table 2 shows some biochemical parameters of *C. gariepinus* reared under natural and artificial environments. The mean TP, TBIL and DBIL were significant among wild and cultured catfishes. However, the mean AST, ALT, ALP and ALB were not significant between the two groups. More importantly, serum proteins concentrations were showing significant hypoproteinaemia especially in the wild catfish. Under situations of stress, many organisms mobilize proteins as an energy source via

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oxidation of amino acids. Hence, the observed hypoproteinaemia could be linked to stress [22] because of exposure to environmental pollutants, diseases or attack by pathogens including haemoparasites.

Table 2. Biochemical parameters (Mean ± SD) of *Clarias gariepinus* reared under natural and artificial environments

Parameters	Wild catfish	Cultured catfish
AST (IU/L)	7.48 ± 0.59	7.6 ± 0.71
ALT (IU/L)	5.00 ± 0.82	4.84 ± 0.85
ALP (IU/L)	74.24 ± 5.11	77.49 ± 17.36
TP (g/dL)	4.16 ± 0.37	4.96 ± 0.36*
ALB (g/dL)	2.84 ± 0.07	3.09 ± 0.14
TBIL (mg/dL)	0.71 ± 0.21	1.07 ± 0.75*
DBIL (mg/dL)	0.26 ± 0.06	0.52 ± 0.51*

Results were determined using student's *T*-test. $P < 0.05$ was statistically significant. *= $P < 0.05$.

Furthermore, the decrease in the TP content is related to the decrease in protein synthesis and absorption or protein loss via haemodilution as well the increase in energy demand by the fish to cope with environmental condition [23]. Although, liver transaminases and ALP activities were not remarkable, as such the results suggest that there was no significant hepatic tissue damage, enzymes synthesis and metabolism in the catfish studied [24]. Overall, variations in the haematological and serum biochemistry in fish may occur depending on the time of the day and season, physiological status, and presence of disease and/or pollutant exposure [25]. Similarly, dietary supplementation with pelleted feed could interfere with the haematological profile, intestinal microbiota and immune system [26].

4. CONCLUSION

The study established that aquaculture environment has great influence on the haematological and biochemical parameters in African catfish. These changes were more apparent in catfish reared under the natural habitat. In conclusion, the haemato-biochemical alterations observed were suggestive of unhealthy state or chronic stressful condition in catfish examined. Therefore, further research should be conducted to identify the specific stress factors due to natural and human causes in the study area. Future studies could also explore the situation in other fish species in order to have a wide view of aquatic conditions and proper appropriate measures to address the problems identified.

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