

Hematological Characteristics of Two Teleost Fish in a Tropical Reservoir

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Abstract The blood condition of the fish is crucial in meeting the health, food, economic and post-harvest needs of fish farmers and consumers. In this study, the hematological conditions of live and sacrificed samples of two commercially important teleosts, *Clarias gariepinus* (African mud catfish) and *Channa africana* (Snake head fish), obtained from Egbe dam located in Ekiti State, southwest Nigeria were studied. Blood samples were collected from tranquilized live fish by puncturing the anal fin vein using 23G x 1^{1/4} sized heparinized plastic syringe and later sacrificed by percussive stunning for post-mortem blood sample collections. Standard hematological analytical procedures were used in the assessment of the various blood parameters. The results obtained evoked significant differences ($P < 0.05$) in the Packed Cell Volume (PCV), White blood Cell Counts (WBC), Red blood Cell Counts (RBC), Hemoglobin (Hb) and Blood platelet (PLT) of the live samples of the two teleosts. *C. gariepinus* had higher values of blood parameters profile than *C. africana* in all the analytical assessments with a higher 2:1 WBC counts, suggesting a lesser environmental and pathological stressors for *C. africana* at the time of sampling. There were no statistical differences ($P > 0.05$) in the blood Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) of the two live fish species. The results of the post-mortem analysis of the blood parameters revealed significant differences ($P < 0.05$) at the different intervals of blood collection with the highest rate of decline in the blood profile within the first 2 hours of death. Rigor-mortis had no visible impact on the decreasing status of the blood profiles of the two teleostean fish because the muscle stiffening was delayed for about 6 hrs after the initialization of the post-mortem study. The results obtained in this study will serve as baseline hematological parameters for use in monitoring of fish health and preservation.

Keywords Post-harvest, Freshwater, Fish, Post-mortem, Hematology

1. Introduction

Fish is one of the potential sources of animal protein and essential nutrients for maintenance of a healthy body [1]. In recent years, fish have become a favourite foodstuff for the majority of societies because of several health reasons [2]. Water, protein, lipid and carbohydrate and mineral elements, such as, sodium, potassium, calcium, magnesium, phosphorus, sulphur, iron, chlorine, silicon, manganese, zinc and iodine are also commonly found in fish. The nutritional composition of fish varies greatly from one species and strains to another; depending on age, feed intake, sex, the environment and seasons [3]. Blood, one of the principal components in fish, aids the normal physiological balance, regulates the various metabolic activities, maintains the acid-base balance and removes the metabolic waste products from tissues. The knowledge of haematological characteristics of fish gives the idea of their

physiological status in relations to various environmental factors. The determination of blood parameters and in particular those of the red blood cell counts are used for assessing fish health [4].

Fish are known to live in close relationship with their environment. Studies have shown that variations in the blood composition of fish depend on the stress effects of the environmental factors [5]. In situations where environmental conditions are not favorable or there is an environmentally induced pathological condition, the blood will reveal conditions within the body of the fish, prior to the visible manifestation of a disease [6]. It has been reported that stressors in the environment can exert some influences on fish hematological characteristics [7]. Since the health of the fish is an important consideration for fish consumers, it is necessary to assess its blood characteristics during capture, processing and preservation.

This study was designed to provide baseline scientific information about the blood values of two commercially important fish species in a tropical reservoir, Egbe Dam in Ekiti State, Nigeria. Information about the hematological characteristics of the fish species in the dam is just growing and the data obtained will improve the existing scientific

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database on fish hematology in Nigeria.

2. Materials and Methods

2.1. Sample Collection

Samples of *Clarias gariepinus* (African mud catfish) and *Channa africana* (Snake head fish) were collected from Egbe Dam (latitude 7°36'N and longitude 5°36'E) in Gbonyin Local Government Area of Ekiti State, Nigeria. The fish were captured with basket traps set overnight under the vegetative part of the dam. Captured specimens were transported early in the morning (between 7:30am and 9:00am) to the laboratory for blood sample collection. Specimens used for blood sample collection were adult fish with the average total length of 19.0-to-25cm.

2.2. Blood Collection and Processing

Blood samples were first collected from live fishes tranquilized with 150mg L⁻¹ solution of tricaine methanesulphate (ms-222). This was done through intravenous withdrawal by puncturing anal fin vein using heparinized plastic syringe fitted with 23 x 1^{1/4}" gauge hypodermic needle. The fish were then sacrificed by percussive stunning for post mortem blood sample collections. Three regimes of post-mortem blood sample collections were observed at 0-30 minutes; 2hours-2:30hours and 4hours-4:30hours). All blood samples collected were preserved in Ethylene Diamine Tetra-Acetic Acid (EDTA) sample bottles. Standard hematological analytical procedures were employed in the assessment of the blood parameters. The micro-hematocrit method was used for the determination of the packed cell volume (PCV) [8]. Hemoglobin (Cyamethemoglobin) and red blood cell concentrations were determined by the methods of [9] while the white blood cell (WBC) count was determined by Neubauer hemacytometer [10]. The derived hematological indices of Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH) and Mean corpuscular hemoglobin concentration (MCHC) were calculated using the standard formula, $MCV = PCV/RBC \times 10$; $MCH = Hb/RBC \times 10$ and $MCHC = Hb \text{ in } 100mg / PCV \times 100$.

Data analysis was performed using SPSS for windows 17.0 package program. Analyses of variance were carried out at 0.05 significance level.

3. Results and Discussion

The results of the laboratory assessment of blood parameters of the live samples of *C. gariepinus* and *C. africana* collected from Egbe dam are presented in Table 1. It was observed that significant differences existed ($P < 0.05$) in the Packed Cell Volume (PCV), White blood Cell Counts (WBC), Red blood Cell Counts (RBC), Hemoglobin (Hb) and Blood platelet (PLT) of the two fish species. *C. gariepinus* had higher values of blood parameters than *C.*

africana irrespective of sex, body size and weight. However, there were no significant differences ($P > 0.05$) in the blood Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) of the two fish species. Age, sex, body size and weight influenced the hematological status of fish [11]. The results obtained in the study showed that the majority of *C. gariepinus* samples collected had a higher condition factor than *C. africana*. This may be indicative of a better ecological well-being for the *Clarias species* in the dam ecosystem than for the *Channa species*. In disease diagnostics, a higher WBC count is usually positively correlated to the immune system stimulation for defense against diseases and environmental stressors [12, 13, 14]. The lower count of WBC ($37.03 \pm 9.13 \times 10^9 \text{ gdl}^{-1}$) obtained in the live specimen of *C. africana* in comparison to the higher profile ($65.51 \pm 6.9 \times 10^9 \text{ gdl}^{-1}$) exhibited by *C. gariepinus* suggests that *C. africana* could be less susceptible to environmental and pathological stressors at the time of sampling because of the lower WBC counts. Leukocytosis was observed to be directly proportional to severity of stress condition in maturing fish and that the condition was a direct stimulation of immunological defence due to the possible presence of environmental stressors [15]. The higher RBC ($3.98 \pm 0.77 \times 10^9 \text{ gdl}^{-1}$) and Hb ($17.26 \pm 1.07 \times 10^9 \text{ gdl}^{-1}$) profiles of *C. gariepinus* compared to *C. africana* ($2.01 \pm 0.24 \times 10^9 \text{ gdl}^{-1}$; $7.92 \pm 1.81 \times 10^9 \text{ gdl}^{-1}$) might result to a higher energy production and the ability to adapt better to physiological stress, such as, high temperature and lowered dissolved oxygen level for *C. gariepinus*, especially, during dry season in the tropics.

The results of the post-mortem examination of the blood samples of *C. gariepinus* and *C. africana* are presented in Tables 2 and 3. Significant differences ($P < 0.05$) existed in the blood parameters of live *C. gariepinus* compared with the post-mortem values. There were gradual reductions in the PCV value (from 48.29 ± 7.12 to $44.80 \pm 8.37\%$) at 0-30 minutes interval when the fish became brain dead and after 4-4:30 hours post-mortem (from 48.29 ± 7.12 to $23.00 \pm 6.87\%$) (Table 2). A diminishing trend in the values was also recorded for RBC and WBC, Hb and PLT, showing sharp drops in the analytical results between samples collected from live-fish and brain dead fish within intervals of 0-30 minutes, 2-2:30 hours and 4-4:30 hours. Significant differences also existed in the MCV, MCH and MCHC values of the blood samples collected at the different scheduled time intervals for the post-mortem examination. Post-mortem blood parameters values of *C. africana* exhibited a similar decreasing trend in the values from 0 hour to the period of 4-4:30 hours. The PCV value decreased from 26.16 ± 6.3 to 24.20 ± 6.05 after 30 minutes of death and progressively from 24.20 ± 6.05 to 16.00 ± 5.38 after 4:30 hours of study. This trend revealed a significant difference ($P < 0.05$) for PCV, WBC, RBC, Hb, PLT, MCV and MCH values at all the post-mortem time intervals. The results obtained for MCHC in the live fish showed no significant difference ($P > 0.05$) in comparison to the

30minutes post-mortem values (Table 3), although, the results obtained for MCHC after 2:30 hours and 4:30 hours showed significant differences ($P<0.05$).

In this study, it was observed that the diminishing trend in the blood values of the two teleosts was negatively correlated with the time of the onset of rigor-mortis (over 5 hours) probably because the fish were killed by percussive stunning. This is in agreement with [16] who reported that *Cyprinus carpio* experienced longer periods before the onset of rigor (over 6 hours) when sacrificed by percussive stunning. The

same authors also observed that the fish had a higher meat quality and blood cortisol concentration than those sacrificed by other methods. It has been reported that the killing of fish by hypothermia (fish killed in iced water) demonstrated the fastest onset of rigor, while a blow on the head gave a delay of up to 18 hours [17]. It was observed that the decline in value of the hematological parameters obtained in the sacrificed fishes became highly significant ($P<0.05$) within the first 2hours of the post-mortem study.

Table 1. Hematological characteristics of live samples of *Clarias gariepinus* and *Channa africana*

Parameter	<i>Clarias gariepinus</i>	<i>Channa africana</i>	ANOVA ($P=0.05$)
PCV (%)	48.29±7.12	26.16±6.30	0.00 ($P<0.05$)
WBC ($\times 10^9 \text{gdl}^{-1}$)	65.51±6.90	37.03±9.13	0.00 ($P<0.05$)
RBC ($\times 10^9 \text{gdl}^{-1}$)	3.98±0.77	2.01±0.24	0.00 ($P<0.05$)
Hb (gdl^{-1})	17.26±1.07	7.92±1.81	0.00 ($P<0.05$)
PLT	94.79±36.09	63.73±57.03	0.00 ($P<0.05$)
MCV (fl)	13.87±64.12	15.14±0.67	0.28 ($P>0.05$)
MCH (pg)	4.78±0.25	4.31±1.32	0.30 ($P>0.05$)
MCHC (gdl^{-1})	36.53±3.42	31.17±1.52	0.19 ($P>0.05$)

Tabulated results are means of the replicates±SD. PCV=Packed Cell Volume, WBC=White blood Cells, RBC=Red blood Cells, Hb=Hemoglobin, PLT=Platelet, MCV=Mean Corpuscular Volume, MCH=Mean Corpuscular Hemoglobin, MCHC=Mean Corpuscular Hemoglobin Concentration

Table 2. Post-mortem hematological characteristics of *Clarias gariepinus*

Parameter	Live Fish	0-30MINS	2-2:30HRS	4-4:30HRS	ANOVA ($P=0.05$)
PCV (%)	48.29±7.12 ^d	44.80±8.37 ^c	28.00±4.66 ^b	23.00±6.87 ^a	0.00 ($P<0.05$)
WBC ($\times 10^9 \text{gdl}^{-1}$)	65.51±6.9 ^d	59.40±17.64 ^c	40.00±11.18 ^b	39.20±18.96 ^a	0.00 ($P<0.05$)
RBC ($\times 10^9 \text{gdl}^{-1}$)	3.98±0.77 ^d	3.62±0.06 ^c	2.34±0.27 ^b	2.14±0.43 ^a	0.00 ($P<0.05$)
Hb (gdl^{-1})	17.26±1.07 ^d	15.60±3.20 ^c	9.32±2.18 ^b	8.04±2.72 ^a	0.00 ($P<0.05$)
PLT	94.79±36.09 ^d	92.06±24.89 ^c	45.20±18.84 ^a	73.20±30.71 ^b	0.00 ($P<0.05$)
MCV (fl)	13.87±64.12 ^d	12.35±0.99 ^c	11.73±0.81 ^a	11.93±1.72 ^b	0.00 ($P<0.05$)
MCH (pg)	4.78±0.25 ^d	4.27±0.19 ^c	3.96±0.61 ^b	3.66±0.63 ^a	0.00 ($P<0.05$)
MCHC (gdl^{-1})	36.53±3.42 ^d	35.41±3.37 ^c	33.14±3.75 ^a	33.80±3.02 ^b	0.00 ($P<0.05$)

Tabulated results are means of the replicates±SD. Means with different superscripts horizontally are significantly different at $P\leq 0.05$. PCV=Packed Cell Volume, WBC=White blood Cells, RBC=Red blood Cells, PLT=Platelet, MCV=Mean Corpuscular Volume, MCH=Mean Corpuscular Hemoglobin, MCHC=Mean Corpuscular Hemoglobin Concentration

Table 3. Post-mortem hematological characteristics of *Channa africana*

Parameter	Live Fish	0-30MINS	2-2:30HRS	4-4:30HRS	ANOVA ($P=0.05$)
PCV (%)	26.16±6.3 ^d	24.20±6.05 ^c	18.80±6.37 ^b	16.00±5.38 ^a	0.00 ($P<0.05$)
WBC ($\times 10^9 \text{gdl}^{-1}$)	37.03±9.13 ^d	34.20±14.99 ^c	23.20±8.01 ^b	18.60±8.01 ^a	0.00 ($P<0.05$)
RBC ($\times 10^9 \text{gdl}^{-1}$)	2.01±0.24 ^d	1.84±0.43 ^c	1.36±0.51 ^b	1.14±0.4 ^a	0.00 ($P<0.05$)
Hb (gdl^{-1})	7.92±1.81 ^d	7.48±1.62 ^c	5.64±1.62 ^b	5.08±1.92 ^a	0.00 ($P<0.05$)
PLT	63.73±57.03 ^d	62.00±30.32 ^c	34.80±19.56 ^b	30.20±17.68 ^a	0.00 ($P<0.05$)
MCV (fl)	16.73±0.67 ^d	15.14±0.99 ^c	12.93±0.84 ^b	11.98±5.16 ^a	0.00 ($P<0.05$)
MCH (pg)	4.31±1.32 ^b	4.08±0.28 ^a	4.44±1.84 ^c	11.39±17.01 ^d	0.00 ($P<0.05$)
MCHC (gdl^{-1})	31.17±1.52 ^b	31.10±1.48 ^b	30.60±2.12 ^a	31.35±6.03 ^c	0.00 ($P<0.05$)

Tabulated results are means of the replicates±SD. Means with different superscripts horizontally are significantly different at $P\leq 0.05$. PCV=Packed Cell Volume, WBC=White blood Cells, RBC=Red blood Cells, Hb=Hemoglobin, PLT=Platelet, MCV=Mean Corpuscular Volume, MCH=Mean Corpuscular Hemoglobin, MCHC=Mean Corpuscular Hemoglobin Concentration

4. Conclusions

This study showed that the hematological parameters of the studied fish species diminished significantly within the first 2 hours while rigor-mortis was delayed. The results obtained in the study revealed that the autolytic reactions on the blood of the fish species presumed rigor mortis. The low profile of the blood level in *C. africana* is suggested to be responsible for its faster diminishing rate compared to *C. gariepinus* which had a higher blood profile. It is recommended that the immediate consumption of freshly harvested fish and or their appropriate processing and storage techniques are critical in fish utilization.

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