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Haematological and serum biochemical profiles of Nile tilapia, *Oreochromis niloticus* from different culture enclosures

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Abstract
The present study was designed to investigate the haematological and serum biochemical parameters of Nile Tilapia *Oreochromis niloticus* from different culture enclosures (plastic tank, sandcrete tank and earthen pond), at the Teaching and Research Farm of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria. Haematological parameters such as red blood cells (RBC), haemoglobin (Hb), white blood cells (WBC), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) and the serum biochemical parameters like protein, albumin, glucose, cholesterol and alanine aminotransferase (ALT) were determined within the three culture enclosures using One-Way Analysis of Variance (ANOVA) at 95% confidence level, comparisons among means were separated by Duncan Multiple Range Test (DMRT) at $p<0.05$. There was significant difference ($p<0.05$) in WBC, PCV, Hb, RBC, MCH and MCHC between *O. niloticus* fingerlings reared in plastic, sandcrete tanks and earthen pond. Fish reared in plastic tank had the highest values of PCV, Hb and RBC (38.0, 12.6 and 4.22), while fish reared in earthen pond had the lowest values of PCV, Hb and RBC (24.3, 7.83 and 2.68). The white blood cell and mean corpuscular volume of *O. niloticus* reared in earthen pond (9.10, 90.7) was higher than the one reared in sandcrete tank (8.57, 90.1) and plastic tank (8.83, 90.6). Also, the result of the blood chemistry showed significant difference ($p<0.05$) in protein and cholesterol values of *O. niloticus* from the three culture enclosures. However, there was no significant difference ($p>0.05$) in ALT, glucose and albumin from the three culture enclosures. *O. niloticus* from earthen pond had the highest protein value of 9.58, while sandcrete and plastic tank had the lowest values that are similar to each other (7.28 and 7.26). However *O. niloticus* from earthen pond had the lowest cholesterol value of 2.01 while sandcrete and plastic tank had 2.12 and 2.15 respectively. This study thus, provides baseline information on the physiological status of *O. niloticus* from different culture enclosures (plastic, sandcrete tanks and earthen pond).

Keywords: Haematology, serum biochemical, culture enclosures, *Oreochromis niloticus*

1. Introduction
The Nile tilapia, *Oreochromis niloticus* (Family Cichlidae) has been widely cultured due to its culture potentials, because it has high reproductive and growth rates, relatively disease free, scaly and hardy in nature [1]. It has been successfully farmed under a wide range of environmental conditions and is an important aquaculture fish species in many parts of the world, particularly in tropical and sub-tropical countries [2, 3].
It is usually a native fish species of high commercial value in lakes and rivers where they are found. The good health status of fish is the main element for their welfare, thus it is of great significant [4]. Blood parameters analyses have proven to be valuable tools in the development of aquaculture system, which helps to analyze the health status of farmed and uncultured fish as these indices provide reliable information on possible exposure to mutagens, metabolic disorders, deficiencies and chronic stress status before clinical symptoms appears [5]. [6] opined that haematological profile reflects the physiological responsiveness of the animals to its internal and external environment. Therefore, any change in the external environment can cause a dysfunction of blood and as such have severe effects on the physiological activities such as resistance to disease, metabolism, breeding performance and health condition of the entire body. In general, blood profile gives important information on fish nutritional, physiological and health conditions.

Hence, the haematological status reflects animal processes. According to [7], the environmental conditions of fish, especially water quality, can influence the packed cell volume (PCV), red blood cells count (RBC), erythrocyte count, white blood cells count (WBC) and haemoglobin (Hb). Also, serum biochemical condition provides information on state of internal organs, electrolytes, proteins as well as nutritional and metabolic parameters [8].

Prompted by these reports, the present study is designed to investigate the haematological and serum biochemical profile of Nile tilapia *Oreochromis niloticus* from different culture enclosures (plastic, sandcrete tanks and earthen ponds). The aim is to obtain baseline knowledge and to check if there will be variation in the haematological and serum biochemical profile of Nile tilapia *Oreochromis niloticus* from different culture enclosures.

2. Materials and Methods

2.1 Sample Collection

Nile tilapia *Oreochromis niloticus* used for this study was obtained from different culture enclosures (plastic, sandcrete tanks and earthen ponds), at the Teaching and Research Farm of the Department of Fisheries and Aquaculture Technology, the Federal University of Technology, Akure, Ondo State. Three fish samples of average weight 127±2.03g from each enclosure were selected for haematological and serum biochemical profile.

2.2 Sample Preparation

Haematological assessment was carried out on *Oreochromis niloticus*. Blood samples were collected through the vertebral blood vessels towards the caudal peduncle. 2 ml of blood from the fish was collected from the cardiac puncture using different 5ml disposable heparinized syringes, with ethylene diamine tetra acetic acid (10 ml EDTA) as anticoagulant.

2.3 Determination of Haematological Parameters

Standard haematological procedures described by [9] were employed in the determination of white blood cell (WBC), red blood cell (RBC), haemoglobin (Hb) and packed cell volume (PCV). The values of mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to the method of [10].

2.4 Serum Biochemical Analyses

Three (3) ml blood sample was also transferred into a tube containing Lithium Heparin (LH) anticoagulant for plasma biochemical analysis. The plasma obtained by centrifugation from the lithium heparinised samples was stored at 20^0 C until analyzed. The parameter determined includes; glucose, total protein, albumin, cholesterol and alanine aminotransferase (ALT) using modified method of different researchers.

2.5 Data analyses

The data collected were analysed by one way analysis of Variance (ANOVA) at 95% confidence level using SPSS (version 22) as described by [11].Comparisons among means were separated using Duncan Multiple Range Test (DMRT) at $p<0.05$.

3. Results

Considering the haematological parameters, it was found that the means and range values of white blood cell (WBC), red blood cell (RBC), haemoglobin (Hb), packed cell volume (PCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) of *Oreochromis niloticus*, observed from the three culture enclosures (Plastic, Sandcrete tanks and Earthen pond) respectively as shown in Table 1 was significantly difference ($p<0.05$). However there was no significant difference in mean corpuscular volume (MCV) of *O. niloticus* from the three culture enclosures.

The following range of values $8.57x10^3$/µl – $9.10x10^3$/µl, 24.3% – 38.0%, 7.83g/dl –12.6g/dl, $2.68x10^3$/µl – $4.22x10^3$/µl, 90.1 fl – 90.7fl, 29.2pg – 30.2pg and 32.2gm/l – 33.4gm/l was obtained for white blood cell, packed cell volume, haemoglobin, red blood cell, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration respectively.

Table 1: Some Basic Haematological Parameters of *Orechromis niloticus* from the Three Culture Enclosures (Plastic, Sandcrete Tanks and Earthen Pond)

Parameters	Plastic Tank	Sandcrete Tank	Earthen Tank
WBC($x10^3$/µl)	8.83 ± 0.35^a	8.57 ± 0.24^a	9.10 ± 0.06^b
PCV (%)	38.0 ± 0.29^c	27.5 ± 1.15^b	24.3 ± 0.88^a
Hb (g/dl)	12.6 ± 0.12^c	9.17 ± 0.38^b	7.83 ± 0.19^a
RBC($x10^3$/µl)	4.22 ± 0.03^c	3.03 ± 0.13^b	2.68 ± 0.08^a
MCV(fl)	90.6 ± 0.40^a	90.1 ± 0.18^a	90.7 ± 0.78^a
MCH(pg)	30.2 ± 0.11^b	30.0 ± 0.04^b	29.2 ± 0.31^a
MCHC(gm/l)	33.4 ± 0.10^b	33.2 ± 0.05^b	32.2 ± 0.44^a

Means in the same row with different superscripts are significantly different at ($p<0.05$)

Table 2 shows the results obtained for the serum biochemical composition (glucose, protein, cholesterol, ALT and albumin) of *Orechromis niloticus* in plastic, sandcrete tanks and earthen pond. The result showed no significant differences ($p>0.05$) in ALT, glucose and albumin of *O. niloticus* from the three culture enclosures. However, the protein and cholesterol of *O. niloticus* obtained from the three culture enclosures shows significant difference ($p<0.05$). The result revealed that *O. niloticus* reared in earthen pond had the highest protein content of 9.58, while sandcrete and plastic tanks had the lower protein content that are similar to each other (7.28 and 7.26). However, *O. niloticus* from earthen pond had the lowest cholesterol level of 2.01 while sandcrete and plastic tanks had 2.12 and 2.15, respectively.

Table 2: Serum Biochemical Composition of *Orechromis niloticus* from the Three Culture Enclosures (Plastic Tank, Sandcrete Tank and Earthen Pond)

Parameters)	Plastic Tank	Sandcrete Tank	Earthen Tank
ALT (g/dl)	24.6 ± 0.02^a	24.8 ± 0.02^a	25.4 ± 0.02^a
Glucose (mg/dl)	9.64 ± 0.02^a	9.64 ± 0.02^a	9.64 ± 0.02^a
Protein (g/dl)	7.26 ± 0.07^a	7.28 ± 0.07^a	9.58 ± 0.01^b
Cholesterol (g/dl)	2.15 ± 0.07^c	2.12 ± 0.01^b	2.01 ± 0.01^a
Albumin (g/dl)	3.25 ± 0.00^a	3.25 ± 0.01^a	3.25 ± 0.07^a

Means in the same row with different superscript are significantly different at ($p<0.05$)

4. Discussion

The result of the haematological parameters of *Orechromis niloticus* observed from the three culture enclosures (plastic, sandcrete tanks and earthen pond) in the present study showed significant difference ($p<0.05$) between the WBC, RBC, Hb, PCV, MCH and MCHC of *O. niloticus* reared in the three culture enclosures, this agrees with the report of [12] who

reported similar values for *O. niloticus* culture in semi-intensive system, However there was no significant difference (p>0.05) in MCV of *O. niloticus* reared in the three culture enclosures. The values gotten from this present study was within the normal range recommended for healthy fish [13-16].

White blood cells count obtained from this study was in consonance with the recommended range for a typical healthy fish [13, 15]. The differences in WBC values in this study could be as a result of differences in culture facilities [17]. WBC values gotten from this study was within the range with the one reported by [18] on Heamatological and serum biochemical profile of Nile tilapia, *Oreochromis niloticus* from Ero Dam in Ikun Ekiti, Ekiti State, Nigeria. In reference to other species, WBC counts in this study are higher than 4.01 x103mm- 3 reported for *P. obscura* [19]. According to [20], WBC counts have implication for immune responses and the ability of the animal to fight infection.

The PCV value of *O. niloticus* reared in earthen pond (24.3) was lower than the value of *O. niloticus* reared in sandcrete and plastic tank (27.5 and 38.0), respectively. However, the mean values of packed cell volume (PCV) obtained from this study were within the range of 22 – 48% [16] and 23 – 43% [21], for healthy fish. This result was also in consonance with the normal range (20 to 50%) recommended by [22] and [23]. These differences in values may be due to environmental condition or species specific hematological characteristics in teleost as reported by [24]. The RBC value of *O. niloticus* reared in earthen pond (2.68) is lower than the value of *O. niloticus* reared in sandcrete and plastic tanks (3.03 and 4.22), respectively. However, RBC value in this study was greater than that of *Clarias anguillaris* (2.60±0.45 µL) from Geriyo Lake, Nigeria [25]. The elevated RBC counts and HB concentration in fish are a response to the higher metabolic demand [26] and physiological adaptation to different modes of life (i.e., habits) and ecological habitats [17]. [23] opined that RBC generally shows inter and intra species differences in the same or different environment.

The mean corpuscular volume of *O. niloticus* in this study did not differ considerably from the values reported by [15] for normal, healthy fish. This finding is thus in consonance with the findings of [27], who respectively report 99.29±2.00 and 116.16 µl mean corpuscular volume in *Chrysichthys nigrodigitatus* from Asejire dam.

The mean values of corpuscular haemoglobin obtained for *O. niloticus* from the three culture enclosures (plastic tank 32.2, sandcrete tank 33.2 and earthen pond 33.4) from this study were similar to findings of [28] and [14]. These values therefore fall within the normal range recommended for healthy fish [15, 29, 12].

Blood biochemical parameters with significant difference (p<0.05) were observed for the protein and cholesterol from the three culture enclosures (plastic, sandcrete tanks and earthen pond). In fish, proteins are among the main energy sources which play an important role in the maintenance of blood glucose [30, 31] opined that serum biochemistry varies from species to species and can be influenced by many biotic and abiotic factors such as water temperature, seasonal pattern, food, age and sex of the fish. The blood biochemistry value gotten from the three culture enclosures from this present study was higher than the values recorded by [32] in *O. aureus* reared in concrete tank. However, the values recorded by [18] on haematology and Serum biochemical profile of Nile Tilapia, *Oreochromis niloticus* from Ero Dam in Ekiti State was higher than the values gotten from this present study. The protein value of *O. niloticus* obtained in earthen pond (9.58) is greater than the value of *O. niloticus* obtained in sandcrete and plastic tank (7.28 and 7.26), respectively. However, the total serum protein for *O. niloticus* in this study was in line with the normal range for healthy fish [32, 33]. Contrarily, this value was lower than 11.25 g l-1 obtained for *Heteropneustes fossilis* [34]. The result from this study was however higher than the value 4.45 g l-1 in *P. obscura* [13] and 4.8 – 7.8 g l-1 in *Oreochromis* hybrid [15].

Total serum protein is the protein component of the blood and it increases with starvation or any other stress. In the present study, protein concentration does not differ significantly between sandcrete and plastic tank but shows highly significant difference between earthen pond and sandcrete/plastic tank of *O. niloticus* used for this study, this difference could be attributed to physiological adaptation and ecological habitats, [17].

Albumin helps in transportation of lipid in fishes and also helps in the general metabolism of fishes. The rise in albumin concentration in animals due to loss through faeces or through break down may result in impaired synthesis In this study albumin content is not significantly difference from the three culture enclosures. Several studies demonstrated that basal levels of glucose varied in ecologically-distinct species, in part influenced by environmental and non environmental factors such as feeding habits and life mode of the fish, particularly related to locomotion. It is reported that glucose in blood serum is the best indicator of stress in fish.

Blood glucose is an important source of energy for many cells. Blood glucose is normally maintained by the breakdown of dietary carbohydrates and a rather complex system of endogenous production. [35] pointed out that temperature affects the blood sugar levels. The values obtained for blood sugar in this study was in accordance with the values range (7.50 – 12.00) reported by [36]. The significant different in cholesterol concentration of *O. niloticus* from the three culture enclosures could be due to variations in activity, environment /culture condition and ecological habitats, [17].

5. Conclusion

The results of this research has established a reference value regarding the selected haematological and serum biochemical parameters of the Nile Tilapia, *Oreochromis niloticus* under different culture enclosures (plastic, sandcrete tanks and earthen pond) employed in this study. Hence, the reference intervals obtained in haematological and biochemical parameters from this study could be helpful as a tool to monitor the health status of Nile Tilapia, *Oreochromis niloticus* and other related fish species. The evaluation of hematological parameters will grant early detection of clinical pathology as well as the presence of disturbance in the environment.

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