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Haematological Parameters and Serum Biochemistry of *Clarias Gariepinus* Fingerlings Reared Under Three Different Culture Systems

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Abstract: This study investigated the haematological and serum biochemical parameters of *Clarias gariepinus* from different culture systems (plastic tank, concrete tank and earthen pond), at the Joseph Sarwuan Tarka Fish Farm of the Department of Fisheries and Aquaculture Makurdi, Benue State. 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), mean corpuscular haemoglobin concentration (MCHC), lymphocytes, neutrophil, monocytes and eosinophil and the serum biochemical parameters like protein, albumin, glucose, AST, cholesterol, sodium, potassium ,calcium, chloride and alanine aminotransferase (ALT) were determined within the three culture system using standard procedures. One-Way Analysis of Variance (ANOVA) at 95% confidence level was employ for comparisons of the various parameters in the different culture enclosure. Means were separated by Duncan Multiple Range Test (DMRT) at $p>0.05$). However, there was a significant difference ($p>0.05$) in Protein, AST, cholesterol, potassium, calcium, chloride, glucose and albumin from the three culture systems. *C. gariepinus* from concrete tank had the highest ALT value of 50.30, while earthen pond and plastic tank had the lowest values that are similar to each other (47.75 and 48.00). Nevertheless, *C. gariepinus* from earthen pond had the lowest sodium value of 88.35 while concrete and plastic tank had 100.35 and 100.35 respectively. This study thus, provides baseline information on the physiological status of *C. gariepinus* from different culture systems.
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1. Introduction

Globally, aquaculture industry contributes 46% of the world fish production and is one of the rapid growing food sectors in the world (FAO, 2020). Aquaculture in Nigeria is primarily based on catfish production and the prospects of fish supply in the country depend on its culture and development (Adewumi and Olaleye, 2011). *Clarias gariepinus* (Family Clariidae) is the most commonly cultivated fish species in the country, making Nigeria the largest producer of *Clarias gariepinus* in Africa and third in the world, after Thailand and Indonesia (FAO, 2010).

The African catfish (*Clarias garipienus*) among other fish species has been reported to be a suitable aquaculture species in Nigeria and other countries in Africa (Eyo *et al*., 2015, Inyang-Etoh and

George, 2018) due to several favorable characteristics which include its ability to tolerate a wide range of environmental conditions and high stocking densities under culture conditions, fast growth rate, acceptability of artificial feed, and high fecundity rate among others (Eyo *et al*., 2015). The general physiological response of fish to threatening situations, as with all vertebrates, is referred to as stress. Such physiological studies can provide many valuable insights to inform fish conservation and management. These include how fishes respond to and tolerate a range of environmental conditions, and how fish bodies and internal processes change throughout different life stages and in different culturing system.

Aquaculture has been practiced successfully in different culture systems ranging from natural water bodies (pens and cages), earthen ponds, concrete tanks, fiberglass tanks and plastic tanks (Dagne *et al*., 2013). The selection of culture facility depends on the available materials, operation size and the level of expertise of the farm manager (Akinwole *et al*., 2014). The dominant culture facilities in Nigeria remain the earthen ponds and concrete tanks (Akinwole and Akinnuoye, 2012).

The health status of fish is one of the major elements for their welfare, thus it is of great significant (Atanasova *et al.*, 2008). Analysis of Blood parameters has shown to be a valuable tool 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 (Bahmani, *et al.*, 2001). According to Esonu, *et al*., (2001) 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.

Therefore, the haematological status of a fish reflects it processes. 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) (Lataretu *et al.*, 2012).

Also, serum biochemical condition provides information on state of internal organs, electrolytes, proteins as well as nutritional and metabolic parameters (Newman *et al.*, 1997). Therefore, there is need to evaluate the haematological and serum biochemical profile of *Clarias gariepinus* from different culture enclosures (plastic, concrete and earthen ponds).

Haematological and serum biochemical studies of cultured fish are important in order to monitor the health of fish during cultivation. Such studies are particularly useful in assessing a fish's physiological and physiopathological status, since morphological and biometric parameters alone do not always give a complete picture (Adakole, 2012; Tavares-Dias and Moraes, 2007).

In warm-blooded animals, changes in the blood parameters which occur because of injuries or infections of some tissues or organs can be used to determine and confirm the dysfunction or injuries of the organs or tissues. However, in fish, these parameters are more related to the response of the whole organism, i.e., to the effect on fish survival, reproduction and growth. Therefore, this study aims at evaluating the haermatological and serum biochemistry of Clarias gariepinus in different culture systems.

2. Material and Methods

2.0. Materials and Methods

2.1 Collection of Samples

African catfish Clarias gariepinus used for this study was obtained from different culture enclosures (plastic, concrete and earthen ponds), at the Joseph Sarwuan Tarka Fish Farm of the Department of Fisheries and Aquaculture Makurdi, Benue State. Ten fish samples of average weight 226.7±5.04g, 211.4±4.05g and 205.4±2.02g from each enclosure were selected for haematological and serum biochemical profile.

2.2 Sample Preparation

Clarias gariepinus 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 for haematological and serum biochemical anlysis.

2.3 Determination of Haematological Parameters

Haematological parameters were analysed following the procedure described by (Svobodova *et. al.*, 1991). 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 Stockham, *et. al.* 2008.

2.4 Serum Biochemical Analyses

Three (3) ml of blood sample was collected and 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 ^{o}C until analyzed. The parameter determined includes; glucose, total protein, albumin, cholesterol, alanine aminotransferase (ALT), sodium (Na), Potassium (k), chloride (Cl) and calcium (Ca) using modified method of different researchers.

2.5 Data analysis

The data collected were analysed using one-way analysis of Variance (ANOVA) at 95% confidence level using SPSS (version 22). Also, means were separated using Duncan Multiple Range Test (DMRT) at $p<0.05$.

3.0 Results

3.1 Haematological Parameters of *Clarias gariepinus* from the three culture enclosures (Plastic, Concrete Tanks and Earthen Pond).

The means and range values of white blood cell (WBC), red blood cell (RBC), haemoglobin (Hb), packed cell volume (PCV), mean corpuscular haemoglobin concentration (MCHC), lymphocytes, neutrophil, monocytes and eosinophil of *Clarias gariepinus*, observed from the three culture enclosures (Plastic, Concrete and Earthen Pond) respectively as presented in Table 1 was not significantly different ($p>0.05$). However, there was a significant difference ($p<0.05$) in mean corpuscular haemoglobin (MCH) of *Clarias gariepinus from* the three culture enclosures. Generally, mean corpuscular haemoglobin (MCH) ranges between 22.45±0.15-24.75±0.15.

Table 1: Basic Haematological Parameters of Clarias gariepinus Examine from three different culture enclosures (Concrete tank, earthen pond, plastic tank)

Parameters	CT1	ET2	PT3	P-value
PCV (%)	33.0 ±1.00	31.50 ±2.50	32.50 ±0.5	0.805
RBC ($X10^{12}$/l)	4.45±0.15	4.45±0.55	4.75±0.45	0.851
WBC ($X10^{9}$/l)	5.10±0.20	5.20±0.40	4.75±0.45	0.693
HB (g/dl)	11.0±0.30	10.00±1.30	10.65±0.45	0.707
MCV (fl)	74.15±0.25	71.20±3.20	71.60±2.80	0.689
MCH (pg)	24.75±0.15	22.45±0.25	23.30±0.40	0.019
MCHC (gm/l)	33.30±0.10	33.30±0.10	33.25±0.05	0.898
Lymphocytes (%)	66.00±1.00	61.00±1.00	64.50±1.00	0.121
Neutrophil (%)	25.00±1.00	28.00±1.00	25.50±1.50	0.303
Eosinophil (%)	3.50 ±1.50	3.50±0.50	3.50±0.50	1.000
Monocytes (%)	5.50±0.50	7.50±0.50	6.50±0.50	0.142

Where; CT1: Concrete tank 1, ET2: Earthen Pond 2, PT3: Plastic tank 3

3.2 Serum Biochemical Composition of *Clarias gariepinus* from the three culture enclosures (Plastic Tank, concrete Tank and Earthen Pond)

The results obtained for the serum biochemical composition (T. Protein, glucose, potassium, chloride, sodium, calcium, cholesterol, ALT, AST and albumin) of Clarias *gariepinus* in plastic, concrete tanks and earthen pond are presented in Table 2. The result showed no significant differences ($p>0.05$) in T. Protein, AST, cholesterol, potassium, chloride, glucose and albumin of C. *gariepinus* from the three culture enclosures. However, the ALTand sodium of *Clarias gariepinus* obtained from the three culture enclosures shows significant difference ($p<0.05$). The result revealed that *Clarias gariepinus* reared in concrete tank had the highest ALT content of 50.30±0.50 while earthen and plastic tanks had the lowest ALT content that are similar to each other (47.75±0.15 and 48.00±0.40). However, *Clarias gariepinus* from earthen pond had the lowest sodium level of 88.35±2.05 while concrete and plastic tanks had 100.35±1.95and 100.35±1.05, respectively.

Table 2: Serum Biochemical Composition of Clarias gariepinus from the Three Culture Enclosures (Plastic Tank, concrete Tank and Earthen Pond)

Parameters	CT1	ET2	PT3	P-value
T. Protein (g/dl)	7.15±0.05	6.80±0.00	6.95±0.25	0.368
Albumin (g/dl)	4.00±0.10	3.85±0.05	4.00±0.10	0.465
ALT (µ/l)	50.30±0.50	47.75±0.15	48.00±0.40	0.031
AST (µ/l)	65.95±4.50	47.75±0.15	48.00±0.40	0.810
Cholesterol	98.90±1.10	93.60±0.80	95.00±1.70	0.117
Glucose (mg/dl)	119.10±11.80	125.55±0.35	129..00±4.10	0.652
Sodium (mmol/l)	100.35±1.95	88.35±2.05	100.35±1.05	0.026
Potassium (mmol/l)	4.40±0.20	4.00±0.30	3.75±0.50	0.267
Chloride (mmol/l)	104.35±1.95	106.35±2.05	100.80±4.40	0.505
Calcium (mg/dl)	6.75±0.45	6.95±0.05	6.55±0.45	0.764

4.0 Discussion and Conclusion

4.1 Discussion

The result of the haematological parameters of *Clarias gariepinus* observed from the three culture enclosures (plastic, concrete tanks and earthen pond) in the present study showed no significant difference ($p>0.05$) between the WBC, RBC, HB, PCV, MCH, MCHC, lymphocytes, neutrophil, monocytes and eosinophil of *Clarias gariepinus* reared in the three culture enclosures. However, there was a significant difference($p<0.05$) in mean corpuscular haemoglobin (MCH) of *Clarias gariepinus from* the three culture enclosures.

The MCH value of *Clarias gariepinus* reared in earthen pond (22.45) was lower than the value of *Clarias gariepinus* reared in plastic and concrete tanks (23.30 and 24.75), respectively. These differences in values may be due to environmental condition or species-specific hematological characteristics as reported by Akinrotimi *et al*., (2011). The mean values of corpuscular haemoglobin obtained for *Clarias gariepinus* from the three culture enclosures from this study were similar to findings of Odo *et al*., (2009) who reported similar values for *Heterotis niloticus*. These values therefore, fall within the normal range recommended for healthy fish (Nilza *et al.*, 2003).

WBC values gotten from this study did not differ significantly. However, WBC counts recorded in this study was higher than 4.01 $x10^3$ mm^3 reported by Adebayo *et al*., (2007) for *P. obscura*. According to Douglass and Jane, (2010) WBC counts also called leukocyte or white corpuscle, a cellular component of the blood that lacks haemoglobin helps to defend the organism against infection and diseases by ingesting foreign materials and cellular debris. The values of WBC recorded for the three different culture system in this study fell within the acceptable range for healthy fish.

The mean values of packed cell volume (PCV) obtained from this study were within the normal range of 22 – 48% for healthy fish. A decreased in PCV indicates anaemia, or haemodilution. The PCV recorded for the three-culture system were within the normal range indicating the suitability of these enclosure for fish culture. However, RBC value in this study was greater than that of *Clarias anguillari*s (2.60±0.45 µL) from Geriyo Lake, Nigeria (Onyia *et al*., 2015). The elevated RBC counts and HB concentration in fish are a response to the higher metabolic demand (Satheeshkumar *et al.,* 2011) and adaptation to different ecological environment.

The mean corpuscular volume of *Clarias gariepinus* in this study did not differ considerably from the values reported by (Hrubec *et al.,* 2000) for normal, healthy fish. The mean corpuscular volume of *C. gariepinus* in this study did not differ considerably from the values reported by Hrubec et.al., (2000) for normal healthy fish. However, the values of MCV recorded were lower than earlier assertion made by Adedeji and Adegbile, (2011) who reported 99.29±2.00 and 116.16 µl mean corpuscular volume in *Chrysichthys nigrodigitatus* from Asejire dam and Oluwalola, *et. al*., (2020) who reported a mean range of between 90.1 ± 0.40 – 90. 7 0.78 fl for *O. niloticus* from different culture enclosures. These values recorded is an indication of the relative well-being of the fish in the different culture enclosure. Adesina (2017) opined that MCV is an indication of the status or size of RBCs and reflects normal or abnormal cell division during RBC production. Thus reduced MCV values could be linked to shrinkage of RBCs produced in low iron environment or by destruction of RBCs leading to anaemia as reported by Adesina (2017).

The lymphocytes, monocytes, eosinophils and neutrophil are indicators of health in fish and is used to get a picture of the status of an animal`s immune system

(Fagbenro *et al*., 2000). The insignificant changes in these parameters of fish in different cultures suggest that any possible stress-related factors (handling during sampling, anti-nutrients) were too low to induce pathological changes in the fish immune status (Fagbenro *et al*., 2000).

The result of the Blood biochemical parameter of *Clarias gariepinus* observed from the three culture enclosures (plastic, concrete tanks and earthen pond) in the present study showed no significant difference ($p>0.05$) between the protein, chloride, potassium, glucose, cholesterol, albumin, AST and calcium. Blood biochemical parameters with significant difference ($p<0.05$) were observed for the ALT and sodium from the three culture enclosures (plastic, concrete tanks and earthen pond). In fish, proteins are among the main energy sources which play an important role in the maintenance of blood glucose. According to Shwetha *et al.*, (2012), 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 results from this study are similar to those reported by Owolabi (2011), Al-Dohail *et al.* (2009) and Acharya and Mohanty (2014).

However, the total serum protein (6.8-7.15) for *Clarias gariepinus* in this study was in line with the normal range for healthy fish (Nwabueze and Rhega, 2015). Contrarily, this value was lower than 11.25 g l-1 obtained for *Heteropneustes fossilis* (Acharya and Mohanty, 2014). The result from this study was however higher than the value 4.45 g l-1 in *P. obscura* (Kori *et al.*, 2005). 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 the three culture enclosures. 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 different from the three culture enclosures. 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. However, temperature affects the blood sugar levels. The significant different in sodium concentration of *Clarias gariepinus* from the three culture enclosures could be attributed to variations in activity, environment /culture condition and ecological habitats, (Goel *et al*., 1984).

5.2 Conclusion

The values gotten from this present study was within the normal range recommended for healthy fish. Therefore, these results established a reference value regarding the selected haematological and serum biochemical parameters of the *Clarias gariepinus* under different culture enclosures (plastic, concrete 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 *Clarias gariepinus* and other related fish species.

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