



## **Haematological Response of *Clarias gariepinus* (Burchell, 1822) Fingerlings Reared in Fish Cum-Duck Integrated System**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author FPA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors UAB and IH managed the analyses of the study. Author JOO managed the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

This investigation was carried out to determine the haematological response of *Clarias gariepinus* fingerlings reared in a Fish cum-duck integrated system. One thousand and eighty pieces fingerlings with mean initial weight (MIW) and standard length (SL) ( $1.8 \pm 0.22\text{g}$ , and  $5.19 \pm 0.44\text{ cm}$ ) respectively were stocked for ten (10) weeks. The haematological investigation revealed that RBC and WBC increased significantly ( $P < 0.05$ ) within treatments. Other haematological variations were also observed in parameters such as PCV, MCV, MCH, MCHC and Hb with significant decrease ( $P < 0.05$ ) in their mean values within treatments as compared to the control. Water quality parameters such as Dissolved oxygen and Transparency shows evidential significant different ( $P < 0.05$ ), while parameters such as Temperature, Total dissolved solid (TDS), Nitrate, Phosphate, Biological oxygen demand (BOD), Turbidity and pH shows no significant difference ( $P > 0.05$ ). This studies shows in conclusion, that there were variations in the haematological and water quality parameters, but it was noticed that the values recorded could not to a greater extent hurt the fish because is still within the tolerable limits as confirmed by other research evidences. More so, the level of gains outweighs the level of damages caused as compared to the economic approach.

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**Keywords:** Fish cum-duck integrated system; haematological; investigation; water quality.

## 1. INTRODUCTION

In many parts of the globe the aquaculture activities has increased giving rise to global efforts to eliminate hunger and malnutrition by supplying fish and other aquatic products rich in protein, essential fatty acids and minerals [1,2]. In recent times the growing global demand for fish cannot be met by supplies from captured fisheries, hence the need for reliable and viable system of increasing fish production to meet the high demand for fish consumption and the aquaculture industry seems to provide the answer [3-6]. Aquaculture is the application of physical and biological principles to business of rearing fish and other aquatic organisms in an artificial enclosure containing water [7]. It entails farming of aquatic organisms and plants in fresh, brackish or marine water. Unlike capture fisheries, aquaculture requires deliberate human intervention in the organisms' productivity which results in yields that exceed those from the natural environment alone [8]. Fisheries and aquaculture is destined to play an important role in human nutrition but the cost is beyond reach of many people. Utilization of grain and animal protein as feed in aquaculture may not be economical as it might lead to food crisis and attention is being redirected to wider use of all resources and integrated fish farming offers a solution to the problem. Recycling of organic wastes for fish culture serves the dual purpose of cleaning the environment and providing economic benefits.

A variety of definitions of integrated fish farming systems (IFFS) exist. They include: practices which link two normally separate farming systems, whereby outputs (usually by-products) of one production sub-system (livestock) are used as inputs by another sub-system (fish) [9,10] or diversifications of agriculture towards linkages between subsystems (or systems of producing fish in combination with other agricultural/livestock farming operations centred on the fish pond [11]. Integrated farming system as an aquaculture system that is integrated with livestock's and in which fresh animal waste is used to feed fish and also reported that there are synergies and complementary between enterprises that comprise a crop and animal component that form the basis of the concept of integrated farming system. According to this concept, integration usually occurs when outputs of one enterprise are used as inputs by another

within the context of the farming system [12]. Stated that "there is no waste", and "waste is only a misplaced resource which can become a valuable material for another product" integrated farming system. Fish live in very intimate contact with their environment, and are therefore very susceptible to physical and chemical changes which may be reflected in their blood components [13]. Blood cell responses are important indicators of changes in the internal and/or external environment of animals. In fish, exposure to chemical pollutants can induce either increases or decreases in haematological levels. Haematology has been developed and well utilized in assessing the health of man and livestock [14]. Opined that fish haematology would be useful in the assessment of suitability of feeds or feed mixtures, evaluation of fish conditions, determination of toxic effect of substances as well as diagnosis of disease. Many factors appeared to constrain close integration of traditional poultry and fish culture. The poor quality supplementary feeds usually given and the fact that confinement is restricted to overnight, result in less and poorer quality manure being available for use in fish culture. Moreover, farm households may already be using the poultry waste which is collectable for other purposes such as fertilizing backyard crops. Recent analysis of current poultry production in small-scale farming households reveals a marginal but important niche. Developing reference intervals or normal range values are also a necessary first step in determining which specific haematological changes can be associated with disease conditions [15,16,17]. Therefore, the purpose of this research work is to investigate the haematological variations in *C.gariepinus* fingerlings that are caused as a result of being raised in fish- cum-duck integrated system.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Location, Design and Procedure

The experiment was carried out at integrated subunit of Aquaculture and Biotechnology department of National Institute for Freshwater and Fisheries Research (NIFFR), New Bussa., Niger State. The experimental design was a completely randomized design (CRD) with two (2) treatments levels and each level having three replicates to test the effect of duck integration on

the blood parameter of *C.gariepinus* fingerlings. The experiment involved two treatments; treatment 'A' stands for system with ducks integration and treatment 'B', stands for system with no ducks integration.

## 2.2 Sources and Stocking of Fingerlings/ Birds

Standard sized fingerlings of *Clarias gariepinus* of at least 6-8cm in standard length (SL) with mean initial weight (MIW) of  $(1.8 \pm 0.22g)$  were sourced from a reputable fish farmer in New Bussa. Twelve adult ducks of mean initial body weight of  $(1.12 \pm 0.28) g$  with no symptoms of diseases were sourced from the market also in New Bussa. The fishes were stocked at 5fish/m<sup>2</sup> and the birds were also stocked at 1600 birds/ha.

## 2.3 Construction of Pond, Pen House and Management

A total land area of 72m<sup>2</sup> was used for this investigation. A total of six (6) rain fed ponds were designed with each ponds inlets and outlet with a dimension of 6 m x 6 m = 36m<sup>2</sup> with replicates summing up to six (6) ponds for the investigation. In the treatment A, with ducks, a partial integration was designed with a pen house constructed on the dyke of the pond. A pen house with area of 3.3m<sup>2</sup> was constructed to house twelve ducks. The same dimension of pond was also designed for treatment B with no ducks stocked.

## 2.4 Management of the System

The management system adopted was, treatment A, with two (2) ponds stocked with 180 pieces of fingerlings each, rely solely on the excretal from the duck with no supplementary feed. Each day in the morning, the Birds were fed ad-libitum with formulated diets for birds that consisted of maize brown, millet and clupeids. When they have been feed to satiation, they will then be released into the system for them to fend throughout the day till around 5:30pm when they will then be pursued into their pen to be served their evening food. They will not be allowed to come out till 7:00am, the next morning for their food again. In the morning every day, the excretal overnight will be served to the fishes in the ponds.

Treatment B, without ducks are fed twice daily at 5% body weight with formulated feed of 40%

crude protein. The experiment lasted for Three (3) months.

## 2.5 Water Quality Parameters Determination

Water quality parameters like; Dissolved oxygen (DO), Biological oxygen demand (BOD), Water temperature, Ambient water temperature, Total dissolved solids (TDS), Nitrate, Phosphate, Transparency, Turbidity, pH and Colour were all determined at the beginning before the commencement of work and fortnightly during the experimental period.

## 2.6 Collection of Blood Sample

In the beginning of the experiment, an initial blood parameter was taking from the pulled population of the fingerlings of *C. gariepinus*. Also, at the end of the experimental period, fishes were sampled for collection of blood. The blood samples were collected into heparin bottles per treatments. At the lab, fishes from which blood Samples were to be taken were incised at the caudal peduncle. The method of blood collection was done according to the method of [18]. The following blood parameters were analysed; Red blood cell (RBC), White blood cell (WBC), Pack cell volume (PCV), Mean cell volume (MCV), Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration. (MCHC).

## 2.7 Analysis of Blood Samples

Blood filled heparinized microhaematocrit capillary tubes were centrifuged at 12000 for 5 minutes using a microhaematocrit centrifuge and haematocrit values read directly. The red blood cell and white blood cell counts were determined using a method devised by Gaafar, et al. [18]. Haemoglobin (Hb) was determined using the method described by [19]. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated from values of haemoglobin, haematocrit and total red blood count using the formula by [20].

## 2.8 Statistical Analysis

The statistical analysis of the haematological parameters was done using SPSS version 20.0. The values obtained were confirmed using one-way ANOVA at 0.05 level of significance. Further

test on those found to be significant was done using Duncan Multiple Range tests (DMRT).

### 3. RESULTS AND DISCUSSION

#### 3.1 Physico Chemical Parameters

Table 1. presents the result of water physico chemical of the system. The values variation was more evident in water quality parameters like dissolved oxygen with values of ( $3.33 \pm 0.58$ ,  $4.40 \pm 0.53$  and  $2.7 \pm 0.58$ ) with significant differences within the treatment for control, treatment A and treatment B respectively.

The result on this table also presented the variation in values for parameters such as Total dissolved solids and Transparency within treatments. TDS had values of ( $31.83 \pm 1.22$ ,  $31.83 \pm 1.22$  &  $20.52 \pm 0.56$ ) respectively for treatment A and B and control treatment respectively. The values for transparency also varied significantly within treatments with ( $0.30 \pm 0.00$ ,  $0.40 \pm 0.02$  and  $0.34 \pm 0.04$ ) cm values for

control, treatment A and treatment B respectively. Every other water quality parameter had no significant variation in their presentation and they seem to be within the range permissible for aquaculture practices.

#### 3.2 Haematological Response of *Clarias gariepinus* Fingerlings

The values presented on Table 2 shows that there were significant differences ( $P < 0.05$ ) within treatments for the haematological parameters measured. The values for the White blood cell (WBC) in the Initial value was  $1.52 \pm 2.65$ , while the values for Treatment A ( $3.18 \pm 1.53$ ) and B ( $3.35 \pm 1.00$ ) increased significantly in Comparison with the initial value. The value for treatment B ( $3.35 \pm 1.00$ ) was significantly highest. The values for Red Blood Cell also showed significant increase in values. The initial value ( $1.70 \pm 0.00$ ) as compared to treatment A ( $2.86 \pm 0.06$ ) and treatment B ( $3.00 \pm .006$ ) respectively, with B ( $3.00 \pm .006$ ) with highest significant value.

**Table 1. Physico chemical parameter of the pond water**

Parameters	Control	Treatment A	Treatment B
Dissolved oxygen (mg/l)	$3.33 \pm 0.58^{ab}$	$4.40 \pm 0.53^b$	$2.7 \pm 0.58^a$
Water temp. (°c)	$30.33 \pm 0.58^a$	$30.00 \pm 0.00^a$	$30.33 \pm 0.58^a$
Ambient temp.(°c)	$26.33 \pm 0.58^a$	$26.00 \pm 0.00^a$	$26.33 \pm 0.58^a$
Total dissolved solid (mg/l)	$20.52 \pm 0.56^b$	$31.83 \pm 1.22^a$	$31.83 \pm 0.57^a$
Nitrate (mg/l)	$0.20 \pm 0.00^a$	$0.17 \pm 0.06^a$	$0.13 \pm 0.05^a$
Phosphate (mg/l)	$0.01 \pm 0.00^a$	$0.01 \pm 0.00^a$	$0.02 \pm 0.00^a$
Biological oxygen demand (mg/l)	$3.00 \pm 0.00^a$	$2.03 \pm 0.16^a$	$2.33 \pm 1.15^a$
Transparency (cm)	$0.30 \pm 0.00^b$	$0.40 \pm 0.02^a$	$0.34 \pm 0.04^b$
Turbidity (cm)	$0.40 \pm 0.00^a$	$0.40 \pm 0.02^a$	$0.37 \pm 0.06^a$
pH	$7.00 \pm 0.00^a$	$7.00 \pm 0.00^a$	$7.00 \pm 0.00^a$

Mean values along the horizontal row with different superscript are significantly ( $P < 0.05$ ) different.

Key: Control - before treatment was applied, Treatment A - system with Duck integration, Treatment B - system without Duck integration

**Table 2. Haematological variations in *Clarias gariepinus* fingerlings integrated with duck in fish cum – duck integrated system**

Parameters	Initial Values	Treatment A	Treatment B
WBC x $10^9/L$	$1.52 \pm 2.65^c$	$3.18 \pm 1.53^b$	$3.35 \pm 1.00^a$
RBC x $10^{12}/L$	$1.70 \pm 0.00^c$	$2.86 \pm 0.06^b$	$3.00 \pm 0.06^a$
PCV (%)	$30.00 \pm 0.10^a$	$23.77 \pm 0.58^c$	$25.77 \pm 0.56^b$
MCH (pg)	$26.27 \pm 0.68^a$	$18.67 \pm 0.58^b$	$15.97 \pm 0.06^a$
MCHC(g/dl)	$32.38 \pm 0.34^a$	$13.67 \pm 0.58^c$	$17.83 \pm 0.29^b$
MCV (fl)	$73.46 \pm 0.41^a$	$33.50 \pm 0.50^c$	$39.97 \pm 0.06^b$
Hb (g/dl)	$9.43 \pm 0.03^a$	$8.20 \pm 0.00^b$	$8.52 \pm 0.45^b$

Mean Values along horizontal row with same superscript are not significantly ( $P > 0.05$ ) different.

Note: (g/dl) = Gramme/decilitre, fl= Fentrolitre, pg= Pictogram, mg/l= Milligramme/litre

Key: WBC - White Blood Cell, RBC - Red Blood Cell, PCV - Pack Cell Volume, MCV - Mean Corpuscular Volume, MCH - Mean Corpuscular Haemoglobin, MCHC - Mean Corpuscular Haemoglobin Concentration Hb – Haemoglobin Content



**Fig. 1. Integration system showing the ducks in the pond, pen house on the pond's dike**

Also in Table 2. there were clear significant decreases and differences ( $P < 0.05$ ) in parameters such as PCV, MCH, MCHC, MCV and Hb respectively within treatments as compared with the initial values.

Integrated fish farming is a system of farming that provides an environment where waste is not entertained, waste are always converted as an output from one system and input to the other [21]. Stated that "there is no waste", and "waste is only a misplaced resource which can become a valuable material for another product" integrated farming system. In the knowledge of this organic build up in the system, water quality parameter is of essence for monitoring. However, the monitored physicochemical parameters were observed not to differ significantly from one another (Table 1.). This was in consonant with the findings of [22] that reveals the tolerable limits of these parameters in rearing system. Treatment A, had the highest dissolved oxygen status ( $4.40 \pm 0.53$ ), this is may be attributed to the biological aeration from the ducks in the integration system, followed by control ( $3.33 \pm 0.58$ ) and Treatment B ( $2.7 \pm 0.58$ ) respectively. This in line with result gotten by Kumar, et al. [23] who considered the effect of ducks stocked as positive on the dissolved oxygen in the water to access the growth of Indian carps.

Haematological analysis has been routinely used in determining the physiological state of animals and known to be affected by different

environmental factors, it is used as a guide in the diagnosis of many diseases and in evaluating the responses to therapy in both animals and human [24]. (Solomon and Okomoda 2012). It was clearly observed from the results of this investigation that RBC & WBC increased with significant differences amidst treatments. Lenfant and Johansen [25] reported that RBC greater than  $1 \times 10^6/\text{mm}^3$  was reported normal for fishes with aerial respiration of which the subject fish in this investigation is inclusive. The rise in WBC shows an immune response to the feed types in the treatments. The result is in agreement with work of [26] on submission of remarkable richness of pollutant (feed source) on the fish blood, where they found that more of these white blood cells and its components are recruited to combat the stressor in the blood stream of the fish. Also, the rise in Red Blood Cell (RBC) of the fish corresponds with findings documented by Shen, et al. [27] that discovered that WBC and RBC expresses similar immune responses gene in *Tilapia* species.

There was significant decrease and differences ( $P < 0.05$ ) in other haematological parameters of the *Clarias gariepinus* species within treatment as compared to the control, this is likely to be as a result of the of pollution from feed sources in the medium which is in agreement with the findings of [28] that reported effect of toxicants on blood parameters in freshwater teleost fish *Clarias batrachus*. PCV and Hb significantly reduced ( $P < 0.05$ ) in the treatments as compared

to the control. This in agreement with the report of [29], who reported decrease in PCV and Hb of *Clarias gariepinus* that were exposed to increased concentration of Sunsate® an herbicide, a toxicant and a pollutant in an acute toxicity test. Although, other haematology parameters in their investigation had different responses of significant increase as opposed to significant reduction in this investigation.

There was also significant ( $P<0.05$ ) reduction in haematological parameters recorded for MCV, MCH and MCHC. This finding is in agreement with the findings of [30]. These authors found out that there was significant reduction in the aforementioned parameters in *Clarias gariepinus* exposed to mixture of Atrazine and Metolachlor in chronic laboratory studies over 14 days.

#### 4. CONCLUSION

This investigation made us to submit to the fact that integrated farming is viable in this dynamic economy and can be tolerated because of its cost. However, there are no terrible damages to the health of fish haematologically and physiologically and as such, encouraged among peasant and rural farmers.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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