RESEARCH ARTICLE

HAEMATOLOGICAL PROFILE AND GROWTH RESPONSE OF AFRICAN SHARPTOOTH CATFISH (*Clarias gariepinus,* Burchell 1822) FINGERLINGS TO LOCALLY FORMULATED AND COMMERCIAL PELLETED DIETS IN TARPAULIN TANKS

| Ofonime Edet Afia [1] | and | Gift Samuel David [2] |

[1.] University of Uyo | Department of Fisheries and Aquatic Environmental Management | Uyo | Nigeria |
[2.] University of Uyo | Department of Fisheries and Aquatic Environmental Management | Uyo | Nigeria |

|Received | 11 May 2017| |Accepted | 21 May 2017| |Published 28 May 2017 |

ABSTRACT

Background: The desire of a fish farmer is to produce table-sized fish within the shortest possible period**.** This can be achieved by providing a good feed since the growth of a fish is influenced by its feed utilization and the feed utilization is a function of the balanced nutrient composition of the feed. Haematological studies have been employed in aquaculture and are usually associated with the feed input because blood parameters have been proved to be valuable tools in determining the health status of the fish in response to the dietary manipulations. **Objective:** This study investigated haematological indices and growth performance of *Clarias gariepinus* fingerlings fed locally formulated (sinking) and commercial (floating) pelleted diets in tarpaulin tanks. **Materials and methods:** Ninety fingerlings of initial mean weight (4.87 g) were observed for an 8 weeks feeding trial with three replicates at a stocking density of 15 fish/m^2. The fish were fed three times daily at 5% biomass. **Results:** Results from growth parameters showed that *C. gariepinus* fingerlings fed floating (commercial) diet had significantly higher ($p<0.05$) final mean weight (921.73 g ± 47.44) than sinking (locally formulated) diet (184.22 g ± 20.54). Fish fed commercial diet had significantly higher ($p<0.05$) production index (1454.13 ± 101.28) than locally formulated (191.43 ± 33.27). Water quality parameters including temperature (°C), dissolved oxygen (mg/l) and pH were not significantly different ($p>0.05$) during the study and were maintained within acceptable range. Haematological analysis shows significant difference ($p<0.05$) in haemoglobin concentration (Hb) between fish fed floating (7.53 ± 0.20) and sinking (5.63 ± 0.18) diets. Packed Cell Volume (PCV) was significantly higher ($p<0.05$) in fish fed floating (24.67 ± 0.88) than fish fed sinking (17.00 ± 0.58) diets. Red Blood Cells (RBC) was also significantly higher ($p<0.05$) in fish fed floating (1.53 ± 0.07) than sinking (1.27 ± 0.03) diets. However, White Blood Cells (WBC) was significantly lower in fish fed floating (3.27 ± 0.09) than sinking (8.43 ± 0.09) feed. Mean Corpuscular Volume (MCV) was significantly higher ($p<0.05$) for *C. gariepinus* fed floating (141.67 ± 1.76) than sinking (124.67 ± 1.76). There was no significant difference ($P>0.05$) in Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) for fish fed floating and sinking feed but both blood parameter was higher in fish fed floating (44.67 ± 1.76; 32.67 ± 0.88) than fish fed sinking (42.33 ± 0.88; 32.33 ± 0.88) respectively. **Conclusion:** Based on these findings, the different feed forms did not significantly affect blood parameters and at such can be utilized by catfish farmers but commercial feed is recommended since it gives better growth response.
Keywords: *floating feed, sinking feed, blood parameters, proximate composition, feed utilization, protein*

1. INTRODUCTION

Fish is very important to humans because it contains protein of very high quality and also has sufficient amounts of all the essential amino acids required by the body for growth and maintenance of lean muscle tissue [1]**.** The desire of fish farmers is to produce table-sized fish within the shortest possible time [2]. Aquaculture alone has the potential to supply Nigeria's requirement for fish if properly utilized. Notwithstanding, it is faced with many problems of which the provision of nutritive and cheap feed to reduce cost of production is a major concern. The act of fish culture has been in existence for long but domestic supply of fish has been inadequate, hence animal protein in the diet of Nigerians is affected from its normal recommended 40% protein level [3].

In an attempt to find cheaper, affordable, available alternative fish feed to imported commercial fish feeds, various local fish feeds have been formulated from different varieties of sources**.** This has led to the emergence and proliferation of many fish feed industries in Nigeria manufacturing and selling all sorts of fish feed with bogus and questionable formulation, nutrients composition and production [4]. Most fish farmers opt for this cheaper local feed without knowing the proximate composition, formulation and processing of the feeds. A good *C. gariepinus* feed should contain essential nutrients such as protein, lipids or fats, ash (minerals), fiber, moisture, NFE (nitrogen free extract or carbohydrates) and vitamins in the right proportion and formulated in a balanced ration which will be acceptable, palatable and durable to the fish for its optimum growth [4]**.** The growth of a fish is influenced by its feed utilization and the feed utilization is a function of the balanced nutrient composition of the feed. Feeding cost is the highest single cost item of most fish farm operations, accounting for about 60% of the total cost of fish production [5].

C. gariepinus occupies a unique position in the commercial aquaculture in Nigeria because it is hardy, tasty, tolerates poor water quality conditions, highly fecund, early growth performance, has an efficient feed conversion especially in the male [5-2] and thereby commands high market value.

Haematological analyses have been routinely used in determining the physiological state of animals. Fish haematology is gaining increasing importance in fish culture because of its importance in monitoring the health status of fish [7,8,9], and the nutritional state of the fish is one of the most important variables altering the blood values [10]. Haematological parameters have been proved to be valuable tools in determining the health status of the fish in response to the dietary manipulations [11,12]. Haematological characteristics of most fish have been studied with the aim of establishing normal value range and deviation from it may indicate a disturbance in the physiological process [13]. At times environmental and physiological factors are known to influence fish haematology, these include stress due to capturing, transportation, sampling, age and sex. However, in most cases, the knowledge of haematological characteristics of the fish is important in toxicological studies and its implication on final consumers which is man [14]. In culture fisheries these studies are usually associated with the feed input. The red blood cells count (RBC), haematocrit (PCV) and haemoglobin (Hb) concentration vary with diet and strain as well as temperature, season of the year and nutritional status of the fish [15]. Banerjee et al. (2002) reported that blood composition is moderately constant under normal condition with little variation above limits [16]. However, the composition of blood can be changed by dietary treatment, malnutrition and disease condition [17]. Blood analysis is a useful means of evaluating the physiological condition of cultured fish with respect to determining the effect of diets and other stressed factors on fish health [9-2]. According to Adeparusi and Ajayi (2004), the analysis of blood is an important factor that could be used in fish feed assessment [18]. Low haematological indices are indicators of anaemic conditions [19]. Ichythyohaematological investigation serves mainly for diagnostic purpose; apart from this main purpose, it is also used to examine the effect of toxic substances on the fish, to evaluate the condition of the fish, to evaluate the non-specific resistance of different fish breeds and strains and of the blood fish, to assess suitability of feeds and feed mixture pellets, to evaluate the effect of stress situation etc. [20-9]. Hence, it can be concluded that blood analysis is a valuable means of evaluating the physiological condition of cultured fish with respect to determining the effect of diets and other stress factors on fish health [9].

Studies of the growth response of *C. gariepinus* to feed have mainly concentrated on the replacement of fish meal with suitable alternatives by using different varieties of plants and animal sources as substitute, supplement or total replacement in fish feed and this has led to the development of all sorts of fish feed with varying or total inclusions of the plants or animals in the feed. Such feeds are often called local, home or farm-made fish or aqua feed [4]. Some studies have actually compared the growth response of *C. gariepinus* fed floating (commercial) and sinking (locally formulated) diets including Ajani et al. (2011), Ekanem et al. (2012), Olanipekun (2014), Mustapha et al. (2014) and Limbu (2015) [21,22,23-4-24]. Studies on haematological responses of *C. gariepinus* to feed have been centered on responses to different feeding level [2], different feed stuff [1-25-19], different toxicants [26,27], and different dietary inclusion level (graded level) or replacement of major feed ingredients such as fishmeal, soybean meal and maize [28-14-29,30,31,32,33,34,35-9]. Based on information from existing literature, there is limited information on the haematological response of *C. gariepinus* fed locally formulated (sinking) and commercial (floating) diets, at such more research is needed in this area since there is a need to understand the physiological condition of fish in relation to blood and the quality of dietary protein feed.

The objective of the present study was thus, to investigate the haematological profile and growth response of *Clarias gariepinus* fed sinking and floating diets.

2. MATERIALS AND METHODS

2.1 Experimental fish: Ninety (90) fingerlings of similar sizes were selected from a unit stock spawned at Fulfillment Fish Farm, Abak Road, Uyo, Akwa Ibom State, Nigeria. The fingerlings used for the experiment were about 9 weeks, 2 days old prior to first feeding and were acclimated for two weeks. The experiment was conducted for eight (8) weeks using six improvised tarpaulin tanks of 1 m^3 volume.

2.2 Experimental feed: Locally available feed ingredients were used in formulating the local diet using Pearson Square method and further enhanced with trial and error method for perfection. The ingredients used were fish meal, soybean cake, groundnut cake, palm kernel cake, white maize, fish premix, lysine, methionine, salt, palm oil and Vitamin C. All feed ingredients were purchased from the popular Ariara International Market, Aba, Abia State, Nigeria. Feed ingredients were properly processed, mixed and pelleted with a locally fabricated pelleting machine to give 2.5 mm pellet sizes. The uncooked nature of carbohydrate in the feed produced the sinking ability. The commercial (extruded) diet (Skretting feed produced in Israel) was purchased from a reputable feed retailer (Phrustep Feeds), 29 Udo Obio Street, Uyo, Nigeria.

2.3 Experimental design: The above diets: sinking (locally formulated) and floating (commercial) feed were used in a feeding trial. The experiment was conducted with 3 replicates for each feeding trial. Each tarpaulin tank measuring 1m × 1m × 1m was filled to a depth of 45cm with borehole water giving $0.45cm^3$ total volume. The tanks were labeled C_1, C_2 and C_3 for the floating (commercial) feed trials and L_1, L_2 and L_3 for the sinking (locally formulated) feed trials.

Ninety fingerlings with mean initial weight (4.87 g) were stocked at a density of 15 fingerlings per tank. At the start of the feeding trial, the acclimatized fish were starved for 24 hours to empty the gut and prepare them for the feeding trial before the initial mean weight was taken. All fish were fed 3 times daily at 5% biomass for 56 days. Pellet sizes of 2.5 mm for both diets were used throughout the duration of the experiment. Fingerlings were weighed every 2 weeks and feed ration adjusted accordingly. Water was also changed bi-weekly after data collection.

2.4 Water quality assessment: The water quality parameters such as dissolved oxygen, temperature and pH were observed weekly (07:00am, Wednesdays). Dissolved oxygen and temperature was measured using DO meter (HI 9461) in mg/l and °C units respectively while pH was measured using a pen type pH meter (pH-009 111).

2.5 Growth data collection: Fishes were sampled fortnightly by draining water from all tarpaulin tanks. All fingerlings from each tank were collected with a plastic filter basket and then weighed to nearest 0.01g using an electronic weighing balance (TD6002A model). Data obtained biweekly was used to determine mean weight gain. At the end of the experiment, results from weight data were used to determine growth response parameters such as mean weight gain, daily weight gain, relative weight gain, number of survival, number of deaths and production index using the formulae below.

Mean weight gain (g) (MWG)

$$MWG = Wt_2 - Wt_1 \quad (1)$$

Where Wt_2 = final mean weight of fish at time T_2

Wt_1 = initial mean weight of fish at time T_1

Production index (PI) [36]

$$PI = \frac{SR \times (MFW - MIW)}{Rearing\ period\ in\ days} \quad (2)$$

Where SR = Survival rate

$$SR = \frac{Total\ no\ of\ fingerlings\ that\ survived \times 100}{Total\ no\ of\ fingerlings\ stocked} \quad (3)$$

MFW = Mean final weigh

MIW = Mean initial weight

Daily weight gain (g/day) (DWG)

$$DWG = \frac{Final\ mean\ weight - Initial\ mean\ weight}{Rearing\ period\ in\ days} \quad (4)$$

Relative weight gain (%) (RWG)

$$RWG = \frac{Final\ mean\ weight - Initial\ mean\ weight \times 100}{Initial\ mean\ weight} \quad (5)$$

2.6 Chemical analysis: Bulk ingredients for formulating the sinking diet (fishmeal, groundnut cake, soybean cake, white maize, palm kernel cake) were sent to Biochemistry Laboratory, University of Uyo for proximate composition. Method used was the standard method of Association of Official Analytical Chemists (AOAC, 2005) of USA [37]. Dried samples of the experimental sinking feed were also sent to Biochemistry Laboratory of University of Uyo for proximate analysis (protein, lipid, fibre, ash and carbohydrate) using standard methods [37]. Body composition of the experimental fish before and after experiment was also carried out in the above named laboratory using standard methods [37].

2.7 Haematological analysis: After 8 weeks haematological studies was carried out on the fishes. Samples of fish were taken out individually from each treatment tank using a plastic filter basket net and placed belly upward on a table. Blood samples of about 2.0 ml were collected from the ventral region near the anal opening using a 2.5 ml syringe and hypodermic needles. The blood samples were introduced into Heparinized Ethylene Diamine Tetraacetic Acid (EDTA) anticoagulant tubes and capped sealed effectively to avoid escape for haematological analysis. The use of plastic syringe is a necessary precaution with fish blood because contact with glass will increase coagulation time and furthermore, the anticoagulants decreases clotting time. The packed cell volume (PCV), haemoglobin concentration (HB), Red Blood Cell (RBC), White Blood Cell (WBC) count and other blood parameters of each of the blood sample, were determined in haematology laboratory of the University of Uyo Teaching Hospital (UUTH), Uyo, using 5-part differential Haematology Auto-analyzer (Mindray BC 5300 model).

2.8 Statistical analyses: Blood, growth and water quality parameters were subjected to one-way analysis of variance (ANOVA) to evaluate mean differences at 0.05 significant levels. Results with P≤0.05 were considered significantly different. The statistical analyses were done using IBM SPSS Inc. (Windows version 22).

3. RESULTS

3.1 Water quality

Table 1 gives the results of water quality parameters obtained during the experimental period. No significant difference (p>0.05) was observed in the water quality parameters of both treatments during the study. Temperature and dissolved oxygen were however higher in fish fed commercial diet, while higher pH values were observed in tanks fed locally formulated diet. The ranges were; water temperature (24.70 – 28.80 °C), dissolved oxygen (4.49 – 9.32 mg/l) and pH (4.70 – 8.50).

Table 1: The table presents the water quality parameters in the tanks during the study.

Parameters	Floating (Mean ± SE)	Sinking (Mean ± SE)
Temperature (°C)	26.40 ± 0.21	26.21 ± 0.22
Dissolved oxygen (mg/l)	7.15 ± 0.48	6.34 ± 0.29
pH	7.57 ± 0.45	7.92 ± 0.45

3.2 Proximate composition of the experimental feeds

Table 2 gives the percentage composition of feed ingredients for the sinking feed. The proximate analysis of experimental feeds is given in Table 3. Proximate analysis of the experimental diets showed significant differences (P<0.05) in the composition of crude protein, crude fibre, crude lipid, total ash and carbohydrate (CHO). The floating (commercial) feed had higher crude protein (45%) and crude lipid (14%) when compared with the sinking (locally formulated) feed of crude protein (22.75%) and crude lipid (8.06). The sinking diet had higher crude fibre (9.66%), total ash (11.50%) and CHO (48.06%) than floating diet of crude fibre (2.5%), total ash (7.5%) and CHO (28.2%).

Table 2: The table presents the percentage composition of the sinking diet (locally formulated).

Feed ingredients	Percentage
Fishmeal	10.18%
Soybean cake	30.56%
Groundnut cake	53.93%
White maize	1.29%
Palm kernel cake	1.29%
Premix	0.25%
Salt	0.4%
Vitamin C	0.1%
Methionine	0.5%
Lysine	1.0%
Palm oil	0.5%
Total	**100%**

Table 3: The table presents the proximate analysis of the experimental diets (dry matter).

Parameters	Floating (commercial)	Sinking (locally formulated)
Crude protein	45%	22.75%
Crude fibre	2.5%	9.66%
Total ash	7.5%	11.50%
Crude fat	14%	8.06%
Carbohydrate	28.2%	48.06%

3.3 Growth response of African catfish fed sinking and floating diets

The growth performance of African catfish fingerlings fed floating and sinking diets is represented in Table 4. The growth response for *C. gariepinus* during the study is shown in Figure 1. At the start of the experiment, the mean weight of the fish fed floating diet was 70.96 g ± 5.84 and 75.01 g ± 3.10 for *C. gariepinus* fed sinking diets. Final weights were 921.73 g ± 47.44 for floating and 184.22 g ± 20.54 for sinking diets. From the results on growth parameters, floating and sinking diets had no significant effect (p>0.05) on mean initial weight (MIW), number of survivors (NoS), and number of deaths (NoD). There were however significant differences (p<0.05) between growth parameters such as mean final weight (MFW), mean weight gain (MWG), daily weight gain (DWG), relative weight gain (RWG) and production index (PI) in *C. gariepinus* fed commercial and locally formulated diet. *C. gariepinus* in tanks C_1 – C_3 fed with floating (commercial) feed showed significantly (p<0.05) higher MFW, MWG, DWG, RWG and PI than fish in tanks L_1 – L_3. Fish fed sinking (locally formulated) diet had higher number of survivors than fish fed with floating diet; also, fish fed floating diet had higher number of deaths when compared to fish fed sinking diet, although no significant differences (p>0.05) were observed.

Table 4: The table presents the growth parameters, feed utilization and survival of *C. gariepinus* during the study.

Parameters	Floating (Mean ± SE)	Sinking (Mean ± SE)
Mean initial weight (g)	70.96 ± 5.84	75.01 ± 3.10
Mean final weight (g)	921.73 ± 47.44	184.22 ± 20.54
Mean weight gained (g)	849.77 ± 44.25	109.20 ± 17.46
Production index (%g/day)	1454.13 ± 101.28	191.43 ± 33.27
Daily weight gain (g/day)	15.19 ± 0.78	1.95 ± 0.31
Relative weight gain (%/day)	92.19 ± 0.39	58.69 ± 2.64
Number of survivors	14.33 ± 0.33	14.67 ± 0.33
Number of deaths	0.67 ± 0.33	0.33 ± 0.33

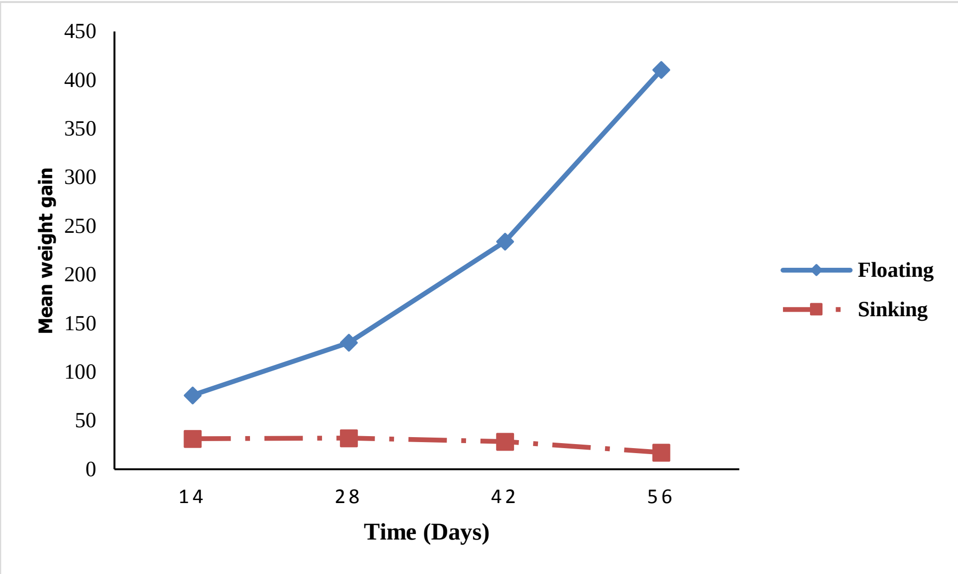

Figure 1: The figure shows the growth response of *C. gariepinus* fingerlings during the study.

3.4 Body composition of *C. gariepinus* during the study

Body composition of the experimental fish before and after the study is presented in Table 5. Crude protein content of the fish before the experiment (53.20%) and fish fed sinking diet (53.20%) showed no significant difference (P>0.05), while there was significant difference (p<0.05) in the crude protein of fish fed floating diet (55.65%) and fish before the experiment (53.20%). The body crude fibre were significantly different (p<0.05) in all experimental fish (initial and final), although fish before feeding trial had highest crude fibre content (14.39%) and lowest in fish fed sinking diet (8.91%). Crude lipid showed no significant difference (p>0.05) in the experimental fish but was highest in fish fed floating diet (16.64%) and lowest in fish before feeding trial (6.34%). Significant difference (p<0.05) was also obtained in total ash composition of the initial and final fish, with initial having highest total ash (23.08%) and fish fed sinking diet with the lowest ash content (10.37%). There was no significant difference (p>0.05) between the body CHO of initial experimental fish and fish fed floating diet, while there was significant difference (p<0.05) between fish fed floating and sinking diets and between initial experimental fish and fish fed sinking diet. The energy value of fish fed floating and sinking diet was not significantly different (P>0.05) while it was significantly different (P<0.05) between initial experimental fish and either of fish fed floating or sinking diet.

Table 5: The table presents the body composition of experimental fish (dry matter).

Parameter (%)	Initial	Floating (commercial)	Sinking (locally formulated)
Crude protein	53.20	55.65	53.20
Crude fibre	14.30	10.74	8.91
Crude lipid	6.34	16.64	15.17
Total ash	23.08	13.11	10.37
Carbohydrate	3.08	3.86	12.35
Calorific value Kcal	282.18	387.80	398.73

3.5 Haematological profile of *C. gariepinus* during the study

Table 6 shows the haematological indices of fish fed commercial and locally formulated diet during the study. There was significant difference ($p<0.05$) in haemoglobin concentration (Hb) between fish fed commercial (7.53 ± 0.20) and locally formulated (5.63 ± 0.18) diets. Packed Cell Volume (PCV) was significantly higher ($p<0.05$) in fish fed commercial (24.67 ± 0.88) than fish fed locally formulated (17.00 ± 0.58) diets. Red Blood Cells (RBC) was also significantly higher ($p<0.05$) in fish fed commercial (1.53 ± 0.07) than locally formulated (1.27 ± 0.03) diets. However, White Blood Cells (WBC) was significantly lower in fish fed commercial (3.27 ± 0.09) than locally formulated (8.43 ± 0.09) feed. Mean Corpuscular Volume (MCV) was significantly higher ($p<0.05$) for *C. gariepinus* fed commercial (141.67 ± 1.76) than locally formulated (124.67 ± 1.76). There was no significant difference ($P>0.05$) in Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) for fish fed commercial and locally formulated feed but both blood parameter was higher in fish fed floating (44.67 ± 1.76; 32.67 ± 0.88) than fish fed sinking (42.33 ± 0.88; 32.33 ± 0.88) respectively.

Table 6: The table presents the haematological indices of *C. gariepinus* during the study.

Parameters	Commercial feed (Mean ± SE)	Locally formulated feed (Mean ± SE)
Hb (g/dl)	7.53 ± 0.20	5.63 ± 0.18
PCV (%)	24.67 ± 0.88	17.00 ± 0.58
RBC (x 10^{12}/l)	1.53 ± 0.07	1.27 ± 0.03
WBC (x 10^{3}/l)	3.27 ± 0.09	8.43 ± 0.09
MCV (fl)	141.67 ± 1.76	124.67 ± 1.76
MCH (pg)	44.67 ± 1.76	42.33 ± 0.88
MCHC (g/dl)	32.67 ± 0.88	32.33 ± 0.88
PLT (x 10^{3}/l)	16.00 ± 1.15	35.67 ± 2.03

4. DISCUSSION

The water quality parameters in the present study were not affected by the diet forms and were within the range recommended for African catfish culture [38,39]. These results highlight that, feeding *C. gariepinus* with commercial and locally formulated diets does not cause significant deterioration of water quality parameters provided the diets are formulated correctly and the fish fed optimally. Although the water temperatures from feeding trials were not different significantly, these were however, within the optimal range (<40 ºC) described for aquaculture [40]. The body temperature of fish changes according to that of its environment, affecting its metabolism, physiology and ultimately affecting the production [41]. Temperature results agree with earlier works of Mustapha et al. (2014) and Limbu (2015) [4-24] and dissimilar with results of Ajani et al. (2011) and Ekanem et al. (2012) [21,22]. Dissolved oxygen is needed for aerobic generation of energy for body maintenance, growth, survival, behaviour and physiology of aquatic organisms [2]. The dissolved oxygen range of 4.49 – 9.32 mg/l obtained from this experiment did not agree with results of Ajani et al. (2001), Ekanem et al. (2012), Mustapha et al. (2014), Limbu (2015), Afia and Ofor (2016) [21,22-4-24-2] but were within tolerable range for fish culture. The ideal pH for biological productivity is 7.0 to 8.5; fish becomes stressed in water with pH ranging from 4.0 to 6.5 and 9.0 to 11.0 [42]. The mean pH level obtained in this study for both feeding trials is assumed not to have affected the fish growth as it was within desirable limits for catfish culture. The result agrees with results of Ajani et al. (2011), Ekanem et al. (2012) and Limbu (2015) [21,22-24] and slightly lower than result of Mustapha et al. (2014) [4].

Growth data parameters, survival and mortality are great tools for evaluating the effect of feed and its value composition on fish species [4]. Fish like other animals; require essential nutrients for metabolic activities like growth, reproduction, repairs, etc. Results obtained agree with De Silva and Anderson (1995) who opined that the quality of a feed is a function of how well that feed meets the nutrient requirement of an animal [43]. The good growth performance and nutrient utilization of fish fed commercial diet are an indication that the feed contained balanced nutrients as seen in the proximate composition. The current results have shown dissimilar growth performance between *C. gariepinus* fingerlings fed commercial (floating) and locally formulated (sinking) diets. Fish fed floating diet showed significant higher growth performance (MFW, MWG, DWG and RWG). These results agree with Mustapha et al. (2014) and Ekanem et al. (2012) who reported higher growth performance for *C. gariepinus* fed floating diets compared to those fed sinking diets [4-22]. The result disagrees with Ajani et al. (2011) who reported no significant difference in the MWG and daily feed intake of *C. gariepinus* fed floating and sinking diets, although they reported higher MWG in fish fed floating diet than sinking diet [21]. And also with Limbu (2015) who reported that feeding *C. gariepinus* using either floating or sinking diets did not significantly affect growth and survival [24]. Olanipekun (2014) reported higher MWG and mean growth rate in *Clarias gariepinus* fed sinking than floating diets [23].

The poor growth of *C. gariepinus* fed locally formulated (sinking) diet in the present study can be traced to the very low percentage composition of crude protein (22.75%), lipid (8.06%) and very high percentage composition of carbohydrate (48.06%), ash (11.50%), and crude fiber (9.66%) in the locally formulated feed compared to its counterpart, commercial diet. The crude protein in the sinking (locally formulated) feed was far less than the acceptable range (30 – 45%) recommended for commercial fish culture [44]. The lipid level was also lower than recommended range (10 - 25%) certified to produce the best growth performance in fish species as reported by Ali et al. (2012) [45]. The high level of CF as against recommended range (<2%) suggested by Agokei et al. (2011) made the fish unable to digest and utilize the high fiber content in the feed [46]. High level of fiber content in feed has been observed to slow the growth of *C. gariepinus* fingerlings [47,48]. Tan et al. (2007) reported that carbohydrate in the diet of *Clarias* species should not exceed 20% as against the present study (48.06%) [49].

The body composition of the fish carcass shows an increase in the value of crude protein and crude fat over the initial fish samples. This agrees with reports of Alegbeleye et al. (2001), Ochang et al. (2007) and Ajani et al. (2011) who reported increase in the protein content of experimental fish carcass above initial [50-34-21]. The increase in the crude protein of all the experimental fish indicates that the different feed (floating and sinking) used had a positive effect on the fish. It shows that the experimental fish converted and utilized the protein from the feed into their body protein. The significant difference recorded in the percentage fat and ash content obtained from the carcass of the fish fed the different feed types may be due to losses due to metabolism or some interaction between constituents [51]. The higher value of body CHO of fish fed sinking diet than fish fed commercial is a reflection of the quality of feed given them. Locally formulated feed had a greater percentage of CHO than commercial feed. The increase in energy (kcal) of *Clarias gariepinus* after the feed trial indicates the fish utilized the feeds.

Haematological parameters are very important factors used for the evaluation of fish physiological status. Their changes depend on fish species, age, and the cycle of the sexual maturity of spawners and diseases [52]. Haematological components of blood are also valuable in monitoring feed toxicity especially with feed constituents that affect the formation of blood in culture fisheries [53].

The haemoglobin concentration (Hb) showed variation among the feed trials with highest Hb recorded for *C. gariepinus* fed commercial diet. Physiologically, haemoglobin is crucial to the survival of fish being directly related to oxygen binding capacity of blood. However, Teixeria (2000) cited by Afia and Ofor (2016) stated that referenced values determined for haematological tests should be carefully interpreted once there is a wide range of physiological variations since these variations might be influenced by environmental conditions, sex, age, feeding system and feeding [54-2]. Low haemoglobin level might decrease the ability of fish to enhance its activity in order to meet occasional demands [55]. The range of Hb (5.63 – 7.53 g/dl) for the feed trials was low and similar with results of Musa et al. (2013), Adeyemo et al. (2003), and Gabriel et al. (2014) [27-56,57]. The Hb results were lower than results of Adewolu and Aro (2009), Terry et al. (2000), Agbabiaka et al. (2013b), Adeyemo (2007), Omitoyin (2006), Ayoola (2011), Osuigwe et al. (2005), Mamman et al. (2013), Dienye and Olamuji (2014), Adewole and Olaleye (2014), and Afia and Ofor (2016) [32-58-28-26-25-1-59-31-14-30-2]. The result was however higher than reports of Fagbenro et al. (2000) [60]. The lowest level observed in fish fed locally formulated diet could imply the diet having negative effects on the blood.

The Packed Cell Volume (PCV) was within the range (17.00 – 24.67 %), with commercial feed being highest. PCV also known as haematocrit is a useful tool in fisheries and aquaculture management for checking anaemic condition in aquatic species. The mean value of PVC for fish fed locally formulated diet was low and this could be attributed to anti-nutritional factors in the feed ingredients during processing since the reduction in the concentration of hematocrit in the blood usually suggests the presence of toxic factors (e.g. haemagluttin) which affects blood formation and growth generally. PCV value for fish fed locally formulated diet was lower than recommended range of 20 – 38% for fish as reported by Erondu et al. (2003) [61]. The PCV range for both feed trials were lower than reports of Adewolu and Aro, (2009), Sotolu and Faturoti (2009), Adeyemo et al. (2003), Abalaka (2013), Agbabiaka et al. (2013b), Mamman et al. (2013), Dienye and Olamuji (2014), Adewole and Olaleye (2014), Afia and Ofor (2016) [32,33-56-62-28-31-14-30-2] and higher than results of Ayoola (2011) [1].

Lower count for Red blood cells was observed in fish fed locally formulated diet. This could be attributed to the low level of protein in the sinking (locally formulated) feed to meet the fish nutrient requirements as haemoglobin is a property of protein of which RBC is a carrier. This might have reduced the production rate of RBC or increase its destruction. The result of RBC count for both feed trials agrees with results of Adeyemo et al. (2003), Osuigwe et al. (2005) [56-59] and disagrees with results of Ayoola (2011), Agbabiaka et al. (2013b), Dada and Ikwerowo (2009), Dienye and Olamuji (2014), Adewole and Olaleye (2014), and Afia and Ofor (2016) [1-28-63-14-30-2]. However, the values recorded for RBC for both feed was within the range of normal haematology of a healthy fish [64,65]. Erythrocyte count greater than 1.00×10^6 mm^{-3} is considered high and indicative of high oxygen carrying capacity of the blood, which is characteristic of fishes capable of aerial respiration and with high activity [29].

White blood cells are the defense cells of the fish body. The increase in WBC (leucopomia) for fish fed locally formulated diet could be attributed to the increase in leucocytes synthesis in the haematopoietic tissue of the kidney and perhaps the spleen as a defense mechanism against the destruction of bacteria and fungi. Lymphocytes are the most numerous cells comprising the leucocytes, which function in the production of antibodies and chemical substances serving as defense against infection [1]. The primary consequence of observed changes in leucocyte count in stressed fish is suppression of the immune system and increased susceptibility to disease [66]. This is true since the amount has implication in immune response and the ability of the animal to fight infection [67]. It is assumed that the locally formulated feed was more favourable for white blood cells synthesis and this collaborates with the findings of Joshi *et al*. (2002) that survival of a fish can be correlated with the increase in antibody production which helps in survival and recovery [55]. The high WBC counts in *C. gariepinus* fed locally formulated diet might be a protective response to the anti-nutritional factors present in the sinking feed. The WBC results from the present study compared unfavourably with results of Ayoola (2011), Abalaka (2013), Dienye and Olamuji (2014), Afia and Ofor (2016) [1-62-14-2].

Mean corpuscular volume range of (124.67 – 141.67 fl) obtained for the feed trials was slightly different from results of Ayoola (2011), Ayeloja et al. (2012), Mamman et al. (2013), Afia and Ofor (2016) [1-68-31-2]. The present result compared unfavourably with reports of Adeyemo et al. (2003), Ochang et al. (2007), Sotolu and Faturoti (2009), Agbabiaka et al. (2013b), Dienye and Olamuji (2014), Adewole and Olaleye (2014) [56-34-33-28-14-30].

The Mean corpuscular haemoglobin range (42.33 – 44.67 pg) from the present study compared favourably with results of Afia and Ofor (2016) [2] and unfavourably with results of Terry et al. (2000), Gabriel et al. (2004), Ochang et al. (2007), Ayoola (2011), Mamman et al. (2013), Adewole and Olaleye (2014), Dienye and Olamuji (2014) [58-57-34-1-31-30-14]. This could be attributed to the difference in culture environment, stocking density, feed type, feed form or other environmental factors that the cultured fish may have been exposed to during the culture period.

Mean corpuscular haemoglobin concentration (32.33 – 32.67 g/dl) obtained in the current study was different from results of Omotoyin (2006), Adeyemo (2007), Agbabiaka et al. (2013b) and Afia and Ofor (2016) [25-28-2]. This might be as a result of the different feed form, specie, age and size of the fishes which consequently influenced blood parameters values. However, MCHC was similar to reports of Ayoola (2011), Adewole and Olaleye (2014) [1-30].

5. CONCLUSION

Most of the blood parameters values are slightly lower than normal due to the condition under which the fishes were kept. These are true to the fact that the tarpaulin tanks used is not the natural habitat of C. gariepinus and also due to small size of the fishes. In conclusion, the present study has revealed slight decrease in most of the haematological profile of C. gariepinus fed different feed forms (sinking and floating) with no negative impact on the health status during culture. Therefore, use of both locally formulated and commercial diets by catfish farmers is encouraged but preferably, commercial diet since it produced better growth response than the locally formulated diet.

6. REFERENCES

1. Ayoola SO. Haematological characteristics of *Clarias gariepinus* (Burchell, 1822) juveniles fed with poultry hatchery waste. *Iranica Journal of Energy and Environment.* 2011; 2(1): 18-23. Available on: http//idosi.org/ijee/2(1)11/3.pdf

2. Afia OE, Ofor CO. Haematological indices of the *Clarias gariepinus* × *Heterobranchus longifilis* (hybrid catfish - *Heteroclarias*) reared at different feeding levels. *Nigerian Journal of Agriculture, Food and Environment*. 2016; 12(3): 6-11. Available on: http//njafe.org/najafe2016vol12n3/2_Afia_and_Ofor.pdf

3. Wokoma SA. Pond management: A proceeding of the aquaculture training programme (ATP). 1987. P. 35-43.

4. Mustapha MK, Akinware BF, Faseyi CA, Alade AA. Comparative effect of local and foreign commercial feeds on the growth and survival of *Clarias gariepinus* juveniles. *Journal of Fisheries.* 2014; 2(2): 106-112. Available on: http://www.journal.bdfish.org/index.php/fisheries/article/view/25/56

5. Fagbenro OA, Nwanna LC, Adepanusi EO, Adebayo OT, Fapohunda OO. An overview of animal feed industry and dietary substitution of feedstuffs for farmed fish in Nigeria. In: Dris R. editor, Crops: growth, quality and biotechnology (current status and future prospects). Finland: WFL Publisher; 2005. p. 91-107. Available on: http://world-food.net/cropsgrowth-quality-and-biotechnology/

6. Nweke S, Ugwumba A. Effects of replacement of fishmeal with duckweed (*Lemna paucicostata*) meal on the growth of *Clarias gariepinus* (Burchell, 1822) fingerlings. *Nigerian Journal of Science.* 2005; 39: 1-11. Available on: http://sciencenigeria.org/index.php/technological-ecological-science/

7. Hrubec TC, Cardinale JL, Smith SA. Haematology and plasma chemistry reference intervals for cultured tilapia (*Oreochromis* hybrid). *Veterinary and Clinical Pathology*, 2000; 29: 7-12. Available on: http://www.ncbi.nlm.nih.gov/pubmed/12070816

8. Khan MA, Abidi SF. Effect of dietary L-Lysine levels on growth, feed conversion, lysine retention efficiency and haematological indices of *Heteropnuestes fossilis* (Bloch) fry. *Aquaculture Nutrition.* 2001; 17: 657-667. Available on: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2095.2010.00815.x/full

9. Jimoh WA, Ajasin FO, Ayeloja AA, Rifhat AO, Shodamola MO. Haematological changes in catfish (*Clarias gariepinus)* fed diets containing water melon seedmeal *(Citrullus lanatus)*. In*:* Proceedings of the 47th Annual Conference of the Agricultural Society of Nigeria, Ibadan. 2013. p. 1234 – 1241. Available on: http://www.researchgate.net/profile/Jimoh_Adeyemi/publication/265161965_Haematological_changes_in_catfish_Clarias_gariepinus_fed_diets_containing_water_melon_seedmeal_Citrullus_lanatus/links/56b0c3d508ae9f0ff7b77048/Haematological-changes-in-catfish-Clarias-gariepinus-fed-diets-containing-water-melon-seedmeal-Citrullus-lanatus.pdf

10. Congleton JL, Wagner T. Blood-chemistry indicators of nutritional status and food intake in juvenile salmonids. *Journal of Fish Biology*. 2006; 69: 473–490. Available on: http://www.webpages.uidaho.edu/fish511/Readings/Readings%202010/Congleton%20and%20Wagner%20blood%20chemistry.pdf

11. Klinger CR, Blazer SV, Echevarria C. Effects of dietary lipid on the hematology of channel catfish, *Ictalurus punctatus*. *Aquaculture*. 1996; 147(3-4): 225–233. Available on: http://203.250.122.194/blood/b_chem/b_chem_032.pdf

12. Mohammed AK, Sambo AB. Haematological assessment of the Nile tilapia *Oreochromis niloticus* exposed to sublethal concentrations of Portland cement powder in solution. *International Journal of Zoological Research*. 2007; 4(1): 48–52. Available on: http://docsdrive.com/pdfs/academicjournals/ijzr/2008/48-52.pdf

13. Rainza-paiva MJT, Ishikawa CM, Das Eiras AA, Felizardo NN. Haematological analysis of 'chara' *Pseudoplatystoma fasciatum* in captivity. *European Aquaculture Society Special Publication.* 2000; 28: 590. Available on: http://

14. Dienye HE, Olumuji OK. Growth performance and haematological responses of African mud catfish *Clarias gariepinus* fed dietary levels of *Moringa oleifera* leaf meal. *Net Journal of Agricultural Science*. 2014; 2(2): 79-88. Available on: http://www.netjournals.org/pdf/NJAS/2014/2/14-025.pdf

15. Barnhart RA. Effects of certain variables on haematological characteristics of rainbow trout, *Salmo gairdneri* (Richardon). *Transactions of the American Fisheries Society*. 1969; 98(3): 411-418. Available on: http://10.1577/1548-8659(1969)98[411:EOCVOH]2.0.CO;2

16. Banergee SK, Patra BC, Bandyopadhyay P, Tewary A. Changes of blood parameter in an Indian carps, *Catla catla* Ham. due to myxozoan parasitic infection. *Indian Journal of Aquatic Biology*. 2002; 17(1): 79-84. Available on: http//

17. Feist SW, Longshaw M. Myxosporiodiosis of fish and the Bryozoan link with proliferate kidney diseases (PKD) of salmonids. *Journal of Fish Diseases*. 2000; 1: 91-108. Available on: http://
18. Adeparusi EO, Ajayi AD. Haematological characteristics of Nile Tilapia (*Oreochromis niloticus*) fed differently processed lima bean (*Phaseolus lunatus* L.) diets. *Journal of Research in Science and Management*. 2004; 2(1): 73-80. Available on: http//cals.arizona.edu/azaqua/ista/editedpapers/Nutrition/Adeparusi-%20Hematological.doc
19. Haruna AD, Adikwu II. Hematological response to non-familiar diets: A study of *Clarias gariepinus*. *Journal of Arid Zone Fish*. 2001; 1: 12-22. Available on: http://
20. Svobodova Z, Pravda D, Palackova J. Unified methods of haematological examination of fish. Czecho-Slovakia: Research Institute of Fish culture and Hydrobiology; 1991. p. 31. Available on: http://books.google.com.ng/books/about/Unified_methods_of_haematological_examin.html?id=5_UWSwAACAAJ&redir_esc=y
21. Ajani F, Dawodu MO, Bello-Olusoji OA. Effects of feed forms and feeding frequency on growth performance and nutrient utilization of *Clarias gariepinus* fingerlings. *African Journal of Agricultural Research*. 2011; 6(2): 318-322. Available on: http//www.academicjournals.org/article/article1380901968_Ajani%20et%20al.pdf
22. Ekanem AP, Eyo VO, Obiekezie AI, Enin UI, Udo PJ. A comparative study of the growth performance and food utilization of the African catfish (*Clarias gariepinus*) fed Unical Aqua feed and Coppens commercial feed. *Journal of Marine Biology and Oceanography.* 2012; 1(2): 1-6. Available on: http://www.academia.edu/attachments/32646550/download_file?st=MTQ5MTU4MjgxNiwxNTQuNjguMjI2LjM0LDQyMzE0NDc2&s=swp-toolbar
23. Olanipekan OE. Growth performance of juvenile catfish (*Clarias gariepinus*) fed with floating (imported) and formulated (sinking) pelleted feeds in floating cages. M.Sc. Thesis, University of Agriculture, Abeokuta, Nigeria. 2014. Available on: http://journal.unaab.edu.ng/index.php/theses/thesis/view/5256
24. Limbu SM. The effect of floating and sinking diets on growth performance, feed conversion efficiency, yield and cost-effectiveness of African sharptooth catfish, *Clarias gariepinus* reared in earthen ponds. *International Journal of Fisheries and Aquatic Studies.* 2015; 2(5): 253-259. Available on: http://fisheriesjournal.com/vol2issue5/Pdf/2-5-71.1.pdf
25. Omitoyin BO. Haematological changes in the blood of *Clarias gariepinus* (Burchell 1822) juvenile fed poultry litter. *Livestock Research for Rural Development*. 2006; 18(11): 1-6. Available on: http://www.lrrd.org/lrrd18/11/omit18162.htm
26. Adeyemo OK. Haematological profile of *Clarias gariepinus* (Burchell, 1822) exposed to lead. *Turkish Journal Fisheries and Aquatic Science.* 2007; 7: 163-169. Available on: http://www.trjfas.org/uploads/pdf_328.pdf
27. Musa SM, Aura CM, Ogello EO, Omondi R, Charo-Karise H, Munguti JM. Haematological response of African catfish (*Clarias gariepinus* Burchell 1822) fingerlings exposed to different concentrations of tobacco (*Nicotiana tabacum*) leaf dust. *ISRN Zoology*, 2013; 203: 1-7. Available on: http://downloads.hindawi.com/journals/isrn/2013/492613.pdf
28. Agbabiaka LA, Madubuike FN, Ekenyem BU. Haematology and serum characteristics of African catfish (*Clarias gariepinus Burchell*) fed graded levels of Tiger nut based diet. *American Journal of Experimental Agriculture*. 2013b; 3(4): 988-995. Available on: http://www.sciencedomain.org/download/MTkxMEBAcGY.pdf
29. Jimoh WA, Ajasin FO, Adebayo MD, Banjo MT, Rifhat AO, Olawepo KD. Haematological changes in the blood of *Clarias gariepinus* fed *Chrysophyllum albidum* seedmeal replacing maize. *Journal of Fisheries and Aquatic Sciences.* 2014; 9(5): 407-412. Available on: http://scialert.net/abstract/?doi=jfas.2014.407.412
30. Adewole HA, Olaleye VF. Haematological profiles of *Clarias gariepinus* fingerlings fed graded levels of blood meal – bovine rumen digesta blend diets. *FUTA Journal of Research in Sciences*. 2014; 10(2): 236-245. Available on: http://journals.futa.edu.ng/index.php/FJRS/article/view/1658/1418
31. Mamman T, Ipinjolu JK, Magawata I. Hematological indices of *Clarias griepinus* (Burchell, 1882) fingerlings fed diet containing graded levels of calabash (*Lagenaria vulgaries*) seed meal. *Journal of Biology, Agriculture and Healthcare.* 2013; 3(17): 100-104. Available on: http://iiste.org/Journals/index.php/JBAH/article/view/8955/9130
32. Adewolu MA, Aro OO. Growth, feed utilization and haematology of *Clarias gariepinus* (Burchell, 1822) fingerlings fed diets containing different levels of vitamin C. *American Journal of Applied Sciences.* 2009; 6(9): 1675-1681. Available on: thescipub.com/PDF/ajassp.2009.1675.1681.pdf
33. Sotolu AO, Faturoti EO. Growth performance and haematology of *Clarias gariepinus* (Burchell, 1822) fed varying inclusions of *Leucaena leucocephala* seed meal based-diets. *Revista UDO Agrícola,* 2009; 9(4): 979-985. Available on: http://udoagricola.orgfree.com/V9N4UDOAg/V9N4Sotolu979.pdf
34. Ochang SN, Fagbenro OA, Adebayo OT. Growth performance, body composition, haematology and product quality of the African catfish (*Clarias gariepinus*) fed diets with palm oil. *Pakistan Journal of Nutrition.* 2007; 6(5): 452-459. Available on: http://docsdrive.com/pdfs/ansinet/pjn/2007/452-459.pdf
35. Soyinka OO, Boafo FO. Growth performance, haematology and biochemical characteristics of *Clarias gariepinus* (Burchell, 1822) juveniles fed quail eggshells as replacement for dicalcium phosphate. *Nigerian Journal of Fisheries and Aquaculture.* 2015; 3(1&2): 49 – 54. Available on: http://repository.unilag.edu.ng/xmlui/bitstream/handle/123456789/732/Growth%20Performance%2c%20Haematology%20and%20Biochemical%20Characteristics%20of%20Clarias%20gariepinus.pdf?sequence=1&isAllowed=y
36. Engle CR, Valderrama D. Effect of stocking density on production characteristics, costs, and risk of producing fingerlings channel catfish. *North American Journal of Aquaculture.* 2001; 63: 201-207. Available on: http://www.tandfonline.com/doi/full/10.1577/1548-8454%282001%29063%3C0201%3AEOSDOP%3E2.0.CO%3B2?scroll=top&needAccess=true
37. Association of Official Analytical Chemists (AOAC). International official methods of analysis. 18th ed. AOAC International, Gaithersburg, MD. 2005. Available on: http://academicjournals.org/journal/JPHE/article-xml/FF7324C50865
38. Boyd CE. Water quality in warmwater fish ponds. Alabama: Craft Master Printers Inc.; 1979; p. 359. Available on: https://www.amazon.com/Water-Quality-Warmwater-Fish-Ponds/dp/0817300554
39. Olurin KB, Olojo AA, Olukoya OA. Growth of African catfish *Clarias gariepinus* fingerlings, fed different levels of cassava. *World Journal Zoology*, 2006; 1(1): 54-56. Available on: https://www.researchgate.net/publication/265035409_Growth_of_African_Catfish_Clarias_gariepinus_Fingerlings_Fed_Different_Levels_of_Cassava
40. Federal Environmental Protection Agency (FEPA) (2003). Nigerian water quality standard for inland surface water. Federal Environmental Protection Agency. P. 238.
41. Bhatnager A, Devi E. Water quality guidelines for the management of pond fish culture. *International Journal of Environmental Sciences*. 2013; 3(6): 1-30. Available on: http://www.ipublishing.co.in/ijesarticles/thirteen/articles/volthree/EIJES31197.pdf
42. Ekubo AA, Abowei JFN. Review of some water quality management principles in culture fisheries. *Research Journal of Applied Sciences, Engineering and Technology.* 2011; 3(2): 1342-1357. Available on: http://scialert.net/broken.php?url=print/rjaset/v3-1342-1357.pdf or http://agris.fao.org/agris-search/search.do?recordID=AV2012074856
43. De Silva SS, Anderson TA. Fish nutrition in aquaculture. London: Chapman and Hall; 1995; p. 320. Available on: http://www.springer.com/gp/book/9780412550300
44. National Research Council (NRC). Nutrient requirements of fish and shrimp. National Academic Press, Washington DC. 2011; p. 392. Available on: https://www.nap.edu/catalog/13039/nutrient-requirements-of-fish-and-shrimp
45. Ali MZ, Zaher M, Alam MJ, Hussain MG. Effect of dietary carbohydrate to lipid ratios on growth, feed conversion, protein utilization and body composition in climbing perch, *Anabas testudineus*. *International Journal of Fisheries and Aquaculture.* 2012; 4(1): 1-6. Available on: http://www.academicjournals.org/journal/IJFA/article-full-text-pdf/33710CC5790
46. Agokei EO, Oparah CA, Aranyo A, Apapa U. Growth of *Clarias gariepinus* juveniles fed five commercial feed. *Continental Journal of Fisheries and Aquatic Science.* 2011; 5(3): 1-5. Available on: https://archive.org/download/GrowthOfClariasGariepinusJuvenilesFedFiveCommercialFeed/Vol5_3_-Cont.J.FisheriesAquaticSci1-5.pdf
47. Adewolu MA, Ikenweiwe NB, Mulero SM. Evaluation of an animal protein mixture as a replacement for fishmeal in practical diets for fingerlings of *Clarias gariepinus* (Burchell, 1822). *Israel Journal of Aquaculture (Bamidgeh).* 2010; 62(4): 237-244. Available on: https://www.researchgate.net/profile/Morenike_Adewolu/publication/234888799_Evaluation_of_an_Animal_Protein_Mixture_as_a_Replacement_for_Fishmeal_i

n_Practical_Diets_for_Fingerlings_of_Clarias_Gariepinus_Burchell_1822/links/02bfe5102b73c8e85d000000/Evaluation-of-an-Animal-Protein-Mixture-as-a-Replacement-for-Fishmeal-in-Practical-Diets-for-Fingerlings-of-Clarias-Gariepinus-Burchell-1822.pdf
48. Agbabiaka LA, Okorie KC, Ezeafulukwe CF. Plantain peels as dietary supplement in practical diets for African catfish (*Clarias gariepinus* Burchell 1822) fingerlings. *Agriculture and Biology Journal of North America.* 2013a; 4(2): 155-159. Available on: http//scihub.org/ABJNA/PDF/2013/2/ABJNA-4-2-155-159.pdf
49. Tan Q, Xie S, Xhu X, Lei W, Yang Y. Effect of carbohydrate to lipid ratios on growth and feed efficiency in Chinese longsnout catfish (*Leiocasis longirostris*). *Journal of Applied Ichthyology.* 2007; 23(5): 605-610. Available on: https://www.researchgate.net/profile/Shouqi_Xie/publication/229994606_Effect_of_dietary_carbohydrate-to-lipid_ratios_on_growth_and_feed_utilization_in_Chinese_longsnout_catfish_Leiocassis_longirostris_Gnther/links/54be5c330cf218d4a16a5cb5/Effect-of-dietary-carbohydrate-to-lipid-ratios-on-growth-and-feed-utilization-in-Chinese-longsnout-catfish-Leiocassis-longirostris-Gnther.pdf
50. Alegbeleye WO, Oresegun AO, Omitoyin O. Use of bambara groundnut (*Vigna subterranean*) meal in the diets of Heteroclarias fingerlings. *Moor Journal of Agricultural Research*. 2001; 2: 54-59. Available on: http//
51. New MB, Tacon AGJ, Csavas I. Farm-made aquafeeds. FAO Fisheries Technical Paper. No. 343, Rome, Italy. 1994. p. 434. Available on: http://www.fao.org/docrep/003/V4430E/V4430E00.HTM
52. Golovina NA. Morpho-functional characteristics of the blood of fish as objects in aquaculture. PhD. Dissertation. University of Moscow, Moscow. 1996. Available on: http://
53. Oyawoye EO, Ogunkunle M. Physiological and biochemical effects of raw jack beans on broilers. *Proceedings of the Annual Conference of Nigerian Society of Animal Production.* 1998; 23: 141-142. Available on: http://
54. Teixeira MA. Haematological and biochemical profiles of rat (*Rattus norvegicu*) kept under micro-environmental ventilation system. *Brazilian Journal of Veterinary Research and Animal Science*. 2000; 37(50). Available on: https://www.lume.ufrgs.br/bitstream/handle/10183/99234/000298666.pdf?sequence=1
55. Joshi PK, Harish D, Bose M. Effect of lindane and malathione exposure to certain blood parameters in a freshwater teleost fish *Clarias batrachus*. *Pollution Research.* 2002; 21(1): 55 - 57. Available on: https://www.researchgate.net/publication/289830930_Effect_of_lindane_and_malathion_exposure_to_certain_blood_parameters_in_a_fresh_water_teleost_fish_Clarias_batrachus
56. Adeyemo OK, Agbede SA, Olaniyan AO, Shoaga OA. The haematological response of *Clarias gariepinus* to changes in acclimation temperature. *African Journal of Biomedical Resources,* 2003; 6: 105-108. Available on: http://www.bioline.org.br/pdf?md03020
57. Gabriel UU, Ezeri GNO, Opabunmi OO. Influence of sex, sources, health status and acclimation on the haematology of *Clarias gariepinus* (Burch, 1822). *African Journal of Biotechnology*. 2004; 3(9): 463-467. Available on: https://www.ajol.info/index.php/ajb/article/view/14998/61495
58. Terry C, Hrubec TC, Stephen AS. Haematology of fish. *Veterinary and Clinical Pathology*, 2000; 174: 1120-1125. Available on: http://
59. Osuigwe DI, Obiekezie AI, Onuoha GC. Some haematological in hybrid catfish (*Heterobranchus longifilis* x *Clarias gariepinus*) fed different dietary levels of raw and boiled jack bean (*Canacalia ensformais*). *African Journal of Biotechnology*, 2005; 4: 1017-1021. Available on: https://www.ajol.info/index.php/ajb/article/view/71218/60182
60. Fagbenro OA, Adedire CO, Ayotunde EO, Faminu EO. Haematological profile, food consumption and enzyme assay in the gut of the African bony–tongue fish *Heterotis* (*clupisudis) niloticus* (Cuvier 1829*)* (Osteoglossidae). *Tropical Zoology.* 2000; 13: 1-9. Available on: http://www.tandfonline.com/doi/pdf/10.1080/03946975.2000.10531125
61. Erondu ES, Nnubia C, Nwadukwe FO. Haematological studies on four catfish species raised in freshwater ponds in Nigeria. *Nigerian Journal of Applied Ichthyology,* 2003; 9: 250-256. Available on: https://www.researchgate.net/publication/229502101_Haematological_studies_on_four_catfish_species_raised_in_fresh_water_pond_in_Nigeria
62. Abalaka SE. Evaluation of haematology and biochemistry of *Clarias gariepinus* as biomarkers of environmental pollution in Tiga dam, Nigeria. *Brazilian Archives of Biology and Technology*. 2013; 56(3): 371-376. Available on: https://www.researchgate.net/publication/262434966_Evaluation_of_the_Haematology_and_Biochemistry_of_Clarias_gariepinus_as_Biomakers_of_Environmental_Pollution_in_Tiga_dam_Nigeria/fulltext/03a2a8d70cf20bec3b6f03bc/262434966_Evaluation_of_the_Haematology_and_Biochemistry_of_Clarias_gariepinus_as_Biomakers_of_Environmental_Pollution_in_Tiga_dam_Nigeria.pdf
63. Dada AA, Ikwerowo M. Effect of ethanoic extracts of Garania kola seeds on growth and haematology of catfish (*Clarias gariepinus*) brood stock. *African Journal of Agricultural Research*. 2009; 4(4): 344-346. Available on: http://www.academicjournals.org/article/article1380793470_Dada%20and%20ikuerowo.pdf
64. Fagbenro OA, Adedire CO, Owoseeni EA, Ayotunde EO. Studies on the biology and aquaculture of feral catfish *Heterobranchus bidorsalis* (Geoffroy St. Hillarie 1809) (Clariidae). *Tropical Zoology*. 1993; 6: 67-79. Available on: http://www.tandfonline.com/doi/abs/10.1080/03946975.1993.10539209
65. Rastogi SC. Essentials of animal physiology. New Delhi: New Age International; 2007. p. 578. Available on: http://
66. Wedemeyer GA, Wood J. Stress: A predisposing factor in fish disease. U.S Fish/Wildlife Service fish diseases leaflet, 1974. p. 399. Available on: http://
67. Douglas JW, Jane KW. In schalm's veterinary haematology. Oxford: Blackwell Publishing Inc.; 2010; p. 1232.
68. Ayeloja AA, Agbebi OT, Jimoh WA. Characterization of diploid and triploid *Heterobranchus bidorsalis* using morphometric, meristic and haematological parameters. *African Journal of Biotechnology*. 2012; 11(27): 7098-1701. Available on: http://www.academicjournals.org/ajb/PDF/pdf2012/3Apr/Ayeloja%20et%20al.pdf

Cite this article: Ofonime Edet Afia and Gift Samuel David. HAEMATOLOGICAL PROFILE AND GROWTH RESPONSE OF AFRICAN SHARPTOOTH CATFISH (Clarias gariepinus, Burchell 1822) FINGERLINGS TO LOCALLY FORMULATED AND COMMERCIAL PELLETED DIETS IN TARPAULIN TANKS. *Am. J. innov. res. appl. sci.* 2017; 4(6): 213-222.