**Research Article**

**Effect of ginger (Zingiber officinale) in the nutrition of african catfish-A cholesterol reducer and fertility enhancer**

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**Abstract**

A twelve weeks nutritional study was carried out to study the effect of ginger (Zingiber officinale) on the growth performance, blood profiles, eggs and sperm quality of juvenile African catfish (Clarias gariepinus). In which juvenile African catfish (Clarias gariepinus) were fed five diets containing 35% CP were formulated having varying inclusion levels (0, 5, 10, 15 and 20 %) of ginger (Zingiber officinale) for Diet 1, 2, 3, 4 and 5 respectively. One hundred (100) juvenile African catfish (94.2±0.02g) were randomly selected, divided into five dietary treatments and stocked at the rate of 10 juveniles per tank (120L) and replicated two times. The fish were fed ad libitum twice daily and weight changes were recorded every two weeks. At the end of the feeding trials, blood samples were taken, the sperm and egg sacs were excised from the fish samples and the sperm and eggs were collected for analysis. Data collected on weight changes, feed-intake, blood parameters and sperm volume, percentage motility, sperm density, percentage livability and death percentage were subjected to one way analysis of variance (ANOVA) using Completely Randomized Design (CRD).

The results revealed that fish increased significantly in weight (P < 0.05) as the level of ginger inclusion increases in diets and utilized the feed efficiently than the control. Significant differences (P < 0.05) were observed in all the growth parameters. Treatment4 (fish fed 15% ginger based diet) had the highest mean weight gain (166.71g), percentage weight gain (176.90%), specific growth rate (0.54%), protein efficiency ratio (1.64) and red blood cells (3.86cmm). Also, fish fed 15% ginger based diet (T4) recorded least alkaline phosphate (13.62u/l), alanine transaminase (22.36u/l) and Creatinine (0.18mg/dl). However, fish fed 20% ginger based diet (T5) had higher sperm motility (67.50%), sperm livability (180.85%), egg volume (40ml), egg weight (36.50g) and egg number (25600) while the least sperm motility and livability (45.00%, 92.05%) respectively were obtained in T4. Although, the least values of egg volume, weight and number (25ml, 24g, 16500) respectively were recorded in control (T1).

Therefore, it can be concluded that 15% ginger can be included in the diet of African catfish (Clarias gariepinus) to enhance growth, good hematological and reduced antinutrients although, greater success were recorded for reproductive performance using higher level of ginger(20%) without detrimental effect.

**Introduction**

The African catfish (Clarias gariepinus) [1], is a species of catfish of the family Claridae and is an important fish species in both aquaculture and capture fisheries [2]. It contributes 22% of animal protein in sub-Saharan Africa and 40% of animal protein for consumption in Nigeria [3]. In Africa, this catfish has been reported to be the biggest in size in terms of length and weight and popularly cultivated species [4]. In Nigeria, Catfish culture started from inception with aquaculture and is majorly the only hope of fish supply sustainability. Recently all over the world, there is a decline in landing from capture fisheries which is an indication that fish stocks have exceeded the point of maximum sustainable yield. Apart from Tilapia, African catfish belonging to the family of Claridae is the most commonly cultivated fish in Nigeria. The steady rise in catfish culture has greatly boosted aquaculture growth in Nigeria. However, the problem of inadequate availability of stock has hampering its production. Although, induced breeding (hypophysation) has been introduced and widely used throughout Nigeria to increase the production of farmed catfish [5]. Currently, natural materials (medicinal plants) such as bitter leaf, scent leaf, bitter kola have been widely accepted as feed additives to enhance feed utilization and aquaculture productive, performance and sustainability [6]. Phytogenic feed additives, also known as phytobiotics

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**Keywords:** Clarias gariepinus; Zingiber officinale; Growth; Serum biochemical indices; Sperm and eggs

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Ginger is a flowering plant whose rhizome is commonly used as spice and flavouring agent. It is cultivated nationwide [8]. Ginger is a spice and medicinal plant that has been used in the pharmaceutical, food and chemical industries. It contains antioxidant and androgenic activities which has used in diseases treatment in many countries worldwide [9]. Ginger and its constituents have antiemetic, antithrombotic, anti inflammatory, stimulant, cholagogue. Androgenic and antioxidant properties. As antioxidants it protect DNA and other important molecules from oxidation and damage and can improve sperm quality and consequently increase fertility rate in men [10]. Ginger, boost metabolism, immune systems as well as effective in decreasing sperm DNA fragmentation (SDF) in infertile men [11].

A study has revealed that inclusion of ginger root powder in laying hens diet increased their egg production and weight compared with control laying hens [12]. It was also reported that, ginger roots essential oil significantly increased the relative uterus weight, egg weight, fertility and hatchability that, ginger roots essential oil significantly increased the relative uterus weight, egg weight, fertility and hatchability.

These studies therefore, investigate the effect of ginger in the nutrition, blood profile and reproduction of African catfish.

**Materials and methods**

**Experimental site**

This experiment was conducted at the fishery unit of Teaching and Research Farm, Ladoke Akintola University of (LAUTECH), Ogbomoso, Oyo state Nigeria.

**Processing of ginger (test ingredient)**

The dried ginger was obtained from a local market in Ogbomoso. The ginger were sun dried to a constant weight, ground to fine powder and stored in an air tight container prior the use for the experiment.

**Experimental diets**

The ingredients such as maize, wheat offal, GNC, soybean, fish meal, oyster shell, bone meal, premix, lysine, salt and vegetable oil were procured from a reputable feed mill in Ogbomoso. Five isonitrogenous (35%CP) diets were formulated in which diet 1 contained (0% ginger), diet 2 (5% ginger), diet 3 (10% ginger), diet 4 (15% ginger) and diet 5 (20% ginger). The ingredients were mixed thoroughly with varying percentage of ginger and then pelleted to reduce dustiness for proper and easy acceptance by the juvenile. The pellets were sanded to constant weight and packed into air tight sack and stored for use.

**Experimental fish**

Two hundred (200) juvenile African catfish were obtained from a reputable farm in Ogbomoso and acclimatized for the period of two weeks after which, one hundred (100) juvenile African catfish (94.24±0.02g) were randomly selected and divided into five (5) dietary treatments. The fish were stocked at the rate of 10 juveniles (4male:6 females) per tank (120L) and replicated two times (due to the number of fish within the weight ranges selected for the study). The water was exposed for three days to allow oxygen dissolution into the water. The waste and faeces in all the tanks were siphoned every day to prevent pollution.

**Feeding and weighing**

The fishes were fed experimental diet (add libitum) twice daily, both in the morning and evening (8:00hrs and 16:00hrs). Fishes were weighed every two weeks for the period of twelve weeks using an electronic digital weighing balance, the record of the feed consumption was also taken.

**Data collection**

Data such as fish weight and feed intake were collected during the feeding trial and the following parameters – Mean weight gain (MWG), Percentage weight gain (PWG), Specific growth rate (SGR), Feed conversion rate (FCR), Protein intake (PI), Protein efficiency ratio (PER) were calculated

\[
\text{Mean Weight Gain (MWG)} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Time interval}}
\]

\[
\text{Percentage Weight Gain (PWG)} = \left( \frac{\text{Mean weight gain}}{\text{Initial mean weight}} \right) \times 100
\]

\[
\text{Specific Growth Rate (SGR)} = \frac{\log W_f - \log W_i}{T_f - T_i} \times 100
\]

\[
W_i = \text{initial weight (g)}, W_f = \text{final weight (g)}, \log = \text{natural log to base}
\]

\[
T_f - T_i = \text{time interval between initial and final weight (days)}
\]

\[
\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed Intake}}{\text{Net weight gain}}
\]

\[
\text{Protein Efficiency Ratio (PER)} = \frac{\text{Net weight gain}}{\text{Amount of protein fed}}
\]

**Blood sample collection**

Blood samples for haematology and serum analysis were collected at the end of the feeding trial from the caudal penducle of both the test and control fishes with new 2ml syringe. The...
blood samples were dispensed into a tube containing Ethylene diamine tetra acetate (EDTA) to avoid clotting of the blood sample and Eppendorf tubes for serum samples preparation. The samples were preserved with ice cubes and taken to the laboratory for analysis.

**Milsts and eggs collection**

Three male and female fishes were randomly selected from all the treatments for milt and egg collection. The fishes were deoxidized and the testes excised and eggs were siphoned from the female ovum with the use of hose. After which the sperm and eggs were viewed under the computer microscope.

**Milt count**

Concentration of sperm will be determined by counting the numbers of spermatozoa in sample dilute with distilled water (100x) in a Burkerhaemocytometer under 400x magnification.

**Percentage motility**

Each sample were estimated using large microscope at 400x magnification, immediately after addition of 20ul distilled water as an activating solution. During spermatoza activation, immotile sperm cell (ISC) was counted, when the activation stopped, whole sperm cell (WSC) as counted, motile sperm cell (MC) was calculated.

\[
\text{MC} = \frac{\text{WSC} - \text{ISC}}{\text{WSC}} \times 100
\]

\[
\text{MC}\% = \frac{\text{MC}}{\text{WSC}} \times 100
\]

**Milt and egg analysis**

The milt was analyzed with the use of a computer aided system and the data were, mathematically elaborated to obtain numerical indices expressing the statue of the ejaculation system and the data were, mathematically elaborated to obtain numerical indices expressing the statue of the ejaculation system and the data were, mathematically elaborated to obtain numerical indices expressing the statue of the ejaculation system and the data were, mathematically elaborated to obtain numerical indices expressing the statue of the ejaculation system.

**Chemical analysis**

Proximate composition of test ingredient (ginger), fish sample and experimental diets were determined according to the methods of Association of analytical chemist [15].

**Statistical analysis**

All data collected during experimental period were subjected to a one-way analysis of variance (ANOVA) using completely randomized design in accordance with SPSS and Duncan’s multiple range tests was employed to reveal significant differences among the means.

**Results**

The proximate composition of the experimental diets is as shown in Table 3. All the diets had averagely 34.75% crude protein, 5.09% crude fibre, 6.80% ether extract, 7.69% ash, 43.23% nitrogen free extract.

The growth performance and nutrient utilization of juvenile African catfish fed ginger based diets was revealed in Table 4. Highest FMW, MWG,ADWG, PWG, SGR, AFI and PI and PER (260.95g, 166.71g, 1.99g, 176.90%, 0.54, 290.56g, 101.71g, and 1.64) were obtained in treatment 4 (15% ginger) while the least FMW, MWG,ADWG, PWG, SGR and PER (212.15g, 117.91g, 1.40g, 125.12% 0.43%, 1.40% were recorded in treatment 5(20% ginger) respectively. Although, the least AFI (224.96g) and PI (78.74) were obtained in T1(Control). Also, the least value of FCR (1.74) was obtained at treatment 4 (15% ginger) while the highest FCR (2.04) was found with treatment 5.

The carcass composition of juvenile African catfish fed ginger meal was recorded in Table 5. T3 having the highest CP (51.82%) while T5 has the least CP value (47.25%), T3 has the highest CF (9.00%) and the least was recorded in T1 (7.41%) and the values of other treatments (T2, T4, T5) are closely related having values (8.80, 8.20 and 8.82%) respectively. Ether extract is highest (21.01%) in T5 and lowest (15.24%) in T2, moisture content of T2 is the highest (9.01%) while the highest was recorded in T4 (2.24%). T4 has the highest ash and

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**Table 1: Gross Composition of the Experimental Diets.**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>T1 (%)</th>
<th>T2 (%)</th>
<th>T3 (%)</th>
<th>T4 (%)</th>
<th>T5 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>20.60</td>
<td>20.60</td>
<td>20.60</td>
<td>20.60</td>
<td>20.60</td>
</tr>
<tr>
<td>Wheat offal</td>
<td>10.30</td>
<td>10.30</td>
<td>10.30</td>
<td>10.30</td>
<td>10.30</td>
</tr>
<tr>
<td>GNC</td>
<td>22.20</td>
<td>22.20</td>
<td>22.20</td>
<td>22.20</td>
<td>22.20</td>
</tr>
<tr>
<td>Soybean</td>
<td>33.30</td>
<td>33.30</td>
<td>33.30</td>
<td>33.30</td>
<td>33.30</td>
</tr>
<tr>
<td>Fish meal</td>
<td>11.10</td>
<td>11.10</td>
<td>11.10</td>
<td>11.10</td>
<td>11.10</td>
</tr>
<tr>
<td>Ginger</td>
<td>____</td>
<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
<td>0.08</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Bone meal</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Premix</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 2: Proximate Composition of Test Ingredient (Ginger).**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Crude Protein (%)</th>
<th>Crude Fibre (%)</th>
<th>Ether Extract (%)</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ginger</td>
<td>8.75</td>
<td>9.20</td>
<td>4.60</td>
<td>6.60</td>
<td>6.20</td>
</tr>
</tbody>
</table>

**Table 3: Proximate Composition of Experimental Diets.**

<table>
<thead>
<tr>
<th>CP (%)</th>
<th>CF (%)</th>
<th>EE (%)</th>
<th>Ash (%)</th>
<th>Moisture (%)</th>
<th>NFE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>34.75</td>
<td>5.20</td>
<td>6.20</td>
<td>7.62</td>
<td>6.60</td>
</tr>
<tr>
<td>T2</td>
<td>34.76</td>
<td>6.02</td>
<td>5.40</td>
<td>7.60</td>
<td>6.62</td>
</tr>
<tr>
<td>T3</td>
<td>34.75</td>
<td>4.01</td>
<td>6.60</td>
<td>6.80</td>
<td>6.71</td>
</tr>
<tr>
<td>T4</td>
<td>34.75</td>
<td>6.80</td>
<td>5.20</td>
<td>7.81</td>
<td>6.61</td>
</tr>
<tr>
<td>T5</td>
<td>34.72</td>
<td>3.41</td>
<td>10.60</td>
<td>8.60</td>
<td>6.62</td>
</tr>
</tbody>
</table>

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Haematology and serum

Haematology of the experimental fish is presented in Table 6. Highest PCV (48%) was discovered in treatments five (T5) while the lowest PCV value (40%) was found with T2. Treatment one (T1) has the highest WBC (12.00cm) while treatment four (T4) has the least value (7.60cm). Treatment two (T2) was discovered to have the highest (37.50%) heterophil while treatment five (T5) has the least (25.00%) value. Highest values of lymphocytes (52.50%) and neutrophils (3.50%), were observed in treatment four (T4) and five (T5) respectively, while the least values (29.00%) and (1.00%) were observed in treatments one (T1) and three (T3) respectively. There was a noticeable difference in the basophil value among the treatments with treatment one (T1) having the highest value (20.00%) and treatment two (T2) having the least value (8.50%).

The findings of the present study on the haematology revealed that *Clarias gariepinus* juvenile fed with ginger meal of 0.08g (T5) produced the highest Hb (15.95gm/%) while that which was fed 0.02g (T2) produced the least (13.30gm/%) value. Highest values (3.86% and 559.00Fl) of RBC and MCV were observed in treatments four (T4) and three (T3) respectively, while the least values (3.33% and 132.50Fl) were observed in treatments four (T4) and three (T3) respectively. Treatment five (T5) recorded the highest (44.00Pg) MCHC while treatment four (T4) recorded the least value (37.50Pg). Treatments three (T3) and one (T1) were recorded to have the highest (33.35g/dl) and least (33.20g/dl) MCHC respectively.

The serum biochemical indices of African catfish fed ginger based diets were presented in Table 7. All serum indices parameters were significantly different (P<0.05) except urea. It was revealed in Table 7 that highest ALP (19.50) was obtained in treatment 3 (T3) while the least ALP (14.04) was obtained in treatment 4 (T4). Highest AST (104.45) and ALT (28.91) was recorded in treatment 2 (T2) while the least AST (59.70) and ALT (18.45) is obtained in treatment 5 (T5). Highest ALB (14.04) was obtained in treatment 2 (T2) while the least ALB (12.05) was recorded in treatment 5 (T5). Highest TP (39.05) and GLOB (25.01) was recorded in treatment 2 (T2) while the lowest TP (34.19) and GLOB (20.81) was obtained in treatment 1 (T1). Highest CHOL (154.81) was recorded in treatment 5 (T5) while the least CHOL (126.99) was obtained in treatment 1 T1. Highest creatinine (0.35) was also recorded in both treatment 2 and 5 (T2 and T5) while the least creatinine (0.18) was obtained in treatment 4 (T4).

**Sperm and eggs quality**

The sperm quality of African catfish fed ginger based diets in Table 8 recorded highest pH value (7.75) was obtained in T1 while the lowest (7.50) was recorded in all the other treatments (T2, T3, T4 and T5). T1 also has the highest volume (4.50ml), T3 and T4 has the lowest (2.00ml).
Spermatocrit highest rate (44.00%) was recorded in T1 while the least (27.50%) was obtained in T4. Sperm motility is highest (67.50%) in T5 and lowest (45.00%) in T4. Highest sperm density (267.50) is obtained in T5 while the lowest (114.30) is T3. Sperm alive is highest (180.85) in T5 and lowest in T3 (114.30) while sperm dead is highest (135.90) in T3 and lowest (79.35) in T2.

The egg quality of juvenile African catfish fed ginger based diets in Table 9, revealed that for parameters (volume, weight and number) T5 has the highest value (40.00ml, 36.50g, 25600) respectively while for parameters (volume, weight, number) T1 has the least value (25.00ml, 24.00g and 16800) respectively

**Discussion**

Medicinal plants have been reported to be growth promoters and immune boosters in livestock and fish nutrition [6,16-18]. The findings of the present study on growth performance of Clarias gariepinus juvenile fed ginger supplemented diets revealed that there was an increase in all the treatments for all parameters, as compared to the control. There was a significant increase in the final weight and weight gain of fish fed 15% inclusion of ginger than the fish fed the control diet. The same trend was observed for the ADWG, PWG, TFF, SGR, PI and PER. The present study agrees with Iheanacho, et al. [18], who reported significant increase in weight gain(WG), specific growth rate (SGR) and final weight (FW) when C.gariepinus juvenile were exposed to varying concentrations (0.25, 0.50, 0.75 and 1.0g/35L) of ginger as compared to the control. The high proximate content of ginger may be an influence on the positive response to growth in treated fish, especially at 15% inclusion level of ginger which has the best response in all the parameters.

Carcass composition was significantly affected by intake of ginger. Moisture content increased with increase in ginger inclusion levels and was least value of 2.26% was found in T4, This agreed with the findings of Ali, et al. [19]. This could be attributed to corresponding decrease in the energy level of diets. Fanullah and Jafri [20], reported a strong inverse relationship attributed to corresponding decrease in the energy level of diets. This agreed with the findings of Ali, et al. [19]. This could be attributed to corresponding decrease in the energy level of diets. This agreed with the findings of Ali, et al. [19]. This could be attributed to corresponding decrease in the energy level of diets. This agreed with the findings of Ali, et al. [19]. This could be attributed to corresponding decrease in the energy level of diets.

Blood is a vital special circulatory tissue, composed of cells suspended in a fluid intercellular substance (plasma) with the major function of maintaining homeostasis [22]. Packed Cell Volume (PCV), also known as haematocrit(Ht or Hct) or erythrocyte volume fraction (EVF), is the percentage of red blood cells in blood [23] and is involved in the transport of oxygen and absorbed nutrients [22]. In this present study PCV values increased from initial value of 45.50% in fish fed the control diet (T0) to final value of 48.00% in fish fed 1.6g ginger diet (T4) which contradicts Korzhuev (1964) [23] who stated that fish haematocrit values ranged between 20% and 35%. The results obtained falls within the range of 20% and 50% in agreement with Etim, et al. [24], who also stated that PCV values above 50% are rarely reported. Increased PCV results to an increased primary and secondary polycythemia [22], however, Sotolu and Faturoti [25] reported that lower PCV values were signifi cantly different (P<0.05). The highest was recorded in T4 (15% inclusion level of ginger) while the lowest value (7.45) was obtained in T1. Crude fibre was high in T3 and this might be as a result of low ash and crude fibre content of the tested ingredient (ginger) as was also observed by Erdal, et al., [21]. Crude protein of fish decreased with increase in ginger inclusion and recorded the highest in T4. This enhanced the crude protein content of C. gariepinus.

**Table 8:** Sperm Quality of Juvenile African Catfish Fed Ginger Based Diets.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1 (control)</th>
<th>T2 (5%)</th>
<th>T3 (10%)</th>
<th>T4 (15%)</th>
<th>T5 (20%)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vol( ml)</td>
<td>4.50</td>
<td>3.50</td>
<td>2.00</td>
<td>2.00</td>
<td>4.00</td>
<td>0.15</td>
</tr>
<tr>
<td>Ph</td>
<td>7.75</td>
<td>7.50</td>
<td>7.50</td>
<td>7.50</td>
<td>7.50</td>
<td>0.36</td>
</tr>
<tr>
<td>Spermatorcrit(%)</td>
<td>44.00</td>
<td>38.50</td>
<td>40.00</td>
<td>40.00</td>
<td>42.50</td>
<td>1.28</td>
</tr>
<tr>
<td>Motility (%)</td>
<td>62.50</td>
<td>62.50</td>
<td>60.00</td>
<td>45.00</td>
<td>67.50</td>
<td>1.14</td>
</tr>
<tr>
<td>Sperm Density</td>
<td>236.00</td>
<td>213.00</td>
<td>190.50</td>
<td>200.50</td>
<td>267.50</td>
<td>4.31</td>
</tr>
<tr>
<td>Sperm Alive</td>
<td>147.67</td>
<td>133.65</td>
<td>114.30</td>
<td>92.05</td>
<td>180.85</td>
<td>4.52</td>
</tr>
<tr>
<td>Sperm Dead</td>
<td>88.65</td>
<td>79.35</td>
<td>135.90</td>
<td>108.45</td>
<td>86.54</td>
<td>4.65</td>
</tr>
</tbody>
</table>

initial value of 3.45% in the fish fed control diet (T1) to the final value of 3.86% in fish fed 15% ginger diet (T4). These values were higher than 1.9x10⁴ L⁻¹ reported for Clarias gariepinus juveniles [28].

The final white blood cell counts (WBC) of C.gariepinus juveniles fed ginger included diets ranged between 7.60cmm in fish fed 15% ginger based diet (T4) and 10.00cmm in fish fed 20% ginger–based diets (T) and were generally lower and significantly different from the initial WBC count (12.00cmm; Tₜ). [29] stated that increasing or decreasing numbers of WBC, are normal physiological reactions to toxicants and these shows the response of the immune system under toxic conditions. However, Soetan, et al., 2013 [30], stated that animals with low white blood cells are exposed to high risk of disease infections while those with high counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases. They also have high degree of resistance to entrance adaptability to local environmental and disease prevalent conditions [22,31-33].

Mean corpuscular volume (MCV) indicates the status or size of the RBCs and reflects a normal or an abnormal cell division during the production of RBC. The result gotten from the present study showed that fish fed with 10% ginger diet (Tₜ), gave the highest volume (559.00Fl) while the fish fed 5% ginger diet (Tₜ), had the least (120.00Fl) MCV value. These values are higher when compared to 79.20-105.32μg/ml reported for Heterocariarias [34]. This increase may be attributed to the swelling of the RBCs as a result of low oxygen condition and impaired water balance in fishes exposed to metal pollution [35].

Mean corpuscular haemoglobin (MCH) values were significantly different. The highest value (44.00Pg) was recorded in fish fed with 20% ginger based diet (Tₜ) while the least (37.50Pg) was recorded in fish fed 15% ginger based diet (Tₜ). These values agrees with Olasunkanmi [36] who reported a significant increase in the final MCH values in C. gariepinus fed raw mucuna seed meal–based diets.

The values recorded for mean corpuscular haemoglobin concentration (MCHC) (33.20g/dl, 33.25g/dl, 33.25g/dl, 33.30g/dl and 33.35g/dl) compares fairly well with 33.97% recorded by Adeyemo, (2007) [37] and values ranging between 28.75 and 37.62% recorded for fish fed M.Oleifera leaf meal–based diet [38].

Serum biochemical indices

In fish, proteins are among the main energy sources which play an important role in the maintenance of blood glucose [39]. The observed increase in the total protein content of fish in the study fed diet containing 0.02g of ginger could be linked with the level of anti–nutrients present in the diets. Yadav, et al. 2003 [40], who also reported a decrease in serum total protein content in Channa punctatus induced with stem–bark extract of Croton tiglium. Decrease in total protein in the fish fed control diet maybe exposed to toxic levels of toxicants which could be attributed to either a state of hydration and change in water equilibrium in the fish or a disturbance in protein synthesis within the liver or both [41].

The slight decrease of serum albumin in the study which can be observed in fishes fed 0.04g and 0.08g of ginger diet might be due to their degradation and utilization for metabolic purposes. The higher values of ALT in the study(5% ginger) may occur due to the blood serum enzyme in the experimental fish efficiently utilized amino acids for metabolic purposes, confirming the observation of Adesina [42]. Transaminases are important enzymes for monitoring the health status of fish [43] and leak out into the bloodstream from dying or damaged liver cells. Increased levels of transaminases in the blood serum of fish are usually associated with dying or damaged liver cells while a decrease could suggest leakage of enzymes into the serum [1,44], which is observed in the study. Increased level of AST in the study which is observed in 15% ginger might be due to stress or due to increased levels of anti–nutrients at higher inclusion.

It increase in response to stress [45] and this can be observed in the study. The lower AST values recorded in fish fed control and15% ginger based diets corroborated the report of [46] that there was inhibition of AST and ALT activities in the liver of catfish after intoxication with dietary ochratoxin. The observation also agreed with that of Dienye and Olumuij, et al. 2014 [38], who reported elevated ALT, AST and ALP. Activities in fish fed 30% M. Olefera leaf meal diet and above which suggested hepatic cellular damage leading to their leakage into the bloodstream [47]. This is also similar to [48], who reported that increase in serum protein, albumin and globulin level maybe as a result of immune response to certain constituents of the extracts which can be observed in the study. Kahlil, et al. [49], also reported that ginger when administered as bath treatment significantly decreased both ALT and creatinine levels in serum of Clarias gariepinus infested with gill monogenia, Bello, et al. [50], also reported that the decrease observed in ALT, ALP and ALB activities might be attributed to stress induced during fish sampling for blood collection, capturing and handling procedure.

The increased sperm motility, sperm density and sperm alive after 12 weeks of treatment with 20% inclusion revealed that with ginger powder boosts the fertilizing ability of semen. A study of male rats on effects of ginger on reproductive functions proved that ginger enhanced fertility in male especially in sperm characteristics which might be as a result of potentability of antioxidant and androgenic properties. In this study, sperm pH is slightly above neutral across all the treatments with the fishes fed the control diet having the highest pH value (7.75) while pH values were uniform (7.50) in all other treatments. The milt volume decreased as inclusion levels increased, the fishes fed the control meal recorded the highest value (4.50ml) and the lowest (2.00ml) in fishes fed 10%(treatment 3) and 15% (treatment 4) of ginger meal, this disagrees with the findings of Dada and Ogundiyile [49] on the effect of velvet beans on sperm quality on African catfish who observed that milt volume increased as inclusion levels increased having its highest value (0.91ml) in D₅ and lowest
(0.59ml) in the fishes fed the control diet. It was also recorded that there was significant difference in the spermatocrit of all treatments, the fishes fed the control diet obtained the highest value (44%), while the least rate (27.50%) was obtained in the fishes fed 15% of ginger meal.

This study revealed that egg volume, weight and number (40ml, 36.50g, 25600) respectively were significantly increased in fishes fed ginger diet inclusion at 20% (treatment 5). This is in agreement with Cek and Yilmaz [51], who reported that the number of eggs is determined based on its weight, the relationship between egg weight and number is also observed in this study. The result obtained from this study also agrees with the findings of Zhao, et al. [11], on the effect of ginger powder on laying performance of laying hens who recorded that egg mass was quadratically increased by ginger powder supplementation at levels up to 20g/kg of diet. This study suggests that ginger has a favourable effect on egg quality of African catfish (volume, number and weight). Furthermore, the increased egg quality shows that treatment with ginger powder improves and enhanced rate of fertilization in eggs.

Conclusion

The result obtained in this study revealed that, inclusion of 15% ginger (treatment 4) in the diet of African catfish generally increased the growth optimally and reduced the serum cholesterol level of African catfish. However, it can be concluded that there was significant difference in the spermatocrit of all treatments, the fishes fed the control diet obtained the highest value (44%), while the least rate (27.50%) was obtained in the fishes fed 15% of ginger meal.

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Reference


