THE EFFECTS OF OKRA (ABELMOCHUS ESCULENTUS) ON CANNIBALISM, HEALTH AND GROWTH PERFORMANCE IN CATFISH (CLARIAS GARIEPINUS)

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Abstract
A 10 week experiment was conducted to check the effect of diced Abelmoschus esculenta (Okra) on control of cannibalism in stocked fingerlings of African catfish (Clarias gariepinus). A total number of 250 catfish fingerlings with average weight of 1.40g±0.10g were randomly assigned to 5 treatments replicated thrice as I, II, III, IV and V representing, control (0g) 10g, 20g, 30g and 40g of Abelmoschus esculenta (Okra) respectively to study the effect that okra level have on weight gain, survival rate, haematological and histo-pathological parameters of Clarias gariepinus. Water quality parameters were also monitored. The data obtained were analysed using descriptive statistics and Anova while Duncan Multiple Range test was used to separate the difference in means. The initial mean weight of the fingerlings in treatment I, II, III, IV and V were 1.39±.04, 1.42±.09, 1.37±.39, 1.38±.02 and 1.45±.07g respectively. The results revealed that fish with no okra recorded the highest final weight value of 24.6g while the least value was recorded in Treatment V (40g okra). There was no significant difference (P>0.05) among the treatments, however, the mean weight of the fish decreased as the inclusion level increased. Hence, the highest mean weight of 23.27g was recorded in the control treatment while the least value (11.15g) was recorded in Treatment V. On the survival rate of the fish there was significant difference (P<0.05) in control with least value of 26.66% while Treatment V had the highest survival rate of 86.66%. Haematological parameters result revealed the highest PVC value of 33.50% in treatment II containing 20g of the diced okra while the least value of 20.50% was recorded in control. Hb followed the same pattern with PVC however, there was significant difference (p<0.05) among the treatments. The WBC increased with increasing inclusion level of the diced okra fruits. The biochemical changes observed revealed that there was significant difference (p<0.05) in the total blood protein, albumin, globulin and blood glucose. The highest value (9.65±0.40) of total protein was recorded in Treatment II and least (7.65±0.35) was obtained in treatment III. Albumin value ranged from 1.95±0.05 in treatment III to 3.35±0.05 in treatment V such as, total protein, blood glucose and albumin. There was significant difference (p<0.05) among the various water quality parameters measured. The nitrate ranged from 1.02 ± 0.28mg/l in control to 1.13 ± 0.01mg/l in treatment IV. DO range between 5.15 ± 0.33mg/l in control to 9.94 ± 0.30mg/l in treatment IV. From this study it can be deduced that survival rate can be increased by reducing cannibalism level among fingerlings of African catfish (Clarias gariepinus) under culture using okra (Abelmoschus esculenta) at 40g level in addition to adequate feeding.

Key words: Clarias gariepinus, Abelmoschus esculenta, Haematology, Cannibalism

Introduction
Catfishes of the family Clariidae, comprise the most commonly cultivated fish in Nigeria. According to (Miller and Atanda, 2011) the growth of aquaculture is rising in Nigeria as a result of catfish farming that is now largely adopted. Fish, especially, catfish (Clarias gariepinus) is a source of food rich in proteins and vitamins, especially, vitamin A (Retinol). They are source of animal protein. It is of the important fish species for aquaculture due to its high growth rate, significant tolerance to environmental stress; induced reproduction in captivity, resistance to high density culture and its market demand (Haylor, 1989). Clarias gariepinus is widely accepted by Nigerian consumers and was acknowledged that, these bigger fish are sold for about twice the price of 30 day old chick (Haylor, 1989). Clarias gariepinus has an average adult length of more than 1 metre long. These fish have slender body, a flat bony head, and a broad, terminal mouth with 4 pairs of barbells. It also has a large accessory breathing organ. It can weigh up to 2 kg or more (Anoop et.al., 2009).

Cannibalism is an act of killing and consuming the whole or major part of an individual belonging to the same species, irrespective of its stage of development. It is a common and widespread phenomenon throughout the animal kingdom (Helcht and Pienaar, 1993; Smith and Reay, 1991). Young fish exhibit allometric growth patterns, high
growth potentials than the older ones, the intensity of cannibalism could reach a maximum in the early weeks or months of life history when the variability of individual growth would be maximum (David et al., 2010).

Heterogeneous size distributions often lead to social dominance, which in turn results in aggressive behaviour and cannibalism (Hecht and Appelbaum, 1988). Cannibalism is thus facilitated by size heterogeneity. But it also affects size heterogeneity, since the smallest fish are consumed by the larger ones, and thus be viewed as a cause or consequence of heterogeneity (Baras, 1999; Haylor, 1999).

Cannibalism among *Clarias gariepinus*, *Tilapia*, *Heterobranchus longifilis* fry and fingerlings have been identified as one of the major problems by small – scale hatchery operators (Royle, 2001). Despite the increasing interest in this species, cannibalism among cultured *Clarias gariepinus* has received little attention and the factors underlying it have not much been investigated in details (Ahmed, 2006). The aim of this study are to determine the effect of *Abelmoschus esculentus* on the rate of reduction of cannibalism and survival in Catfish fingerlings and also know the effect of *Abelmoschus esculentus* on the haematology of *C. gariepinus* fingerlings and histopathological effect on the liver as well as determine the effect on serum biochemistry.

**Materials and Methods**

**Description of Experimental Site**

The experiment was carried out at the Fish hatchery Complex, Federal University of Agriculture Abeokuta, Ogun state, Nigeria.

**Collection of Fish and Experimental Design**

A total number of 250 *Clarias gariepinus* fingerlings was obtained from a reputable fish farm in Abeokuta metropolis and was transported to the experimental site in a 50litre capacity keg. The experimental fish was distributed in 15 plastics tanks of 1m x 1m x 1m (200m²) dimensions arranged in rows into 5 treatments and replicated thrice. The feeding trial was carried out for 10 weeks.

Experimental fish were acclimatized in a fibre glass tank for a period of 7 days during which fish were fed twice daily. After acclimatization, fingerlings were weighed and randomly distributed into experimental tanks. Fresh Okro fruits (*Abelmoschus esculentus*) were bought from Osiele Market in Odeda Local government Area of Ogun State, Nigeria. Phytochemical screenings of the fruits were carried out using standard procedures (Sofowora, 1993). These procedures were carried out to determine the chemical compounds naturally present in the fruits. The fruits was then diced into smaller sizes and weighed with Hanah sensitive scale model number tn202. The weighed fruits were then poured into each plastic tank filled 2/3 that is 150m³ containing the fish in this order 0g, 10g, 20g, 30g and 40g as treatments 1-5 respectively.

Feeding regime was twice daily for ten (10) weeks at 3% body weight using commercial feed (coppens) of 1.2mm size grade obtained at Ayoteni stores Obantoko, Abeokuta. The water was regularly replaced once every week. Also, mortality was monitored in all the treatments and recorded throughout the experiment period to estimate survival rates.

**Water Quality Parameters**

The water quality was measured using a standard procedure. The readings were taken once a week, very early in the morning between 7:00 and 8:00am throughout the experimental period. Some of the water parameters measured were; dissolved oxygen, nitrates and ammonia level.

**Determination of Dissolved Oxygen (mg/l)**

The determination of dissolved oxygen (DO) of the water sample was carried out using Winkler's method. The water sample was collected in a DO bottle of 300ml BOD bottle, 2mls of Manganese sulphate was first added after which 2mls of alkali-iodide was added to the solution and lastly 2ml of sulphuric acid was also added to the water sample after which it was taken to the laboratory where it was titrated against sodium thiosulphate using starch as the indicator. The end product of
the titration was noticed by a characterized colourless liquid.

**Determination of Nitrate (mg/l)**
Sodium salicylate (colorimeter) method (Ademoroti, 1996) was used to measure the concentration of nitrates in the water sample used for the experiment. Water sample was flocculated by addition of Mercury (II) oxide. The solution was allowed to settle for 5 minutes and later filtered. 2 ml of the filtrate was pipette into an evaporating dish. 1 ml of 1.0% sodium salicylate solution was added and evaporated to dryness for at least 30 minutes in a drying oven at 105°C. Sample residue was removed from the oven and allowed to cool after which 2 ml of concentrated sulphuric acid was added to dissolve the solids. 15 ml sodium, 15 ml distilled water was added followed by 15 ml sodium-hydroxide and titrated. The development of a yellow colour gives an inference of the presence of nitrate in the water sample. The titre value at which the yellow colour developed gave the amount of nitrate in the water sample.

**Fish Growth and Nutrient Utilization Parameters**
The growth parameters was calculated following the method of Bagenal (1978)

- **Mean Weight Gain** = \( W_f - W_i \)
  Where:
  \( W_f \) = Final weight of the body
  \( W_i \) = Initial weight of the body

- **Percentage Weight Gain (PWG)** = \( \frac{\text{Mean Weight Gain}}{\text{Mean Initial Gain}} \times 100 \)

- **Daily Growth Rate (DGR)** = \( \frac{W_f - W_i}{T} \)
  Where:
  \( W_f \) = Mean final weight of the body
  \( W_i \) = Mean initial weight of the body
  \( T \) = Culture period (days)

- **Survival Rate S (%)** = \( \frac{N_f}{N_0} \times 100 \)
  \( N_f \) = Total number of fish alive at the end of the experiment
  \( N_0 \) = Total number of fish stocked at the beginning of the experiment

**Feed Conversion Ratio** = \( \frac{\text{Dry Feed Intake} \times 100}{\text{Weight gain of fish}} \)

**Collection of Blood Sample**
Blood was collected from the experimental fish at the end of the experiment by putting them on a tray. A damp cloth was used to hold the fish to avoid slipping off while cutting. A small sample of the whole blood was drawn from the caudal vein of the fish using 1.5 ml syringe and needle. Blood was collected in the morning to avoid diurnal variation. Collected blood samples were transferred from the syringe into sample bottles (EDTA) containing anticoagulant, for haematological studies and some blood was kept undisturbed for clotting. After retraction of clot, the supernatant serum was pipette into labelled sample bottles and was stored in a refrigerator until analyzed.

**Haematological Studies**
The following parameters was analyzed on the blood samples, they include; Packed cell volume (PCV), Red blood cell (RBC), Haemoglobin (Hb), White blood cell (WBC) total and differentials Heterophil (HET), Lymphocyte (LYM), Eosinophil (EOS), Monocyte (MON) and Basophil (BAS) at the end of trials.

**Serum Biochemistry**
The serum biochemestry parameters like protein, albumin, globulin, and cholesterol were estimated using standard kits and procedures.

**Statistical Analysis**
All data were analyzed using descriptive statistics and one-way Analysis of variance. Duncan multiple range tests were used to evaluate significant difference between treatment means. All analyses were subjected to statistical package for social science (SPSS) version 17.

**Results**
Survival and Growth Response of *Clarias gariepinus* Fingerlings Stock with Okra (*Abelmoschus esculentus*) Extract
The survival rate, growth performance and nutrient utilization of catfish fingerlings stocked in water containing diced okra at different
Biochemical changes in the blood of *Clarias gariepinus* fingerlings stock with okra (*Abelmoschus esculentus*) extract

Biochemical changes in the blood of *Clarias gariepinus* fingerlings stocked with okra extract is presented in Table 3. There was significant difference (p<0.05) in the total blood protein, albumin, globulin and blood glucose. The highest value (9.65±0.40) of total protein was recorded in Treatment II and least (7.65±0.35) was obtained in treatment III. Albumin value ranged from 1.95±0.05 in treatment III to 3.35±0.05 in treatment V. The blood glucose value ranged from 5.50±0.50 in treatment V to 6.85±0.15 in treatment II.

Water Quality Parameter of *Clarias gariepinus* fingerlings stock with okra (*Abelmoschus esculentus*) extract

The mean weekly water quality parameters in the experimental tanks during the experiment are presented in Table 4. There was significant difference among the various water quality parameters observed. The nitrate ranged from 1.02 ± 0.28 in control to 1.13 ± 0.01 in treatment IV. DO range between 5.15 ± 0.33 in control to 9.94 ± 0.30 in treatment IV. Ammonia increases as the concentration increases with the least recorded in control. The value ranged from 0.66 ±0.20 to 4.49±0.06.

Phytochemical Analyses

Quantitative analysis of (*Abelmoschus esculentus*) okra fruit is presented in Table 5. The parameters such as alkaloids, saponins anthraquinones, phenols, steroid, oxalate, phytate, anthocyanin, tannin and flavonoid percentages as active compounds were shown.

Haematological indices of *Clarias gariepinus* fingerlings stock with okra extract

Table 2 shows the haematological parameters of the experimental fish stocked in water containing varying inclusion levels of okra fruits. There was no clear trend in various parameters measured. The highest PVC value of 33.50% was obtained in treatment II containing 20g of diced okra fruits while the least value of 20.50% was recorded in the control. Hb followed the same statistical pattern with PCV however, there was significant difference (p<0.05) among the treatments. In the case of WBC, it increased with increasing inclusion level, hence the highest values of 11.90 was recorded in treatment V which was significantly different (p<0.05) higher than other treatments while the lowest value of 9.85 was recorded in the control. The Lymphocyte value ranged between 59.00 in control to 66.50 in treatment IV containing 30g of okra fruits and there was significant difference (p<0.05) among the treatments.

Table 1: Growth, Cannibalism and survival parameters of *Clarias gariepinus* Fingerlings Stock with Okra (*Abelmoschus esculentus*) Extract

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control</th>
<th>Okra 10g</th>
<th>Okra 20g</th>
<th>Okra 30g</th>
<th>Okra 40g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Initial Weight (g)</td>
<td>1.39±0.04</td>
<td>1.42±0.09</td>
<td>1.37±0.39</td>
<td>1.38±0.02</td>
<td>1.45±0.07</td>
</tr>
<tr>
<td>Mean Final weight (g)</td>
<td>24.66±7.93</td>
<td>23.28±1.05</td>
<td>16.11±5.44</td>
<td>16.12±5.58</td>
<td>12.93±1.54</td>
</tr>
<tr>
<td>Weight Gain (g)</td>
<td>23.27±7.95</td>
<td>21.86±1.06</td>
<td>14.75±5.79</td>
<td>14.75±5.89</td>
<td>11.55±1.55</td>
</tr>
<tr>
<td>Initial No of Fingerlings</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Final No of Fingerlings</td>
<td>4</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Mortality No (Cannibalism)</td>
<td>11</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Survival Rate %</td>
<td>26.66±17.64ab</td>
<td>60.00±13.41ab</td>
<td>62.22±4.44ab</td>
<td>73.33±3.84a</td>
<td>86.66±6.66a</td>
</tr>
</tbody>
</table>

Means with similar superscript along the column indicate there is no significant difference
The Effects of Okra (Abelmoschus esculentus) on Cannibalism

Table 2: Haematological indices of Clarias gariepinus fingerlings stock with okra (Abelmoschus esculentus) extract

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>10g</th>
<th>20g</th>
<th>30g</th>
<th>40g</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV (%)</td>
<td>20.50±4.50a</td>
<td>33.50±2.50a</td>
<td>25.00±0.00bc</td>
<td>22.50±0.50bc</td>
<td>27.00±5.00ab</td>
</tr>
<tr>
<td>HB (g/dl)</td>
<td>6.80±1.60a</td>
<td>11.20±0.90a</td>
<td>8.35±0.05ab</td>
<td>7.50±0.20bc</td>
<td>9.00±1.70ab</td>
</tr>
<tr>
<td>RBC x10^12/L</td>
<td>0.80±0.23b</td>
<td>1.37±0.10a</td>
<td>1.05±0.01ab</td>
<td>0.93±0.07b</td>
<td>1.06±0.21b</td>
</tr>
<tr>
<td>WBC (x10^3/L)</td>
<td>9.85±0.45d</td>
<td>10.70±0.40</td>
<td>10.40±0.30</td>
<td>11.25±0.45</td>
<td>11.90±0.20</td>
</tr>
<tr>
<td>HET (%)</td>
<td>36.00±2.00a</td>
<td>33.00±0.00ab</td>
<td>38.50±2.50b</td>
<td>29.00±4.00a</td>
<td>37.00±4.00a</td>
</tr>
<tr>
<td>LYM (%)</td>
<td>59.00±2.00b</td>
<td>62.00±2.00ab</td>
<td>59.00±2.00b</td>
<td>66.50±3.50a</td>
<td>59.50±3.5b</td>
</tr>
<tr>
<td>MON (%)</td>
<td>0.20±1.32a</td>
<td>0.50±0.05a</td>
<td>1.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.50±0.05b</td>
</tr>
<tr>
<td>EOS (%)</td>
<td>4.50±0.50a</td>
<td>3.00±0.00ab</td>
<td>2.50±0.50b</td>
<td>4.00±0.00a</td>
<td>3.50±0.50ab</td>
</tr>
<tr>
<td>BAS (%)</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
<td>0.00±0.00a</td>
</tr>
</tbody>
</table>

*Means with different superscripts along same row show significant (p<0.05) difference

Table 3: Biochemical Changes in the Blood of Clarias gariepinus fingerlings stock with okra (Abelmoschus esculentus) extract

<table>
<thead>
<tr>
<th>Treatments</th>
<th>TPROT (g/l)</th>
<th>ALB (g/l)</th>
<th>GLO (g/l)</th>
<th>AST (IU/L)</th>
<th>ALT (µmol/l)</th>
<th>CREAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8.70±0.40b</td>
<td>3.05±0.75b</td>
<td>5.65±0.35b</td>
<td>25.20±1.10b</td>
<td>27.35±1.05a</td>
<td>0.45±0.05ab</td>
</tr>
<tr>
<td>10g</td>
<td>9.65±0.05b</td>
<td>2.45±0.45bc</td>
<td>6.85±0.15a</td>
<td>28.90±0.20a</td>
<td>23.80±1.05a</td>
<td>0.55±0.05a</td>
</tr>
<tr>
<td>20g</td>
<td>7.65±0.35ed</td>
<td>1.95±0.05c</td>
<td>5.70±0.40b</td>
<td>30.20±0.80a</td>
<td>25.20±1.00a</td>
<td>0.45±0.05ab</td>
</tr>
<tr>
<td>30g</td>
<td>8.70±0.30b</td>
<td>2.25±0.25bc</td>
<td>6.15±0.25ab</td>
<td>25.65±0.35b</td>
<td>25.65±1.35a</td>
<td>0.50±0.10a</td>
</tr>
<tr>
<td>40g</td>
<td>7.85±0.55ed</td>
<td>3.35±0.05a</td>
<td>5.50±0.50b</td>
<td>28.45±1.95a</td>
<td>26.70±0.60a</td>
<td>0.35±0.05a</td>
</tr>
</tbody>
</table>

*Means with different superscripts along same row show significant (p<0.05) difference **TPROT: Total Protein, ALB: Albumin, GLO: Globulin, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, CREAT: Creatinine

Table 4: Water quality parameters of Clarias gariepinus fingerlings stock with okra (Abelmoschus esculentus) extract

<table>
<thead>
<tr>
<th>Treatments</th>
<th>NO₃</th>
<th>DO</th>
<th>NH₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.02±0.28b</td>
<td>5.15±0.33a</td>
<td>0.66±0.02a</td>
</tr>
<tr>
<td>II</td>
<td>1.08±0.00b</td>
<td>6.94±0.06c</td>
<td>1.85±0.16d</td>
</tr>
<tr>
<td>III</td>
<td>1.05±0.01b</td>
<td>8.38±0.09ab</td>
<td>2.71±0.09c</td>
</tr>
<tr>
<td>IV</td>
<td>1.13±0.01a</td>
<td>9.76±0.03a</td>
<td>3.16±0.00b</td>
</tr>
<tr>
<td>V</td>
<td>1.03±0.00b</td>
<td>9.94±0.06a</td>
<td>4.49±0.06a</td>
</tr>
</tbody>
</table>

**NO₃: Nitrate, DO:Dissolved Oxygen, NH₃: Ammonia**
Table 5: Quantitative analysis of phytochemical parameter in okra (*Abelmoschus esculentus*)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% of chemical active compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tannin</td>
<td>1.16</td>
</tr>
<tr>
<td>Saponin</td>
<td>2.11</td>
</tr>
<tr>
<td>Alkaloid</td>
<td>1.48</td>
</tr>
<tr>
<td>Flavonoid</td>
<td>5.67</td>
</tr>
<tr>
<td>Phenol</td>
<td>1.72</td>
</tr>
<tr>
<td>Steriod</td>
<td>0.92</td>
</tr>
<tr>
<td>Antherquinone</td>
<td>0.61</td>
</tr>
<tr>
<td>Anthocyanin</td>
<td>0.23</td>
</tr>
<tr>
<td>Oxalate</td>
<td>4.88</td>
</tr>
<tr>
<td>Phytate</td>
<td>10.21</td>
</tr>
</tbody>
</table>

Histopathological changes of *Clarias gariepinus* fingerlings stocked with okra (*Abelmoschus esculentus*) fruits

Plate 1: A section of liver showing the portal connective tissue that is very prominent with an extensive portal degeneration and necrosis at 0g (Control treatment) x400, H&E
Plate 2: A section of liver showing no visible lesions at 10g (treatment 2) x400,H&E

Plate 3: A section of the liver showing multifocal areas of severe hepatic vacuolation at 20g (treatment 3) x400,H&E

Plate 4: Section of the liver showing severe diffuse hepatic degeneration and necrosis at 30g (treatment 4) x400,H&E
Plate 5: Section of the liver showing moderate diffuse vacuolation of hepatocytes with nuclei intact and centralized at 40g (treatment 5) x400, H&E

Discussion
The insignificant difference (p>0.05) among the treatments initial weight ensured that there was no bias in selecting the experimental fish. The high weight gain of control (23.27g) as shown in table 1 was as a result of the relatively higher weight gain of four (4) of the catfish fingerlings (shooters) found at the end of the experimental period. The weight gain of the fish samples in all the treatments was decreasing as the inclusion level increased; this could be attributed to cannibalism due to growth disparity among the control at 0g because as the inclusion levels increased the rate of cannibalism decreased. This situation can be affirmed to be true and is congruent with the findings of Biu et al. (2015). However, the non significant difference observed in the mean weight gain depicted that numerical differences were insignificant. The size disparity between the relatively larger fingerling that exhibited the abnormal growth pattern and the other fingerlings resulted in an increased incidence of cannibalism in the catfish population of control treatment this observation was in agreement with (Obirikorang et al., 2014). The low level of cannibalism that is mortality number (4 and 2) recorded in treatments IV and V with 30g and 40g okra fruits respectively when compared to control treatment (11) showed higher survival rate (73.33%, 86.66% and 26.66%) respectively as indicated in table 1. The reason for this could be based on the slimy nature of the okra fruits in the stocking medium wherein the water was so slimy that the fish could not attack or get hold of each other, thus preventing cannibalism among the fish in the okra treatment. According to Barton et al. (2002) size variation is viewed as both a cause and effect of cannibalism and social dominance is one of the causes of size variation which in turn results in hierarchical territoriality and aggressive behavioural pattern. Also, Reddy et al. (1995) reported that several environmental factors, particularly when these are limiting have been found to influence the behavioural pattern of African catfish fingerlings, thereby affecting the rate and extent of cannibalism in line with that okra fruits. These include the availability of alternative prey, availability of food, feeding frequency, density, light, refuge, size variation, feed distribution (Reddy et al., 1995). In a similar study by Abdelhamid et al. (2010) improving the survival rate of the African catfish, suggested that grading technique of separating of the biggest fry from the general population can reduce cannibalism phenomena drastically, although such practice can be labourious in large scale production.

The results obtained on the haematology of *Clarias gariepinus* (Table 2) showed a significant difference (p<0.05) in PVC, Hb, RBC, WBC and LYM parameters. Haematological results are used for clinical diagnosis of fish physiology which is determined by the effect of the internal and external physical environment (Adeyemo, 2005). The values are within the acceptable range, indicating that the okra fruits dropped in the culturing medium is not toxic to *Clarias gariepinus* and are safe to be added up to (40g) concentration level. These values were higher than those reported by Kefas et al. (2015) when the same fish species was caught and analysed for haematological indices in Lake Geriyo, Yola, Nigeria. The decrease in haematological parameters such as Hb and RBC of the control and treatment IV okra inclusion levels and other treatments was an indication that blood was not lost in fish compared with what was reported when *Leucaena leucocephala* was fed to *Clarias gariepinus* (Sotolu and Faturori, 2009). The values obtained although with significant differences for both control and
The Effects of Okra (Abelmoschus esculentus) on Cannibalism

okra inclusion levels, were within the range of healthy fingerlings of catfish (Omoniye et al., 2002). The highest white blood cell WBC value recorded in fish from treatment V containing 40g okra inclusion level could be attributed to increased production of leucocytes in the hematopoietic tissue of the kidney and perhaps the spleen (Omoniye, 2002, Ayoola, 2011). Lymphocytes are the most numerous cells comprising the leucocytes which function in the production of antibodies and chemical substances serving as defensives against infection (Joshi et al., 2000).

Das et al. (2004) reported that the concentration of blood plasma protein is an indicator to general health condition of fish. Although, Abdali et al. (2011) reported that a reduction in plasma protein is an indicator of the effect of toxins in the kidney, spleen and liver, the results obtained in this study showed a significant increase in the total plasma protein of C. gariepinus in treatment II (containing 10g of okra) when compared to control fish. The decrease in protein level with higher levels of okra concentration (40g) may be attributed to the destruction or necrosis of cells and consequent impairment in protein synthesis (Singh and Singh, 2002) and may be due to mobilization of protein to meet energy requirements and to sustain increased physiological activity (Martinez et al., 2004). There was a non-general significant (p<0.05) increase in other biochemical parameters in fish treated okra in relative to control fish. This is desirable because reduction in blood glucose level might be as a result of hypoxic condition induced by experimental condition. The increase in blood glucose level recorded in this study agrees with the findings of Obaro and Nzeh (2014) who observed higher blood glucose concentration in fish exposed to extract of Azadirachta indica leaf. Increase in the blood glucose concentration might have resulted from an increase in plasma catecholamine and corticosteroid hormones (Pickering, 1981).

Physicochemical parameters of the water observed in the study showed that the condition in the experimental tanks were favourable for the culture of C. gariepinus. Offem and Ayotunde (2008) also observed similar values that were conducive for normal health of H. longifilis.

Conclusion

From the study, okra (Abelmoschus esculentus) fruit slime could reduce cannibalism within a population when the concentration is high. In a culture situation, this can easily be resolved or sufficiently reduced by satiation feeding with suitable feeds and size-grading of the fish to remove larger individuals from the population. The haematological parameters (Packed Cell Volume, Haemoglobin, Red blood Cell, White Blood Cell) revealed that concentration of okra fruits could be included up to 40g in the stocking medium of C. gariepinus fingerlings without any negative effect on it health. The water quality parameters should also be considered when stocking ponds with catfish fingerlings. Inherent size variations within full-sibling groups tend to be lower than that between mixed-sibling groups that resulted to reduced incidents of cannibalism. It is thus imperative to stock similar-sized, full-sibling catfish fingerlings in production facilities to reduce cannibalism. Overall it is clear from the study that cannibalism in fingerlings catfishes cannot be completely eliminated by adequate feeding although its rate can certainly be reduced.

Recommendation

The findings in the present study recommend further investigation on the okra fruits concentrations level in order to ascertain its full potential in cannibalism control of African catfish fingerlings.

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