EVALUATION OF LEMON GRASS (Cymbopogon citratus) AS PHYTO-ADDITIVE IN THE DIET OF AFRICAN CATFISH (Clarias gariepinus) FINGERLINGS

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Abstract
The dietary effects of Lemon grass (Cymbopogon citratus) leaf powder meal on growth performance and immune response of African catfish (Clarias gariepinus) was evaluated. Five (5) isonitrogenous diets (40% crude protein) supplemented with 0.0g (D1), 0.5g (D2), 1.0g (D3), 1.5g (D4) and 2.0g (D5) of C. citratus leaf powder was prepared and fed to C. gariepinus fingerlings (mean weight 7.30 ±0.02g) for a period of eight weeks. Fifteen C. gariepinus fingerlings were randomly distributed into 15 plastic tanks (50litres) each representing five treatments in triplicates. Feeding was done twice daily. After the feeding trial, fish from each treatment group were challenged with pathogenic Aeromonas salmonicida, through intraperitoneal (I/P) injection and observed for 14 days for abnormal clinical signs and mortality. There was a significant difference (p>0.05) in the mean weight gain, mean feed intake and specific growth rate of fish fed diets with reduction as inclusion levels of C. citratus leaf powder increases. There were significant differences (p>0.05) in white blood cells among treatments. At the inclusion level of 2.0gkg⁻¹ of C. citratus, the best immunity against A. salmonicida was recorded. The result of this study has shown that C. citratus can be incorporated into fish feed at 0.5g100g⁻¹feed as a growth promoter in African catfish, C. gariepinus fingerlings for sustainable aquaculture.

Keywords: Growth performance, immune response, Aeromonas salmonicida, immunity, therapeutic

Introduction
Aquaculture is one of the most important options in animal protein production and requires high quality feeds with high protein content. This feed can also contain some complementary additives to keep animals healthy and favour their growth (Sayed et al., 2011). It is an agricultural sector which requires continued research with scientific technical development and innovations (Ibrahem et al., 2010). One of the major interests in fish farming worldwide is how to diminish production cost and extend outputs in the shortest time as feeding cost accounts for about 60-70% of the total cost of production (Adeparusi and Famurewa, 2011). Researchers are continually looking for commercial diets that will permit optimal growth of fish without health hazards to consumers (Baruah et al., 2008). Addition of natural growth promoters feed additives from herbs and spices has been a major research interest to replace synthesized ones used. This is because plants are natural sources of safer and cheaper additives (Dong-Hoon et al., 2012), which are non-toxic, biodegradable, and biocompatible (Sudagar and Hajibelou, 2010). The use of these plant-based additives allows fish farmers to maximize performance through improvement in health, weight gain, reproduction, and feed efficiency. In recent years, some of the herbal substances have been reported to possess hepatogenic, hepato-protective and growth stimulating properties. This properties helps to tone up liver resulting into better overall performance and higher profitability due to increased efficiency of feed utilization (Bhaskar et al., 2003).

Locally, C. citratus has been used for various medicinal purposes. C. citratus, commonly known as lemon grass, is a tropical perennial herb belonging to the grass family Poaceae (true grasses), and grow in the tropical and subtropical regions from mountains to grass lands and to arid zones. The name lemongrass is derived from the typical lemon-like scent of the essential oil present in the plant. C. citratus an immuno-stimulant; is aromatic in nature and produce commercially important oils, like citronella (Ambrose et al., 2016). It is commonly used in traditional Indian, Chinese, and Brazilian medicines (Negrelle and Gomes, 2007). C. citratus has been shown to be effective in the treatment of fever and infections in humans (Agbafor and Akubuogvo, 2007). The leaves of the plant have also been reported to have anti-inflammatory and antioxidant properties (Vanisha and Hema, 2012). This study aims to work on the various haematological and immunomodulatory effect of C. citratus leaf meal in African Catfish.
Materials and Methods

Experimental Design
The feeding trial was conducted in 15 plastic tanks (50 liters each) at the Teaching and Research Fish Farm of Fisheries and Aquaculture Technology Department, The Federal University of Technology, Akure. The tanks were filled to two-thirds of their volume with water supply from the farm’s water source; a volume that was maintained throughout the experimental period. To sustain and maintain the optimal environmental condition needed to support maximum fish growth, the water was changed twice a week.

Experimental Fish
Four hundred (400) *C. gariepinus* fingerlings with average mean weight (7.30 ± 0.02 g) were purchased from a reputable fish farm in Akure, Ondo State. The fingerlings were acclimatized to laboratory condition for 14 days. After acclimatization, two hundred and twenty-five (225) *C. gariepinus* fingerlings were randomly selected and distributed into fifteen plastic tanks (50 liters) at a stocking density of 15 fish per tank representing five treatments in triplicates. The fish were not fed for 24 hours prior to being placed on experimental diets. Ten (10) randomly selected samples were used for proximate and haematology composition before the commencement of the experiment.

Collection of *Cymbopogon citratus* and Preparation of Plant Powder
Fresh leaves of *C. citratus* was collected within the vicinity of Federal University of Technology Akure and identification was carried out at the Department of Crop soil and Pest Management, Federal University of Technology, Akure, Ondo State. The leaves were air-dried at room temperature (27°C) to reduce the moisture content, then milled into a fine powder using Binatone electric blender (model BLG 402) before incorporating it into the feed. The method of Akubugwo and Ugbo (2007) was used for quantitative phytochemical analysis.

Experimental Diets
Five (5) isonitrogenous diets (40% crude protein) were formulated using the composition of Fagbenro and Adebayo (2005) and labelled as D1 (Control), with D2, D3, D4, and D5 containing *C. citratus* leaf powder at 0.5 g, 1.0 g, 1.5 g, and 2.0 g/100 g of feed respectively as presented in Table 1. Other feed ingredients for the experiment were purchased from a reputable feed mill in Akure, Ondo State, Nigeria. Ingredients including Fish meal, Soya bean meal, Yellow maize, Cod liver oil, and Vit. Premix was measured using an electric sensitive weighing balance (Model PB 3002) and then thoroughly mixed in a Hobart A-2007 pelleting and mixing machine (Hobart Ltd, London, UK) to obtain a homogeneous mass; cassava starch was added as a binder. The resultant mash was pressed without steam through a mixer with a 2mm diameter size. The pellets produced was dried at a room temperature of (27-30°C) and stored at -4°C until the start of the experiment.

Feeding Trial Experiment
The feeding trial lasted for 56 days and the fish were fed at 5% of their body weight twice daily between the hours of 08:00 - 09:00 hrs and 16:00 - 17:00 hrs GMT. Fish were batch weighed (to the nearest gram) every fortnight using sensitive electronic weighing balance (NAPCO JA410) then feeding rations adjusted accordingly. Water quality parameters were monitored weekly using modern equipment such as Hanna multi-parameter meter (Hanna HI98060 model) for temperature (°C), oxygen meter (JPP-607) for dissolved oxygen (mg/L) and by using pH-009IIIATC (High Accuracy Pen-type Portable pH meter) meter for pH measurement. All measurements were taken at a depth of 10 cm. Fish mortality was also monitored and recorded in each tank throughout the period of the experiment.
Table 1: Gross and proximate Composition of Experimental Diets (g/100g feed) for C. gariepinus Fingerlings

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow maize (10%)</td>
<td>26.10</td>
<td>25.60</td>
<td>25.10</td>
<td>24.60</td>
<td>24.10</td>
</tr>
<tr>
<td>Fish meal (72%)</td>
<td>24.00</td>
<td>24.00</td>
<td>24.00</td>
<td>24.00</td>
<td>24.00</td>
</tr>
<tr>
<td>Soya bean meal (45%)</td>
<td>45.30</td>
<td>45.30</td>
<td>45.30</td>
<td>45.30</td>
<td>45.30</td>
</tr>
<tr>
<td>Cod Liver Oil</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>*Vit. Premix</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Binder (starch)</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Cymbopogon citratus Powder</td>
<td>0.00</td>
<td>0.50</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
</tr>
</tbody>
</table>

**% Proximate Analysis**

- Crude protein: 40.28, 40.23, 40.18, 40.13, 40.08
- Crude lipid: 13.68, 13.81, 12.71, 12.15, 10.84
- Crude fiber: 2.39, 2.81, 3.06, 3.16, 3.18
- Moisture: 10.62, 10.01, 9.49, 11.37, 9.67
- Ash: 6.24, 5.40, 6.01, 6.50, 6.27
- NFE: 26.40, 28.06, 27.02, 27.54, 30.98

Vitamin premix: A Pfizer livestock product containing the following per kg of feed: A = 4500 I. U, D = 11252 I. U, E = 71 I. U, K3 =2 mg, B12 =0.015mg, panthothenic acid = 5 mg, nicotinic acid = 14 mg, folic acid = 0.4mg, biotin = 0.04 mg, chlorine = 150 mg, cobalt = 0.2 mg, copper = 4.5mg, iron = 21 mg, manganese = 20 mg, iodine = 0.6 mg, selenium= 2.2mg, zinc = 20 mg, antioxidant = 2 mg.

Water quality parameters such as temperature, pH, and dissolved oxygen concentration were monitored weekly throughout the experimental period.

Proximate Analysis of Experimental Fish and Diets

The leaves of C. citratus, a sample of the five experimental diets and that of the fish at the beginning and end of the feeding trial were analyzed for the proximate composition using AOAC (2005) method.

Evaluation of Growth Performance and Nutrient Utilization

Fish sampling was carried out early in the morning fortnightly by transferring fish from the plastic tank into the weighing bowl. Weights of fish were taken using sensitive electronic weighing balance (NAPCO JA410) and then recorded accordingly. After every weighing, the fish were returned carefully into their respective tank. The feed fed and weekly weights recorded were used to compute the growth parameters according to Hephner, (1998); Becker et al., (1999) and Burel et al., (2000). The following growth indices were evaluated:

**Weight Gain (WG)** = W2 - W1;

W1 and W2 is the initial weight of fish and the final weight of fish in each tank.

**Specific Growth Rate (SGR (%/day))** = \[ \frac{100}{T} \ln \frac{W_2}{W_1} \]

Where, W1 and W2 are the initial and final weight of fish respectively, and T represents the duration of feeding trial.

Feed Conversion Ratio (FCR) = \[ \frac{\text{Feed consumed (g)}}{\text{Weight gain by fish (g)}} \]

Protein Efficiency Ratio (PER) = \[ \frac{\text{Weight gain by fish (g)}}{\text{Live body weight (g)}} \]

Survival (%) = \[ \frac{\text{No. of fish at the end of the experiment}}{\text{No. of fish at the onset of the experiment}} \times 100 \]

Hematological Examination

Fish specimens were removed from each plastic tank for blood analysis. One ml of blood from the fish were collected from cardiac puncture using different 5ml disposable heparinized syringes, with ethylene diamine tetra acetic acid (EDTA) as an anticoagulant. The blood analysis followed the method that was previously described by Svobodova et al., (1991). A blood sample taken from the fish was analysed for the estimated numbers of White blood cells (WBC)erythrocytes, hemoglobin (Hb), Packed Cell Volume (PCV), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC). White blood cell count was made from nine (9) fishes of each treatment in a Neubauer counting chamber. For differential count of leucocytes, whole blood on glass microscope slides was dried in air, and then stained with May-Grunwald/Giemsa. One hundred white blood cells from each smear were assessed and the percentage of different types of leucocytes was calculated.
**Challenge Test**

A challenge test was conducted at the end of the feeding experiment. A pathogenic strain of *Aeromonas salmonicida* (1 x 10^6 CFU/ml) was obtained from the Department of Crop Soil and Pest Management, Federal University of Technology Akure Ondo State. This strain was isolated and cultured on an agar plate at 20-25°C for 24hrs in the post graduate laboratory of the Department of Crop Soil and Pest Management, with all safety measures observed, the isolates were stored in 30% glycerol in Broth Heart Infusion (BHI) chamber prior to use.

On termination of the feeding trial, ten fish from each of the five treatment group were randomly taken, and then injected intraperitoneally with virulent *A. salmonicida* (1 x 10^6 CFU/ml, 2% of their individual body weight) and observed for a 14 day period for any physiological or pathological symptoms and mortality at various time intervals.

**Results and Discussions**

A pH of 6.65±1.28 obtained in this study is slightly acidic. This is in line with the pH range of 6.1-7.6 reported by Bichi et al., (2014). Temperature values recorded in this experiment is in line with the work of Afzal et al., (2007) who recommend a temperature range of 25-320C for good optimum performance of fish.

The result of proximate composition of *C. citratus* used in this study is as follows in percentage crude lipid, moisture, crude protein, crude fiber, carbohydrate, and ash were 12.76 %, 29.42%, 4.16%, 26.52%, 20.65%, and 7.18% respectively.

The results obtained for the growth response, nutrient utilization and survival of *C. gariepinus* fed with *C. citratus* leaf meal are shown in Table 2. There was a significant difference in mean weight gain (P<0.05) across the treatments. The specific growth rate of the fish ranged between 2.82±0.05 in D5 and 3.53±0.17% in D2. Fish fed D2 recorded the best FCR (1.19) being the most efficient in the conversion of feed to the flesh while fish fed D5 recorded the poorest FCR (1.43). However, there is no significant difference (P>0.05) in the FCR of fish from D1 – D4.

There was a significant difference in protein efficiency ratio recorded for fish fed D1 - D5. The Mean Weight Gain (MWG) of this study followed a continuous decreasing pattern with increasing levels (from 0.5g to 2.0g) 100-1g of feed of *C. citratus* leaf powder, thus showing an inverse relationship. The result of this experiment showed that the inclusion of *C. citratus* leaf meal powder at different inclusion level had effects on the growth of *C. gariepinus* fingerlings. Weight gain, feed conversion ratio, and specific growth rate are usually considered as the most important measurement of productivity of diets (Hossain et al., 1995; Omitoyin and Faturoti, 2000). Growth performance decreased with increasing level of *C. citratus* added to the diets. The results obtained in this study corroborates the works of (Turan et al., 2005; Dada and Ikuerowo 2009; Dada and Sonibare, 2015) who reported the use of herbal additives Chromolaena odorata (Ssiam weed), *Trifolium pretense* (red clover) and *Garcinia kola* seed extracts as growth promoters on *C. gariepinus* juveniles and brood stock respectively. Some authors also reported the use of different medicinal plants extracts as growth promoting agents in fishes such as red *Pagrus major* (sea bream) (Ji et al., 2007), and narrow-clawed crayfish *Austacus leptodactylus* juveniles (Turan et al., 2012).

The decrease in the MWG of the fish with higher inclusion level of *C. citratus* leaf powder could be attributed to the presence of anti-nutritional factors in *C. citratus* leaves. In a similar work done by Francis et al. (2001), it was revealed that at lower levels of inclusions, there is a physiological mechanism in fish that could compensate for the presence of anti-nutrients and their negative effect may not be felt, but at higher levels of inclusion, when the limit might have been exceeded, then the negative effect of these anti-nutrients will be well pronounced.

Blood parameters are good bio-markers or diagnostic tools to study the effects of diets on organ function, which is vital information for health assessment and management of fish under culture (Mesalhy-Aly et al., 2008). From the result presented in Table 3, it can be seen that the fish fed *C. citratus* incorporated diets showed improved blood parameters because as the quantity of *C. citratus* increase in the feed, the blood indices/parameters also improved. There was a significant difference (P<0.05) in the haematological indices of the fish after the experimental period. All the haematological parameters obtained in this study are within the recommended physiological ranges reported for *C. gariepinus* and they showed no significant difference (P>0.05) in mean corpuscular volume, mean corpuscular haemoglobin concentration, mean corpuscular haemoglobin, or packed cell volume in all treatments. Differences in blood parameters among the treatment could, therefore, be ascribed to differences in the inclusion level of dietary *C. citratus* leaf meal in the diets.
During the 14 days observation period while survival was the control diet (D1) had the highest mortality rate of 93%. The results of the challenge test (Figure 1) showed that the MCV values were similar to the values reported for rarely reported (Clark et al., 1981) and values above 50% are associated with stress (Gauthier and Rhodes, 2009), pathogens; they cause disease in aquatic organisms in exhibition of a darkened pigment, deep and shallow ulcers, bloody spots, as well as peeling of fish skin were observed from the third day after the introduction of bacteria before mortality began. The packed cell volume was within the range of 20 to 50% reported by Piets et al., (1981) and values above 50% are rarely reported (Clark et al., 1976; Etim et al., 1999).

MCV values were similar to the values reported for Heteroclarias fed Carica papaya leaf meal incorporated diet (Anyanwu et al., 2011).

The results of the challenge test (Figure 1) showed that the control diet (D1) had the highest mortality rate of 93% during the 14 days observation period while survival was highest (95%) in fish fed with diet D5. There was significant difference (P < 0.05) in the survival of the fish at the end of the experiment. There was During the challenge period, it was observed that the fish fed the control diet were jumping out from the water while those left in the tank swam just below the water surface and were upright in the water. Clinical signs like slight exophthalmos (popeye), an exhibition of a darkened pigment, deep and shallow ulcers, bloody spots, as well as peeling of fish skin were observed from the third day after the introduction of bacteria before mortality began.

Many bacterial agents are considered to be opportunist pathogens; they cause disease in aquatic organisms in association with stress (Gauthier and Rhodes, 2009), therefore a greater understanding of the interactions between stress and disease occurrence is needed. In the

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### Table 2: Growth Performance and Nutrients Utilization of *Clarias gariepinus* Fingerlings Fed Different Levels of *Cymbopogon citratus* Leaf Meal.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Mean Weight (g)</td>
<td>7.30±0.07a</td>
<td>7.28±0.06c</td>
<td>7.29±0.05e</td>
<td>7.30±0.03a</td>
<td>7.31±0.05c</td>
</tr>
<tr>
<td>Final Mean Weight (g)</td>
<td>52.27±4.12e</td>
<td>52.67±5.62e</td>
<td>43.90±1.42b</td>
<td>43.10±2.46b</td>
<td>35.57±0.81a</td>
</tr>
<tr>
<td>Mean Weight Gain (g)</td>
<td>44.97±4.08e</td>
<td>45.33±5.56e</td>
<td>36.57±1.36b</td>
<td>35.80±2.46b</td>
<td>28.23±0.85b</td>
</tr>
<tr>
<td>Mean Feed Intake (g)</td>
<td>55.90±4.22e</td>
<td>54.03±7.85e</td>
<td>47.77±1.27b</td>
<td>46.67±2.70b</td>
<td>40.40±1.22a</td>
</tr>
<tr>
<td>SGR (%/day)</td>
<td>3.5±0.13c</td>
<td>3.53±0.17c</td>
<td>3.21±0.05b</td>
<td>3.17±0.10b</td>
<td>2.82±0.05a</td>
</tr>
<tr>
<td>Protein Efficiency Ratio</td>
<td>2.01±0.05bc</td>
<td>2.10±0.07c</td>
<td>1.92±0.03b</td>
<td>1.92±0.12b</td>
<td>1.75±0.09b</td>
</tr>
<tr>
<td>Feed Conversion Ratio</td>
<td>1.24±0.03ab</td>
<td>1.19±0.04a</td>
<td>1.30±0.02b</td>
<td>1.30±0.02b</td>
<td>1.43±0.07b</td>
</tr>
<tr>
<td>Feed Efficiency Ratio</td>
<td>0.80±0.02bc</td>
<td>0.84±0.03c</td>
<td>0.77±0.02b</td>
<td>0.77±0.05b</td>
<td>0.70±0.05a</td>
</tr>
<tr>
<td>% Survival</td>
<td>91.10±3.81a</td>
<td>91.10±7.18a</td>
<td>91.10±3.81a</td>
<td>91.10±3.81a</td>
<td>95.53±3.87a</td>
</tr>
</tbody>
</table>

Means with similar superscripts on the same row are not significantly different (P > 0.05), SGR: Specific Growth Rate

<table>
<thead>
<tr>
<th>Parameters</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (g/100ml)</td>
<td>9.80±1.59a</td>
<td>10.06±1.12ab</td>
<td>11.90±0.20b</td>
<td>10.80±0.56ab</td>
<td>9.53±0.74a</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>29.33±4.73a</td>
<td>30.33±5.31ab</td>
<td>35.33±0.58b</td>
<td>32.33±1.55ab</td>
<td>28.33±2.08a</td>
</tr>
<tr>
<td>WBC(10³/mm³)</td>
<td>65.66±19.14ab</td>
<td>68.00±9.64ab</td>
<td>53.66±5.03a</td>
<td>63.33±1.15ab</td>
<td>76.66±10.26b</td>
</tr>
<tr>
<td>RBC(10⁵/mm³)</td>
<td>3.13±0.51a</td>
<td>3.37±0.40ab</td>
<td>3.93±0.12b</td>
<td>3.60±0.17b</td>
<td>3.23±0.29a</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>33.37±0.12a</td>
<td>33.20±0.50a</td>
<td>33.66±0.31a</td>
<td>33.37±0.15a</td>
<td>33.66±0.15a</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>31.33±2.92a</td>
<td>29.90±0.35a</td>
<td>30.26±0.93a</td>
<td>30.00±0.60a</td>
<td>33.66±0.15a</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>93.80±0.82a</td>
<td>90.13±0.71a</td>
<td>89.87±2.16a</td>
<td>89.83±1.43a</td>
<td>87.73±2.24a</td>
</tr>
<tr>
<td>Neutrophil (%)</td>
<td>66.33±3.51a</td>
<td>62.33±5.69a</td>
<td>60.33±2.52a</td>
<td>59.33±4.04a</td>
<td>59.33±2.31a</td>
</tr>
<tr>
<td>Lymphocyte (%)</td>
<td>31.67±5.13a</td>
<td>36.00±7.21a</td>
<td>39.33±1.15b</td>
<td>39.67±5.03a</td>
<td>32.00±3.61a</td>
</tr>
<tr>
<td>Monocyte (%)</td>
<td>1.00±1.00b</td>
<td>1.00±1.00b</td>
<td>1.00±1.00b</td>
<td>0.00±0.00b</td>
<td>0.67±1.15b</td>
</tr>
<tr>
<td>Eosinophil (%)</td>
<td>0.67±1.15b</td>
<td>0.67±1.15b</td>
<td>0.00±0.00b</td>
<td>1.00±1.00b</td>
<td>1.33±0.57b</td>
</tr>
<tr>
<td>Basophils (%)</td>
<td>0.33±0.56a</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 similar superscripts on the same row are not significantly different at (P > 0.05), Hb: Haemoglobin, PCV: Packed Cell Volume, WBC: White Blood Cell, RBC: Red Blood Cell, MCHC: Mean Corpuscular Haemoglobin Concentration, MCH: Mean Corpuscular Haemoglobin, MCV: Mean Corpuscular Volume.

The value range of WBC recorded in this study was higher than the range reported by Sotolu and Faturoti (2009). The level of white blood cells in the blood of fish has an implication on the immune system and the ability of the animal to fight infection (Douglas and Jane, 2010).

The packed cell volume was within the range of 20 to 50% reported by Piets et al., (1981) and values above 50% are rarely reported (Clark et al., 1976; Etim et al., 1999).
The present study, *C. citratus* significantly improved the survival of *C. gariepinus* against *A. salmonicida* and administration of medicinal plants has been reported to improve the immune system of fishes (Panigrahi *et al.*, 2004) confirming that *C. citratus* leaves meal diets can stimulate the production of antibody in fish which provide disease protection in animals and human beings (Watts *et al.*, 2001).

**Conclusion**

This study established the effectiveness of *C. citratus* leaf powder at 0.5g 100g−1 feed as a growth promoter in African catfish, *C. gariepinus* fingerlings. The use of *C. citratus* should be encouraged, as it will minimize the dependence on synthetic growth promoter, and it is also a viable means of reducing the cost of fish feeding since *C. citratus* leaf meal is cheap and readily available. The study also revealed that *C. citratus* leaf meal significantly improved the blood profile of the fish, indicating an enhancement in the immune system of the fish, which was confirmed in the challenge test.

![Figure 1: Survival of *C. gariepinus* Fed on *C. citratus* Supplemented Diets Challenged with *A. salmonicida*](image)

**References**


