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Growth Response of African Catfish (*Clarias gariepinus*) Fed Dietary Inclusion Levels of Green Leaf (*Amaranthus cruentus*)

[1]Ariweriokuma S.V, [2]Gabriel U.U, [3]Ansa E.J,*[4]Akinrotimi O.A

[1,2]Department of Fisheries and Aquatic Environment, Rivers State University of Science and Technology, PMB 5080 Port Harcourt, Nigeria.
[3,4]African Regional Aquaculture Center of Nigeria Institute for Oceanography and Marine Research, P.M.B 5122 Port Harcourt, Rivers State, Nigeria.
**ojoakinrotimi@yahoo.com*

Abstract: *A study was conducted to determine the growth responses of the African catfish (Clarias gariepinus) to dietary inclusion of green leaf (Amaranthus cruentus) of the Amaranthecea family. 360 fingerlings of Clarias gariepinus fish of mean weight 1.98±0.25g from the same stock were randomly stocked at 20 fishes per plastic aquarium at 6 treatment levels, each with 3 replicates. The effect of partial and total replacement of the commercial fish premix with the green leaf on the growth variables and nutrient utilization, were assessed. Six practical diets with graded replacement levels of commercial premix by dry Amaranthus cruentus green leaf powder at 0%, 20%, 40%, 60%, 80% and 100% were formulated and fed to C. gariepinus fingerlings for 16 weeks at 5% biomass. The dietary groups were designated Co (control), X_{20}, X_{40}, X_{60}, X_{80} and X_{100} inclusion levels. Diet Co contained 100% commercial premix, while diet X_{100} contained 100% dry green leaf powder. The other treatment groups had their different graded levels of fish and leaf premixes. The results obtained from the study indicated that Amaranthus cruentus leaf when used as a premix in the diet of Clarias gariepinus fingerlings can completely replace commercial fish premix at the 100% inclusion level. The highest values of growth performance were: final weight 175.50±0.34g, weight gain 173.02±0.85g, daily weight gain 18.91±0.21g, Absolute growth rate 160.21±2.43 and specific growth rate 2.18±0.12 were recorded in the control and closely followed by the X_{100} treatment group. There was no significant difference ($P > 0.05$) between the values in the control and X_{100} diet.*

Keywords: *Fish feed, Aquaculture, Vitamin, Green leaf, Growth*

1. INTRODUCTION

Aquaculture production in the world has grown tremendously from subsistence to commercial level within the last few years with Asian and the Western Europe contributed the highest volume of production in the world, while sub Saharan Africa contributed the least. Despite the low aquaculture production in sub-Saharan Africa, some improvements are taking place, when compared to the past production trends (Akinrotimi *et al*., 2011a; FAO, 2014). In Nigeria, the last few years witnessed a rapid expansion in aquaculture. Available data showed that fish production from aquaculture ranges from 15,840 in 1991 to 25,720 metric tons in the year 2000 and 86,350 metric tons in 2010 (FDF, 2011). However, there exists evidence that substantial part of fish production comes from home stead farms, rural aquaculture and small scale fish farms located in different parts of the country (Akinrotimi *et al.*, 2007a; Akinrotimi *et al*., 2011b). However, Olagunju *et al*. (2010) observed that production varies from 0.5mt/ha in small scale to as much as 10mt/ha in large scale for earthen ponds and this largely depends on level of management intensity.

The catfish (*Clarias gariepinus)* has been cultured intensively in the country since 1985 and this species is grown by both small-scale and large – scale fish farmers in all the states of the federation with a total production of 61,916mt valued at US86 million in 2007 making Nigeria the largest producer of catfish in Africa, and third in the world (FAO, 2010). This specie has gained much popularity as a promising farmed fish in aquaculture production (Ozigbo *et al*., 2013). It is an economically important food fish cultured primarily in fresh water ponds in tropical countries (Babalola and Apata, 2006). *C gariepinus* exhibits many qualities which make it suitable for commercial culture, these include its rapid fast growth, tolerance in regards to poor water quality conditions and high fish yield with great economical benefits, has a high survival rate under culture conditions and readily accepts artificial feeds (Nwadukwe and Ayinla, 2004). Other qualities that make this fish suitable for commercial culture include high disease resistance, high fecundity, air-breathing characteristics and good market potentials (Anyanwu *et al.,* 2007a; Akinrotimi *et al.,* 2007b).

With the introduction of tank culture cum flow through, enhanced by water recirculation systems, there has been a considerable increase in production of fish per unit area throughout the federation. The level of growth and intensification witnessed in aquaculture recently has raised several crucial issues that need to be addressed in the context of the sustainability of the aquaculture industry (Adikwu and Haruna, 1999; Sikoki, 2006; Akinrotimi *et al*., 2014). One of these critical issues is in the area of fish nutrition. Jamu and Ayinla (2003) opined that for aquaculture to be a productive and profitable venture, fish feed management is a determinant factor and accounts for at least 60 percent of the cost of fish production, as fish feed enhances, improves and sustains aquaculture development. There is therefore the need to develop a variety of relatively low price, locally available high quality feed ingredients suitable for constituting basic diets for the sustenance of the aquaculture industry (ADCP, 1983; Baruah *et al*., 2003; Gabriel *et al*., 2007a). Many studies have shown that the essential nutrient requirements of fish are proteins, carbohydrates, lipids, vitamins and minerals (Thompson, 1993; Tibbets *et al*., 2004; Jhingran, 2014; Gabriel *et al*., 2007b).Vitamins and minerals are usually presented in the form of premixture (premix) which are additives usually provided as a commercially prepared package. This feed additive among others is added to fish feed, for optimal fish growth (Wantanabe *et al.,* 1991; Saoud *et al.,* 2008; Azaza *et al*., 2013).

In this study, *Amaranthus cruentus* green leaf was used as a premix to replace commercial premix partially and totally as a source of vitamins and minerals in the fish diet fed to *Clarias gariepinus* fingerlings. *Amaranthus cruentus* is possibly the highest nutritious green leafy vegetable known (Pamplona-Roger, 2004), with high levels of essential micro-nutrients and is very rich in vitamins and minerals (USDA, 2005; NRC, 2006). It is an annual edible flowering green plant in the family Amaranthacea. It is a native to the Mediterranean region (Helland *et al*., 2010), but cultivated throughout the world today (Francis *et al*., 2001; Belton *et al*., 2011). It can easily be obtained at all times of the year and it is easy to prepare. The objectives of this study were therefore to assess the effect of replacing commercial vitamin and mineral premix with graded levels of dry ground green leaf powder serving as premix in the diet of *C. gariepinus* fingerlings on the survival and growth parameters of *C. gariepinus* fingerlings.

2. MATERIALS AND METHODS

Experimental Site and Fish Acclimation

This work was carried out at the Fisheries and Aquatic Environmental Laboratory at the Rivers Sate University of Science and Technology, Nkpolu, Port Harcourt, Rives State, Nigeria. Three hundred and sixty (360) fingerlings of *Clarias gariepinus* fish of the same stock and mean weight 1.98 ± 0.25g were obtained from the African Regional Aquaculture Centre (ARAC), Aluu, Port Harcourt. They were transported in oxygen bags to the experimental site. The fish was acclimated to laboratory conditions for two weeks and were fed twice daily with the locally purchased feed at 5% bodyweight. The fish were then stocked 20 fingerlings each into 18 plastic basins of dimension (1.2m x 0.6m x 4.8m).

Experimental Procedure

The feed were formulated and produced using locally purchased feed ingredients such as fish meal, soya bean meal, groundnut cake, corn meal, red palm oil, iodized salt, commercial purchased fish premix and dried and ground *Amaranthus cruentus* green leaf which served as the test premix that replaced the fish premix partially and totally. All the feed ingredients were measured out according to feed formulation suitable for *Clarias gariepinus* fish. The thoroughly mixed 1kg feed ingredients was then shared into six portions designated C_O (control), $X_{20,}$ X_{40} ,X_{60}, X_{80} And X_{100} . The control diet contained 100% commercial fish premix, while $x_{100\ diet}$ contained 1oo% (percent) green leaf powder only. X_{20} portion contained 80% (percent) fish premix and 20% (percent) green leaf powder while X_{40} portion contained 60 percent fish premix and 40 percent green leaf powder x_{60} portion contained 40 percent fish premix and 60 percent green leaf powder, while x_{80} portion contained 20 percent fish premix and 80 percent green leaf. Six practical diets were therefore formed with partial and total replacement of the commercial fish premix with green leaf powder. The dough of each practical diet was then extruded separately through a meat mincer to produce strand which were cut into pellets and sun dried separately for 72 hours or more. The dry pellets were broken into crumbles that can be swallowed by the finger lings and were separated with Labels in small plastic bags. These were stored on wooden racks in a cool dry room.

Feeding of Experimental Fish

The fingerlings were handfed to visual satiety twice daily at 8.00hr and 17.00hr. The daily ration of 5% body weight was divided into two and half fed to fish each time. The weight of feed fed was adjusted every two weeks. The fish were cultured for 16 (sixteen) weeks.

Evaluation of Growth Parameters

The following indices were determined:

Relative Growth (RG) = Growth as percentage of initial body weight.

$$\frac{W_t - W_o \times 100}{W_O}$$ (Orisamuko, 2006)

W_t = body weight at time t

W_o = initial body weights

Weight Gain (RWG)

$$WG = \frac{\text{Final weight initial weight}}{\text{initial weight}}$$ (Mbagwu and Adeniji, 1988).

Specific Growth Rate (SGR)

$$SGR = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1} \text{ X } 100$$ (Brown, 2002).

Where W_2 = Weight of fish at time T_2 days

W_t = Weight of fish at time T_1 days

$\log_e$ = Natural log base e.

Daily Growth Rate (DGR)

$$DGR = \frac{Mean\ increase\ in\ weight\ per\ day}{Body\ weight\ of\ fish}$$ (Richinr, 1979)

Daily Rate of Feed Intake (DRFI) = $\frac{Mean\ ration\ per\ day}{Body\ weight\ of\ fish}$

(Madu *et al.*,1999).

Percentage Weight Gain (PWG)

The percentage weight gain was calculated from the relationship between weight gain and mean fish weight.

$$PWG = \frac{Mean\ weight\ gain}{Mean\ fish\ weight} \text{ x } 100$$ (Richinr,, 1979).

Feed Conversion Ratio (FCR)

The feed conversion ratio (FCR) was expressed as the proportion of dry food fed per unit live weight gain of fish (Reay 1979).

$$FCR = \frac{Live\ weiht\ gain\ (g)}{Dry\ feed\ fed\ (g)}$$ (Brown, 2002).

Gross Feed Conversion Efficiency (GFCE)

The gross feed conversion efficiency was calculated according to Stickney (1980), as a percentage of the reciprocal of food conversion ratio.

$$FCE = \frac{1}{FCR} \text{ x } 100$$ (Utme, 1979).

Statistical Analysis

The data obtained from the study were collated, analyzed and presented in graphs. using statistics software 8.0 for windows. Data were first tested for normality (Kolmogorov - Smirnov test) and homosesdasticity of variance (Bartetts test). When these conditions were satisfied, a two way analysis of variance (ANOVA) was employed to reveal significant differences in measured variables among control and experimental groups. When a difference was detected ($P < 0.05$), Tuckey's multiple comparison test was applied to identify which treatments were significantly different (Wahua, 1999).

3. RESULTS

Final Weight

The final weight of the experimental fish increased with feeding period. The highest final weight (175.60 ± 30.41g) in the feeding trial peeked at week 16, followed by week 14(135.35 ± 19.26g) and week 12(75.22 ± 13.58g) while the lowest value (3.80 ± 0.25g) was recorded in week 2. The final weight followed a definite increasing trend from week 2 to 16. There were significant differences ($P<0.05$) between some of the weeks (week 6-16) of the experimental period (Table 1). The responses to final weight of experimental fish in the treatment groups showed that the highest values (175.50 ± 0.34g) was recorded by the control diet C_o followed by diet x_{100} (160.68 ± 0.39g). The lowest value (59.44 ± 0.46g) was recorded in x_{40} diet. (Table 4.8). There were significant differences ($P<0.05$) between the control and diets x_{40}, x_{60} and x_{20} but not much significant difference ($P>0.05$) between the control and diet x_{100}. (Table 2). In the graph (Figure 1), the final weight at the end of the experimental period showed the control diet (Co) as the highest value followed by X_{100}, $X_{20,}$ X_{80} X_{60} and X_{40} diet showed the lowest value.

Weight Gain

The highest value (173.40 ± 30.41g) of weight gain was recorded in week 16 followed by week 14 (133.37 ± 22.83g) and week 12 (73.94 ± 19.26g), while the lowest value (1.92 ± 0.2g) was observed in week 2. There were significant differences ($P<0.05$) in weight gain from week 8 to 16. There was an increasing definite trend in weight gain from week 2 to the end of the experimental period (Table 1). The response of weight gain to dietary treatment in the experimental fish showed that the control diet Co recorded the highest value (173.02 ± 0.88g) followed by diet X_{100} (158.70 ± 0.66g) and diet X_{20} (120.44 ± 0.64g). The Lowest value (57.46 ± 0.71g) was recorded in diet X_{40} (Table 2). The weight gain in all the experimental diets tends to increase as the experimental period increased, higher values were recorded in C_0 , $X_{100,}$ X_{80} and$X_{60,}$ while, lower values were however observed in diet X_{40} and X_{60} (Figure .2).

Daily Weight Gain

The result obtained from daily weight gain of experimental diet recorded the highest value (13.13 ± 2.38g) in week 16, followed by week 14(9.68 ± 2.00g) and week 12(5.71 ± 1.36g). The lowest value 0.14 ± 0.02g) was recorded in week 2. There were significant differences ($P<0.05$) between some of the weeks (Table 1).The response of daily weight gain of the experimental fish to dietary treatments showed that highest value (18.91 ± 0.21g) was recorded in the control diet, followed by diet X_{100} (17.04 ± 0.23g), and diet X_{80} and the lowest value (10.47 ± 0.46g) was recorded in X_{40} diet (Table 2). The trend in values of daily weight gain in relation to experimental period was as follows: control (C_0) $>X_{100}>X_{80}>X_{20}>X_{60}>X_{40}$ (Figure 3).

Specific Growth Rate

The lowest value of Specific Growth Rate (2.08 ± 0.11) was recorded in week 10 followed by week 14(2.06 ± 0.02) and week 12 (2.00 ± 0.15). The lowest value (0.63 ± 0.63) (0.00) was recorded in week 2. There were variations in values from week 2 to week 16 with significant differences ($P<0.05$) between some of the weeks (Table 1).The responses of SGR to dietary treatment indicated that the control diet co recorded the highest value (2.18 ± 0.12) followed by diet X_{100} (2.10 ± 0.36). The lowest value (1.46 ± 0.23) was recorded in diet X_{40}. (Table 2). There was no significant difference ($P>0.05$) between the control diet co and diet X_{100}. Significant differences ($P<0.05$) exist between the control and diets X_{20}, X_{40}, X_{60} and X_{80}. (Figure 4).

Feed Input

Feed input increased as the experimental period increase with the highest value (124.83 ± 20.53g) in week 16 and lowest value (1.35 ± 0.05g) in week 2. (Table 1). In respect to the experimental diets the highest value (190.8 ± 0.84g) was recorded by diet X_{40} followed by diet X_{60} (188.4 ± 0.66g). The lowest value (147.8 ± 0.88g) was recorded in the control diet. Diet X_{100} recorded a value of (154.66 ± 0.88g). (Table 2).At the end of the experiment, the values in the experimental diet in relation to the period followed this trend X40>X_{60}>X_{20}>X_{80}>X_{100}>Co (Figure 5).

Abslute Growth Rate (AGR)

The results of AGR showed that the highest value (93.16 ± 26.61) was recorded in week 16 while the lowest value (1.20 ± 0.15) was recorded in week 2. The values recorded followed an increasing definite trend from week 2 to 16 (Table 1). The responses of AGR to dietary treatment showed that the control diet Co recorded the highest value (160.2 ± 2.43) followed by diet X_{100} (155.21 ± 2.16), and diet X_{80} (100.64 ± 2.89). (Table 2). There was no significant difference (P>0.05) between the control diet and diet X_{100} but significant differences (P<0.05) exist between the control diet and the other dietary levels. There was an increasing trend in AGR values at the end of the experimental period in relation to different diet, thus: control (co) >X_{100}>X_{80}>X_{20}>X_{40}>X_{40} (Figure 6).

Percentage Weight Gain

The percentage weight gain within the experimental period showed that the highest value (9757.33 ± 1800.05) was recorded in week 16 while the lowest value (120.39 ± 15.97%) was recorded in week 2. (Table 1). In the dietary groups, the highest value (158.85 ± 0.62%) was recorded in the control diet followed by diet X_{100} (131.61 ± 0.84) while the lowest value (67.44 ± 0.61) was recorded in diet X_{40} (Table 2). There was an increasing trend in the values of percentage weight gain from week 2 to week 16, and significant differences (P<0.05) exist between some of the weeks. (Figure 7).

Survival Rate The highest survival rate (100.05 ± 0.15%) was recorded in week 2 while the lowest value (94.34 ± 2.89 %) was recorded in week 16 (Table 1). No significant differences (P>0.05), in value existed between the weeks of the experimental period. In response to the dietary treatment, the range in survival rate was between 100.78 ± 6.69 to 95.34 ± 0.01%. There were no significant differences (P>0.05) in all the treatment groups. (Table 2). In relation to experimental diets, the percentage survival of the fish decreased as the experimental period increased (Figure 8).

Tables

Table1. *Mean Values of Growth Parameters of C. gariepinus Fingerlings Feed Experimental Diet for 16 Weeks*

	Weeks							
Parameters	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**
Mean weight (g)	1.98 ± 0.25	1.98 ± 0.25	1.98 ±	1.98 ±	1.98 ±	1.98 ±	1.98 ±	1.98 ±
Final weight (g)	3.80 ± 0.25^{f}	5.12 ± 0.47^{e}	9.29 ± 1.36^{d}	19.05 ± 3.91^{c}	46.29 ± 9.20^{d}	75.22 ± 13.58^{b}	135.35 ± 19.26^{ab}	175.60 ± 30.41^{a}
Weight gain	1.92 ± 0.2^{f}	3.14 ± 0.5^{f}	7.31 ± 1.33^{f}	17.07 ± 3.91^{e}	44.31 ± 9.25^{d}	73.94 ± 19.26^{c}	133.37 ± 22.83^{b}	173.40 ± 30.41^{a}
Initial mean length (cm)	5.14 ±	5.14 ±	5.14 ±	5.14 ±	5.14 ±	5.14 ±	5.14 ±	5.14 ±
Final length (cm)	7.20 ± 0.46^{f}	9.68 ± 0.72^{e}	11.25 ± 1.32^{d}	14.29 ± 0.55^{c}	15.26 ± 0.63^{bc}	16.16 ± 1.04^{b}	17.85 ± 2.34^{ab}	21.88 ± 2.00^{a}
Length increase (cm)	2.06 ± 0.42^{f}	4.54 ± 0.55^{e}	6.11 ± 1.09^{d}	9.15 ± 0.69^{c}	10.12 ± 0.87^{c}	11.02 ± 0.89^{c}	12.71 ± 2.69^{b}	15.74 ± 1.68^{a}
Feed imput (g)	1.35 ± 0.05^{f}	2.73 ± 00.05^{f}	3.58 ± 0.33^{f}	13.4 ± 2.80^{e}	34.50 ± 7.60^{d}	50.60 ± 13.80^{c}	97.63 ± 18.26^{b}	124.83 ± 20.53^{a}
Daily weight gain (Dwa) (g)	0.14 ± 0.15^{f}	0.019 ± 0.02^{f}	0.25 ± 0.04^{f}	1.23 ± 0.·27^{e}	3.55 ± 0.75^{d}	5.71 ± 1.36^{c}	9.68 ± 2.00^{b}	13.13 ± 2.35^{a}
Absolute growth rate (AGR)	1.20 ± 0.15^{f}	1.86 ± 0.22^{f}	4.25 ± 0.73^{f}	9.97 ± 2.15^{d}	28.30 ± 5.94^{d}	43.51 ± 10.96^{c}	72.28 ± 15.81^{b}	93.16 ± 26.61^{a}
Percentage weight gain %)	120.39 ± 15.97^{f}	186.17 ± 22.87^{f}	424.67 ± 72.90^{f}	980.33 ± 214.48^{e}	2828.88 ± 596.99^{d}	4101.98 ± 1497.76^{c}	7243.06 ± 1593.66^{b}	9757.33 ± 1800.05^{a}
Relative growth rate (RGR) (%)	1.06 ± 0.22^{h}	1.18 ± 0.18^{ef}	1.18 ± 0.18^{ef}	2.66 ± 0.32^{e}	4.55 ± 0.84^{d}	6.58 ± 1.79^{c}	9.18 ± 2.66^{b}	11.88 ± 2.40^{a}
Specific growth rate (SGR) (%d^{-1})	0.63 ± 0.00^{c}	1.63 ± 0.20^{ab}	1.63 ± 0.20^{ab}	0.90 ± 0.51^{c}	2.08 ± 0.11^{a}	2.00 ± 0.15^{a}	2.06 ± 0.02^{a}	1.79 ± 0.08^{ab}
Percentage survival (%)	100.55 ± 6.15^{a}	100.78 ± 6.69^{a}	98.78 ± 6.69^{a}	98.50 ± 3.09^{a}	98.50 ± 3.09^{a}	96.82 ± 5.45^{a}	95.67 ± 56.69^{b}	95.34 ± 2.89^{b}
Condition factor (k)	1.13 ± 0.17^{a}	0.73 ± 0.13	0.73 ± 0.13^{a}	0.62 ± 0.14^{a}	1.45 ± 0.23^{a}	2.31 ± 0.24^{a}	2.28 ± 0.05^{a}	1.38 ± 0.25^{a}

Means in the same column with similar superscripts are not significantly different (P>0.05).

Table2. *Response of Growth Parameters In C. gariepinus to Dietary Treatments, Fed Experimental Diets For 16 Weeks (Mean ± S.D)*

GROWTH Parameters	**C_0**	**X_{20}**	**X_{40}**	**X_{60}**	**X_{80}**	**X_{100}**
Initial mean weight (g)	1.98 ± 0.25^{a}	1.98 ± 0.25^{a}	1.98 ± 0.25^{a}	1.98 ± 0.25^{a}	1.98 ± 0.25^{a}	1.98 ± 0.25^{a}
Final weight gain	175.50 ± 0.34^{d}	122.42 ± 0.41^{b}	59.44 ± 0.68^{a}	74.30 ± 0.81^{a}	111.48 ± 0.82^{b}	160.68 ± 0.39^{d}
Weight gain	173.02 ± 0.88^{d}	120.44 ± 0.64^{ab}	57.46 ± 0.71^{a}	72.31 ± 0.66^{a}	109.50 ± 0.71^{b}	158.70 ± 0.66^{c}
Initial mean length (cm)	5.14	5.14	5.14	5.14	5.14	5.14
Final length (cm)	21.88 ± 0.62^{ab}	14.86 ± c0.71^{b}	15.86 ± 0.88^{a}	16.34 ± 0.91^{a}	18.14 ± 0.62^{a}	19.89 ± 0.88^{b}
Length increase (cm)	16.74 ± 0.53^{c}	14.72 ± 0.88^{ab}	10.72 ± 0.92^{a}	11.20 ± 0.88^{a}	13.01 ± 0.11^{b}	14.75 ± 0.62^{ab}
Feed Input (g)	147.8 ± 0.88^{a}	168.2 ± 0.91^{ab}	190.8 ± 0.84^{c}	188.4 ± 0.66^{c}	162.4 ± 0.71^{ab}	154.66 ± 0.88^{ab}
Daily weight gain (g)	18.91 ± 6.21^{c}	13.61 ± 0.32^{b}	10.48 ± 0.46^{a}	11.81 ± 0.31^{a}	15.71 ± 0.21^{ab}	1764 ± 0.33^{c}
Absolute growth rate (AGR)	160.21 ± 2.48^{c}	80.61 ± 1.32^{b}	60.34 ± 1.61^{a}	65.21 ± 1.22^{a}	100.6 ± 2.89^{ab}	155.21 ± 2.16^{c}
Percentage weight gain %	158.85 ± 0.62^{c}	100.40 ± 0.81^{b}	74.41 ± 0.61^{a}	79.11 ± 0.81^{a}	109.61 ± 0.92^{b}	131.61 ± 0.84^{c}
Specific growth rate SGR	2.18 ± 0.12^{c}	1.70 ± 0.11^{b}	1.46 ± 0.23^{a}	1.51 ± 0.14^{a}	1.74 ± 0.21^{b}	2.10 ± 0.36^{c}
Percentage survival (%)	98.72 ± 0.01^{c}	100.58 ± 1.71^{c}	96.61 ± 0.81^{c}	96.34 ± 0.72^{b}	95.50 ± 0.01^{c}	98.10 ± 0.01^{c}
Condition factor (k)	1.68 ± 0.03^{e}	1.97 ± 0.04^{a}	2.68 ± 0.04^{b}	2.13 ± 0.03^{b}	1.18 ± 0.01^{a}	1.44 ± 0.01^{a}

Means within the row with different superscript are significantly different (P>0.05).

Figures

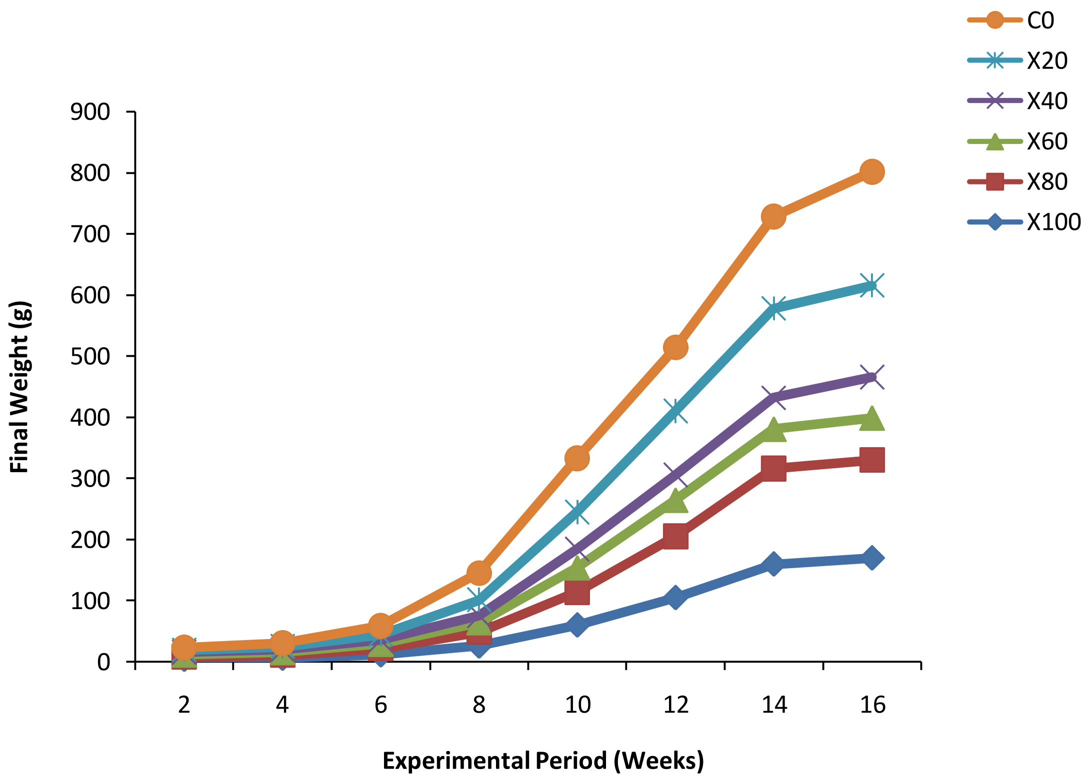

Figure 1: Changes in the Final Weight of *C. gariepinus* fed Experimental diet

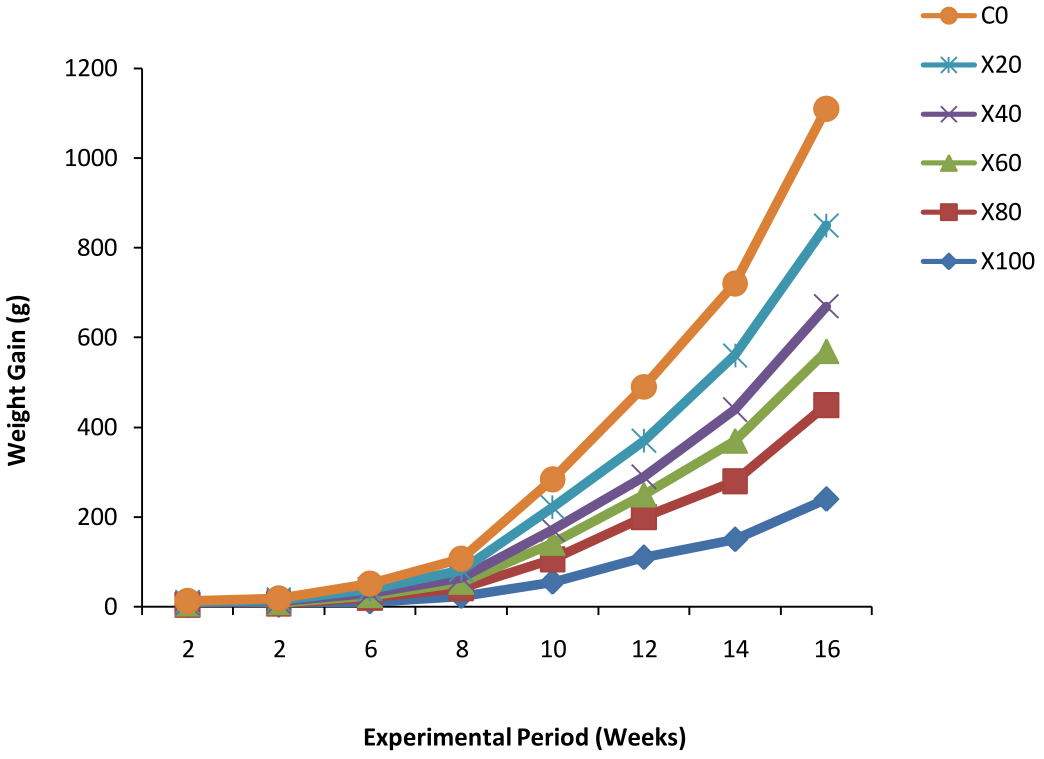

Figure 2: Changes in the Weight Gain of *C. gariepinus* fed Experimental diets

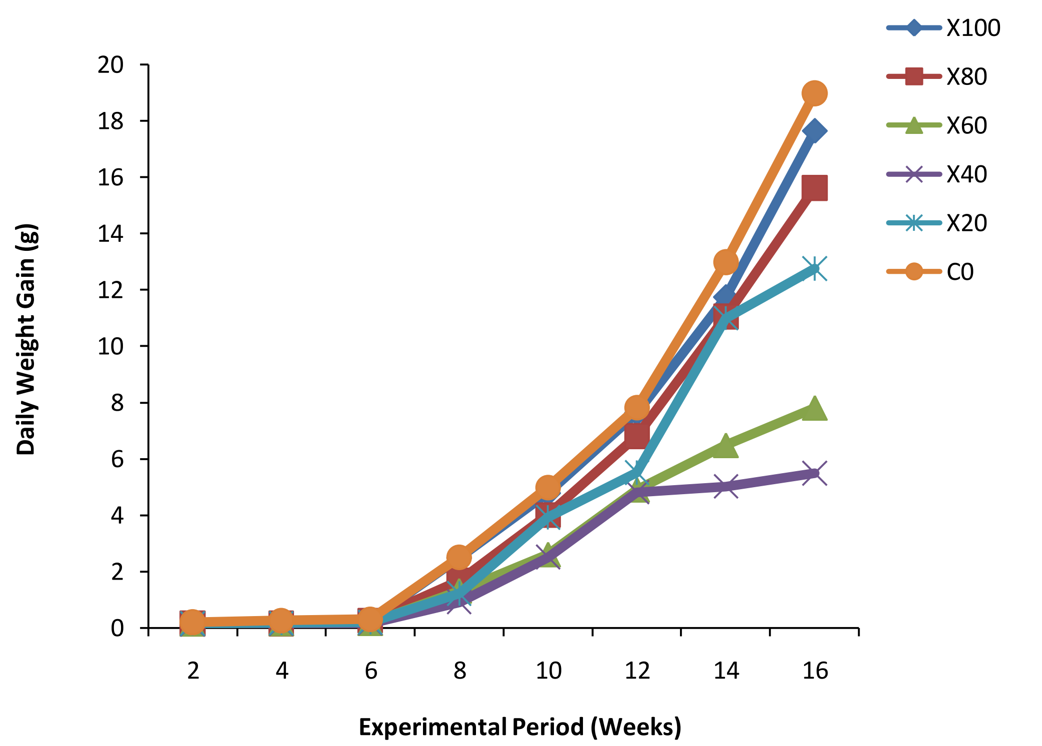

Figure 3: Changes in the Daily Weight Gain of *C. gariepinus* Fed Experimental Diets

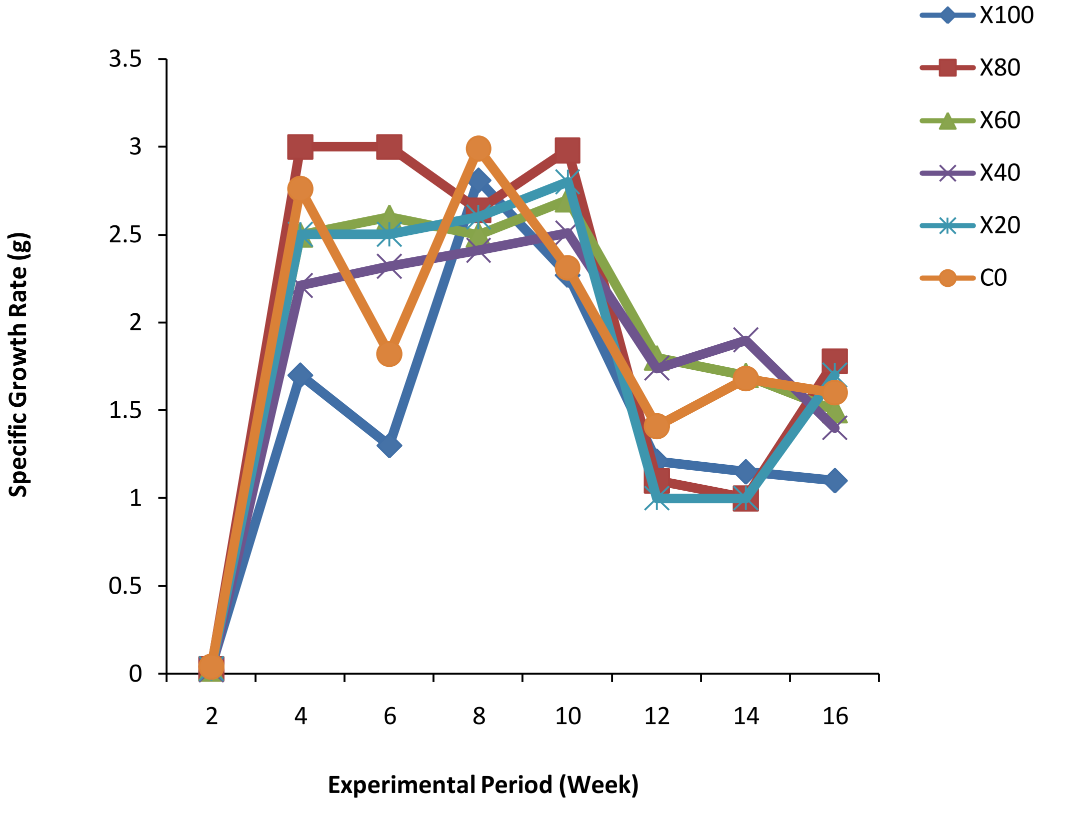

Figure 4: Changes in Specific Growth Rate of *C. gariepinus* fed Experimental Diets

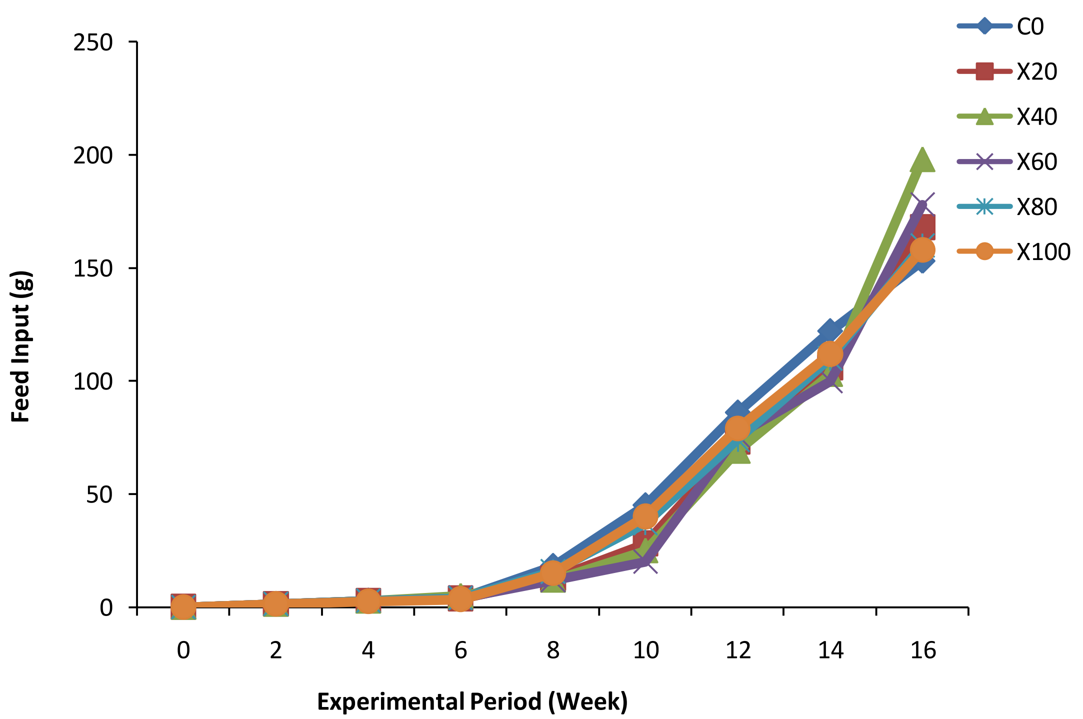

Figure 5 : Changes in Feed Input of *C. gariepinus* fed Experimental Diets

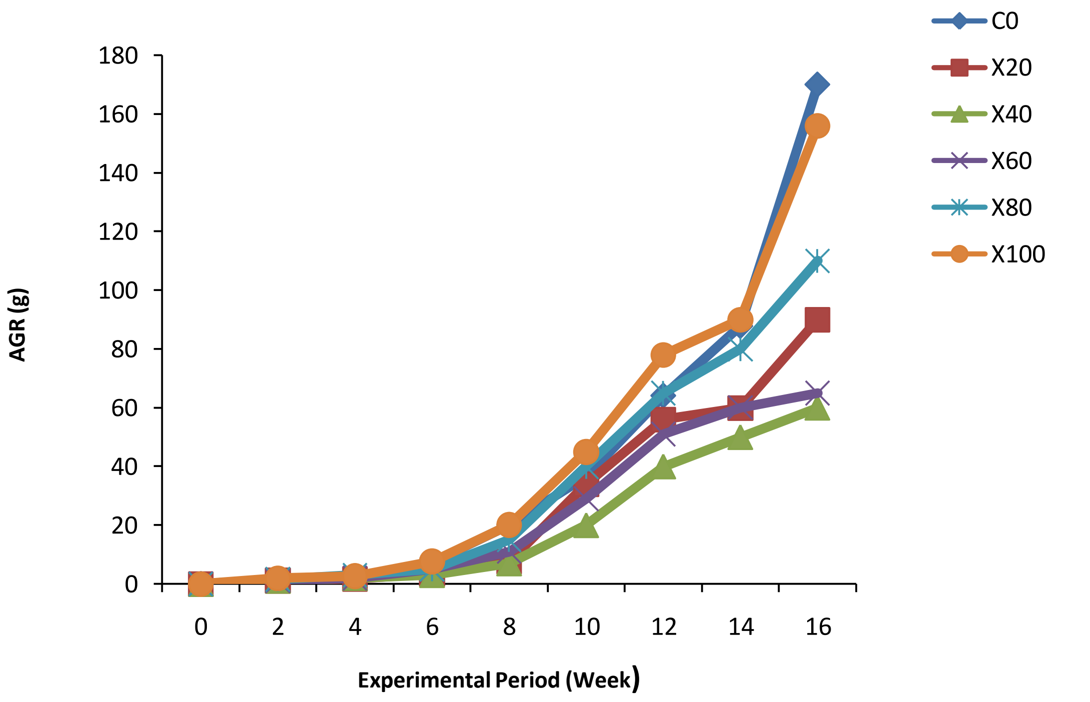

Figure 6: Changes in Absolute Growth Rate (AGR) of *C. gariepinus* Fed Experimental Diets

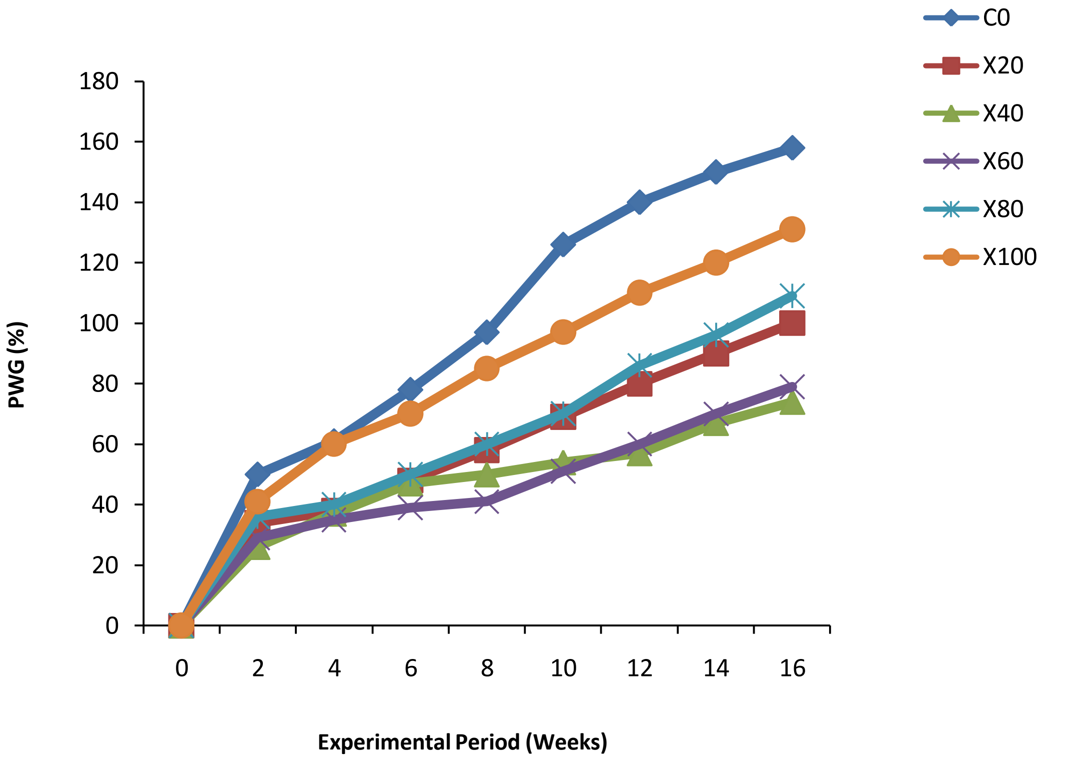

Figure 7 : Changes in Percentage Weight (PWG) Gain of *C. gariepinus* Fed Experimental Diet

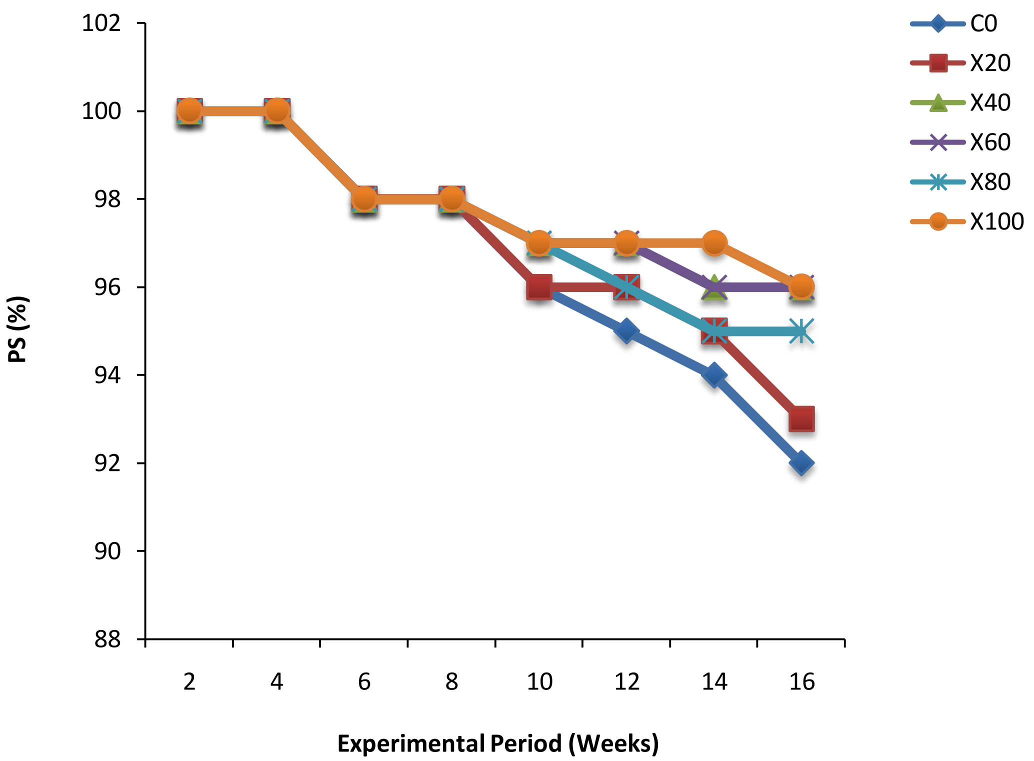

Figure 8: Changes in Percentage Survival (PS) of *C. gariepinus* fed Experimental Diets

4. DISCUSSION

The good growth and survival rates for the development stages of *C. gariepinus* fingerlings were possibly achieved because of the maintenance of good water quality. The observed water temperature quality of about 27^0c for *C. gariepinus* fingerlings in the experiment approximates values near optimal temperature for growth in fresh water (Boyd, 1982). The ranges of temperature for growth and protein gain in *Clarias gariepinus* fingerlings. One of the most unique features of catfish such as *C. gariepinus* is its air breathing ability to survive low dissolved oxygen (DO) conditions (Phumee *et al.*, 2011). Therefore, the DO levels in the range of 4.29 mg/l to 6.22mg/l could support good growth. Ammonia reaches water through fish excrement from microbial decay of undigested feed particles. One of the factors for poor growth of fish in culture medium has been attributed to the accumulation of ammonia (Ganguly *et al.*, 2011).Robinette (2006) reported that 0.12mg/l)of ammonia caused reduced growth and gill damage in channel catfish. According to his studies, a concentration of 0.52mg/l of ammonia caused a 50% reduction in growth and no growth occurred at 0.97mg/l. The values of ammonia (0.15mg/l in X_{4o} and 0.14mg/l in X_{60}) may also have caused a reduction in growth of fish in these treatment groups, because of its toxic level.

However, growth and survival of fish in these media were still appreciable and good compared to other observed values of earlier reported works as cited. The most prominent deficiency symptoms observed were stunted growth and poor appetite in X_{40} and X_{60} dietary groups. According Barrow *et al.* (2008) vitamin interactions may occur when an overdose of similar vitamins in a diet are consumed by organisms including fish. This may have occurred in the x_{40} and x_{60} dietary levels where an overdose of similar vitamins from the fish and green leaf premixes might have occurred. According to these authors, the symptoms of an overdose in take of similar multi vitamins include an unusual or an unpleasant taste in the mouth, an upset stomach, weight loss, muscle weakness, stomach bleeding, uneven heart beat, confusion and others. Hence the probable unpleasant taste in the mouth of these fishes in the X_{40} and X_{60} levels may have led to the unpalatability of feeds hence low intake of the feeds as was observed in the abundance of uneaten feeds at these levels Bacteria decay of these feeds must have occurred to release toxic levels of nitrite and ammonia which according to studies by

Boyd, (1982), Robinson, (1990), Vivien *et al.*, **(**1998), Robinette, (2006) and Ovie, (2010) have led to stunted growth due to loss of weight.

The mineral and chemical composition of the experimental diets across the dietary treatments did not differ much. The content of the experimental diets is a reflection of the nutritive value of the materials present; and the proximate composition of the experimental diets fell within the range expected to support good growth of fish (Li *et al*., 2014). In general, 10 – 20% lipid in fish gives optimal growth rate without producing an excessive fatty carcass (Tibbetts and Lall, 2013). The lipid content (13.45 to 13.55%) fell within this range. The range of values for the protein contents across the dietary groups (38.45 to 38 – 68%) also fell within the acceptable range (28 - 39 percent) for catfish growth (Borgstorm, 1992).

Ash and fiber contents (not more than 8 – 12 percent is needed for optimal fish growth (Condey, 2002). And the values in this study (8.64 to 8.75%) fell within that range. A higher fiber and ash content generally reduce the digestibility of other feed ingredients in the diet resulting in high waste output which may cause pollution and poor growth. Ash supplies both macro and micro – minerals to the fish while fiber acts as a filter and when added in the correct level assist in digestion but when in excess reduces the absorption of iron, zinc and other minerals (Crawford and Allen, 2007). The values of the moisture content fell within the range of correct moisture contents of the feed which will improve the quality of pellets in terms of hardness and durability and storage condition and consistency in weight maintenance of pellet fish feeds (Fuller, 1999). The values of the analyses of the proximate, vitamin and mineral compositions of *Amaranthus cruentus* leaf were relatively consistent with the findings of Pamplona – Roger (2004) and USDA (2005). It has also been shown that all Amaranthus including the English spinach (*Spinacia oleracea*) have similar compositions of high nutritional values because of the high levels of essential macro and micro nutrients like carotene, vitamin C, Iron, calcium and copper. It is also a rich source of vitamin A, folic acid, folate, Vitamin B_2 ,B_6, magnesium, manganese, selenium, potassium, phosphorus, zinc, niacin, protein, fibre and omega 3- fatty acid. It also contains some amount of carbohydrate and kcal of energy according to Pamplona – Roger (2004) . Some of the nutrients were not analyzed because of the unavailability of the appropriate machinery of analyses. Since most of the analyzed values were within the limit of the mineral and vitamin requirements as recommended by Woodward (1994), they were adequate to support the growth, survival and good health status of the fast growing *Clarias gariepinus* fingerlings.

The vitamin and mineral composition of *Amaranthus cruentus* leaf was able to support the survival, rapid growth health and maximal weight gain of *Clarias gariepinus* fingerlings. This agrees with the report recorded for rainbow trout with a vitamin mix containing the minimal requirement levels of Woodward (1994). Studies by Nwanna *et al.* (2004) showed a contrast to the much higher recommendations of vitamin requirements by fish that had prevailed in the last two decades (Halver, 1982, 1989, NRC 1981) and these were based on early studies of the vitamins requirement of pacific salmon (Halver, 1982, 1989). These early studies have recently been subjected to critical analyses (Woodward, 1994). Studies on the water soluble needs of rainbow trout (Woodward, 1994) fed the fish Semipurfied diet (Cho *et al*., 1985; Cho and Cowey, 2004), with high feed intake and growth rates have shown that the early data for salmons were overestimated. Even in Chinnock Salmon, El – Sayed (1998) reported that for several water soluble vitamins (folic acid, B-6, riboflavin, pantothenic acid), the needs reported earlier were overestimated. The outcome of vitamins in this study was closely consistent with the report made by Woodward (1994). Results obtained for rainbow trout are applicable to at least some other fin fishes (Dongmeza *et al*., 2009), including *C. gariepinus*. The vitamin and mineral contents in this study were adequate to support the growth and survival of *C. gariepinus* fingerlings.

5. CONCLUSION

The results obtained from this study shows that *Amaranthus cruentus* leaf can be used as an alternative source for total replacement of commercial premix in the culture of *Clarias gariepinus* fish. It also indicated that *A. Cruentus* plant which is available all year round in most parts of the country can be used to replace commercial premix up to the 100 percent inclusion level. From this study, the control diet gave the best result in terms of final weight, weight gain, daily weight gain, absolute growth rate and specific growth rate followed very closely by diet X_{100}.

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AUTHORS' PROFILE

Mrs Senapuba Ariweriokuma, graduated from University of Ibadan, Nigeria, with Bachelor of Science degree in Zoology (1978), obtained Master of Science (MSc) in Aquaculture, in 2008, from Rivers State University of science and Technology, Port Harcourt, Nigeria. She joined Rivers State Post Primary School Board as a class room teacher and rose to the rank of principal for many years. She retired recently as zonal director of schools in Okrika Education Zone, in Rivers State, Nigeria. She is presently a PhD student in the Department of Fisheries and Aquatic Environment, Faculty of Agriculture, Rivers State University of science and Technology, Nkpolu-Oroworukwo, Port Harcourt, Nigeria.

Prof. Ugwemorubong Ujagwung, Gabriel holds a Bachelor of Science (B.Sc. Hons.) degree in Zoology (1988) from the University of Port Harcourt, Port Harcourt; Master of Philosophy degree in Aquaculture (1995) from the Rivers State University of Science and Technology, Port Harcourt and Doctor of Philosophy degree in Fisheries and Hydrobiology (2006) from the University of Port Harcourt, Port Harcourt, Nigeria. He started his lecturing career as an Assistant Lecturer in 1995, at the then Rivers State College of Education, now, Ignatius Ajuru University of Education, Port Harcourt. He later moved to Rivers State University of Science and Technology, Port Harcourt in 1996, where he rose to the rank of Professor in 2010. Prof Gabriel have published above a hundred articles in referred journals, he has also supervised many undergraduate and post graduate students who have successfully graduated. Prof Gabriel is an erudite scholar with many years of teaching and research experience, he has taught several specialized and general courses in Aquaculture and Fisheries at the under-and postgraduate levels including applied statistics. His research interest covered various areas of fish farming including fish nutrition, impacts of some plant extracts, agro-chemicals and hydrocarbon on the condition, mortality, behaviours, biochemistry and haematology of the clariids; effect of salinity changes on the physiology of black chin tilapia, Sarotherodon melanotheron and C. gariepinus and early life stages of the latter, the effect of culture system on the haemogram of the clariids, effect of common on farm practices on the physiology of cultured species and the use of various local plants as anaesthetics for commonly cultured species. He is an active member of many professional associations such as: West Indian Ocean Marine Science Association (WIOMSA); Zoological Society of Nigeria; Fisheries Society of Nigeria and Association of Aquatic Sciences of Nigeria.

Dr Ebinimi Joe Ansa, is an Assistant Director Research and Center Manager at the African Regional Aquaculture Center (ARAC). She has been trained in Integrated Fish Farming at Wuxi, China and Fisheries Restocking and Stock Enhancement at CIHEAM, Zaragoza, Spain. Twice she earned the Nuffic Fellowship of the Netherlands Fellowship Programme (NFP) for Fisheries Governance and for Fisheries data collection and analysis. She is also a 2011 Post- doctoral Fellow of the esteemed African women in Agricultural Research and Development (AWARD) Fellowship. She is a Co-coordinator of the Aquaculture Working Group of the African Fisheries Reform Mechanism of the African Union- Inter African Bureau for Animal Resources (AU-IBAR). Dr Ansa is aquaculture and fisheries management expert and seeks solution to mitigate the problems attributed to climate change and pollution effects on aquatic life through aquaculture and selected species of fish. Dr Ansa is also the Editor-in-Chief of the Nigerian Journal of Fisheries and serves on the Editorial Board of Continental Journal of Fisheries and Aquatic Science

Dr. Akinrotimi Ojo Andrew, graduated from Obafemi Awolowo University, Ile-Ife, Nigeria with Bachelor of Agriculture degree in Animal Science (1999), obtained Post graduate diploma, PGD in Fisheries; Master of Science (MSc) and Doctor of philosophy (PhD) degrees in Aquaculture, in 2007, 2009, 2014 respectively, from Rivers State University of science and Technology, Port Harcourt, Nigeria. He joined African Regional Aquaculture Centre of Nigerian Institute for Oceanography and Marine Research, Port Harcourt, (Affiliated to Rivers State University of Science and Technology) in 2005 as a Research officer II and rose to the rank of Principal Research officer in 2014. He is an aquaculture specialist with the scientific and technical expertise in various research activities; management of fisheries stock through mass production of fish seed and improved culture techniques of fin and shell fishes. He is also involved in health management of cultured fish, through determination of haematological and biochemical profiles. Dr Ojo has carried extensive research on toxicological evaluation and safety assessment of some marine sea food. Discovery of some botanicals that could effectively replace synthetic anaesthetics used in intensive aquaculture and stock enhancement of shell fishes (shrimps, oyster, and bloody cockle) and fin fishes (cat fish, tilapia, mullets and groupers). He has been involved in teaching and training of fisheries students (undergraduate and post graduate), and fish farmers in innovative aquacultural practices. He has published over 100 articles in both local and international referred journals, 15 papers in conference proceedings. He is presently the editor- in-chief of International Journal of Sustainable Agricultural Research Punjab, Pakistan, serves on Editorial Board of 22 International Reputable Journals across the globe. He is a member of Fisheries Society of Nigeria, and Aquatic Science Society of Nigeria.