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GROWTH PERFORMANCE OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) JUVENILES CULTURED WITH FISH FEEDS FORMULATED WITH DIFFERENT NUTRITIONAL COMPONENTS

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ABSTRACT

Success in aquaculture depends on the availability of quality fish feeds and the adoption of excellent feeding frequency for an increased growth rate of cultured species. This study was carried out to evaluate the growth rate of African catfish (*Clarias gariepinus*) juveniles reared with fish feeds of different nutritional components. *Clarias gariepinus* juveniles of mean weight (10.63±0.35g) and recorded mean length of 11.21±10.10cm with four experimental feeds, namely, Treatments 1-4 (T1-T4) for nine weeks, in a complete randomized design. Results showed that T4 performed significantly ($P<0.05$) better than other treatment groups in terms of mean weight gain (73.52±1.93g), mean length gain (10.97±0.58cm), specific growth rate (1.33±0.17), feed conversion ratio (1.17±0.01) and protein efficiency ratio (1.37±0.11). Lower growth performance values of 31.92±0.78g, 6.17±1.16cm, 0.76±0.34, 1.53±0.25 and 0.95±0.16, respectively, were recorded in T3. The condition factor (K) was within 0.77 to 0.89, which was not within the stipulated range recommended for tropical fish culture. A high survival rate of (>85%) was recorded among all treatments. Water quality parameters monitored throughout the research were observed to be within tolerable limits for fish culture. This study, therefore, showed that the experimental diet (T4), which contained 45% crude protein, 14% lipid content, 2.6% crude fiber and 10.0% ash content, was considered adequate for optimal growth performance in the culture of *Clarias gariepinus* juveniles.

***Keywords*:** Fish feed formula, *Clarias gariepinus*, Growth rate, Survival rate, Condition factor.

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1. INTRODUCTION

Fish is a cheap source of protein with great nutritive benefits and together with its essential nutritional component, the demand for fish has been on the increase (Iloba et al. 2021). Aquatic animals in general are considered to have high protein content, rich in essential amino acids when compared to terrestrial protein source (Sampels 2014). However, with the continuous increase in human population, aquaculture becomes the only option for adequate fish supply in Africa (Gabriel et al. 2007).

Clarias gariepinus is a widely cultured fish in various countries (Oke et al. 2016; Opiyo et al. 2017) due to its omnivorous nature and its ability to withstand unfavorable climatic conditions (Onuoha et al. 2018; Iloba et al. 2021). African catfish (*Clarias gariepinus*) which belongs to the family of Clariid fishes, is one of the most globally cultured fish species (FAO 2014), with Nigeria being the top producing country followed by Netherlands, Brazil, Hungary, Kenya and other African countries (FAO 2016). In Nigeria, domestication of *Clarias gariepinus* dates back to the 1950's (Anetekhai 2013) but its inclusion as a culturable specie began in the 1970's (Hecht et al. 1988; Dauda et al. 2018). Increase in the domestication of *Clarias gariepinus* was brought about by the following positive reasons: - acceptability of *Clarias gariepinus* by most tribes in Nigeria, high resistance to harsh weather conditions, high market value twice that of other culturable fish species such as Tilapia, easy culture system whether extensive or intensive culture systems and to minimize the overexploitation of wild fish stocks inorder to balance the demand of the steadily increasing population (Anetekhai 2013; Issa et al. 2014; Nyadjeu et al. 2020; Yaqoob and Fasakin 2021).

Despite the success of aquaculture in Nigeria, the country contributes to 5.4% of global importation of fish products in terms of volume, making it the world's fourth largest importer after China, Japan and United States of America (Yaqoob and Fasakin 2021). Major constraints of aquaculture in Nigeria is the non-availability of nutritionally quality fish feeds as fish feeds contribute to about 60% of the total cost of production in aquaculture (Jamu and Ayinla 2003). In most developing countries, fish feed technology of the aquaculture sector is still underdeveloped (FAO 2011) which in turn adds to the bulk of factors affecting aquaculture in Nigeria. This reason alone has brought about high dependence on imported fish feeds from developed countries by Nigerian farmers.

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AIFP (2004) reported importation of approximately 4000 tons of quality fish feeds in Nigeria every year. There is need for the development of the feed technology sector of aquaculture in Nigeria using locally available feed ingredients in the production of quality fish feeds in order to reduce cost of production and maximize productivity of fishery products. This quality fish feed availability will determine if an aquaculture enterprise will be profitable or not and also if the protein demand of the ever-increasing populace will be supplied or not.

2. MATERIALS AND METHODS

2.1. Experimental Design

This study was conducted in the departmental fish farm of Fisheries and Aquaculture Department, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. The study lasted for a period of nine weeks. The experimental design was completely randomized in twelve plastic aquaria tanks measuring 39.5cm X 28cm X 26.5cm. Ninety-six juveniles of *Clarias gariepinus* of mean weight 10.63±0.35g and mean length 11.2±10.10cm were collected from Nnamdi Azikiwe University fish farm. They were acclimatized for two weeks and based on the nutritional component of different fish feeds used for the study, the juveniles were assigned to four treatments in three replicates namely, T1, T2, T3, T4 and were fed twice daily at 5% body weight.

Sampling was done weekly by random selection to determine weight and length gain, using sensitive scale (Phocee'nne Mod.PH-SF 40), meter rule and 5mm mesh size net. Total length was measured to the nearest 0.1mm and weight to the nearest 0.01g.

2.2. Growth Performance Indices

This was determined using the following formulae according to Sawhney and Gandotra (2010) and Soyinka and Boafo (2015)

$$\text{Mean weight gain (g)} = \frac{W_f - Wi}{\text{No of days}}$$

Where: W_f is the final mean weight, W_i is the initial mean weight of fish

$$\text{Mean length gain (g)} = \frac{\text{Final length gain} - \text{initial length gain}}{\text{No of days}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

$$\text{Specific growth rate (SGR)} = \frac{\text{Ln } W_f - L_n W_i}{\text{No of days}}$$

Where: W_f = Weight at time of observation (g), W_i = Initial weight, L_n = The natural logarithm

$$\text{Protein efficiency ratio (PER)} = \frac{\text{Increase in body weight (g)}}{\text{Protein intake}}$$

$$\text{Percentage survival} = \frac{\text{Initial number of fish stocked} - \text{mortality X 100}}{\text{Initial number of fish stocked}}$$

$$\text{Condition factor (K)} = \frac{W \text{ X } 100}{L^3}$$

Where: W = Weight gain, L = Length gain

Water quality parameters were measured using Jenway portable pH meter model 350, Mercury-in-glass thermometer (Deluxe) and dissolved oxygen meter (Lasany®).

2.3. Statistical Analysis

Data obtained on growth and nutrient utilization indices were computed and analyzed using one-way analysis of variance (ANOVA) at $P<0.05$ using SPSS (version 20.0) and differences between treatment means separated using Duncan's multiple range test (Duncan 1955).

3. RESULTS

3.1. Proximate Analysis of Sample Fish Feeds

Proximate analysis of treatment diets was done according to AOAC (2006) and results presented in Table 1. Nutritional components of treatment feeds were different with T4 having higher values of crude protein (CP), lipids (%), ash content (A), calcium (Ca) and phosphorus (P) more than the values observed in T1, T2 and T3 but lower values of crude fiber (CF) less than values in T1, T2 and T3.

3.2. Growth Performance

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The results of the growth performance of *Clarias gariepinus* juveniles used for the study were shown in Table 2. Juveniles fed with T4 fish feeds recorded the highest weight gain and length gain with values significantly higher ($P<0.05$) than all other treatments. Least values of weight and length gain were observed in juveniles fed with T3 experimental feeds. Higher specific growth values were recorded in T4 which was not significantly different ($P>0.05$) from T1 and T2 but significantly different ($P<0.05$) from T3. Lower feed conversion ratio values of 1.17±0.01 was recorded in T4 while highest value of 1.53±0.25 was recorded in T3. Protein efficiency ratio was observed to be highest in T4 (1.37±0.11) which showed a significant difference ($P<0.05$) when compared to T1, T2 and T3. Percentage survival rate was observed to be greater than 80% in all treatments. There was no significant difference ($P>0.05$) in the condition factor among treatments however highest value (0.89) was recorded in T1.

Table 1: Proximate composition of treatment feeds

Treatments	CP (%)	L (%)	CF (%)	A (%)	Ca (%)	P(%)
T1	45.0	12.0	2.0	7.0	1.5	1.0
T2	42.0	12.0	4.0	7.5	1.5	0.8
T3	42.0	12.0	5.0	6.0	0.8	0.6
T4	45.0	14.0	2.6	10.0	1.7	1.1

Table 2: Growth performance of four experimental fish feeds used in the culture of *Clarias gariepinus* juveniles

Parameters	T1	T2	T3	T4
Initial weight (g)	10.75±0.18	10.75±0.35	10.56±0.35	10.63±0.35
Final Weight (g)	56.64±1.29ab	68.79±0.06c	42.48±0.40a	84.25±1.28d
Mean weight gain (g)	45.89±1.12ab	58.04±0.61c	31.92±0.78a	73.52±1.93d
Initial length (cm)	11.08±0.14a	11.09±0.21a	11.24±0.27a	11.21±0.10a
Final length (cm)	18.57±1.58a	20.72±0.68b	17.41±1.43a	22.18±0.68c
Mean length gain (cm)	7.49±1.44ab	9.63±0.46bc	6.17±1.16a	10.97±0.58c
Specific growth rate (g)	1.01±0.68b	1.17±0.15b	0.76±0.34a	1.33±0.17b
Mean feed intake (g)	64.02±0.09a	71.74±1.58ab	62.02±0.27a	86.00±1.79b
Feed conversion ratio	1.40±0.15	1.24±0.03	1.53±0.25	1.17±0.01
Protein efficiency ratio	0.98±0.15a	1.16±0.14b	0.95±0.16a	1.37±0.11c
Survival rate (%)	93.75±0.14	87.50±0.21	87.50±0.01	93.75±0.14
Condition factor (K)	0.89±0.06	0.77±0.02	0.80±0.02	0.77±0.01

Values (mean±SD) bearing different alphabets in a row differ significantly ($P<0.05$).

3.3. Water Quality Parameters

The results of the water quality parameters monitored throughout the study period are shown in Table 3 and were observed to be within the permissible limits for fish culture in the tropics. Temperature values were within the range of 26 to 27°C, pH values were found within 7 to 8, while dissolved oxygen values were above 5mg/L.

Table 3: Water quality parameters monitored in the study

Parameters	T1	T2	T3	T4
Temperature (°C)	26.83±0.03	27.31±0.12	26.50±0.14	27.08±0.03
pH	7.30±0.01	7.12±0.05	7.08±0.10	7.99±0.07
Dissolved Oxygen (mg/L)	5.31±0.03	6.12±0.15	5.91±0.12	6.04±0.11

4. DISCUSSION

Productivity in aquaculture can be hindered by inadequate environmental conditions, which usually have a tremendous influence on water quality of culture system. The results of the physico-chemical parameters obtained in this study were within the acceptable range for fish culture as recommended by Boyd (1990). Temperature values of *Clarias gariepinus* juveniles cultured in the study were observed to be within the range of 26.83 and 27.08 which is in line with range values of 25°C to 32°C recommended by Akinwole and Faturoti (2006). pH values in the study ranged from 7.08 to 7.99 which is within the range 7.0 to 10.0 recommended by Njoku et al. (2015) and Ehiagbonare and Ogunrinde (2010). Dissolved oxygen values in the study ranged from 5.31 to 6.12mg/L which is within the range values (>5mg/L) recommended by Saloom and Duncan (2005). The results of the water quality parameters are in line with the results recorded in Tiamiyu 2018 in monitoring water quality under laboratory conditions. Therefore, growth performance of experimental fish could not have been influenced or altered by water quality.

Proximate composition of fish feeds provides vital information on the nutritional contents of fish feeds utilized in aquaculture. Fish growth is greatly influenced by the nutritional components of feeds utilized by fish (Ayuba and Iorkohol 2013). In Nigeria, there is minimum knowledge of the nutritional contents of fish feeds produced by

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various feed companies due to the fact that there is absence of legal control on the nutritional components of feed ingredients and quality of feed produced.

Optimal growth performance results recorded in T4 in this study could be as a result of its proximate composition values of 45% crude protein, 14% lipids, 2.6% fiber contents, 10.0% crude ash, 1.7% calcium and 1.0% phosphorus. High growth performance of fish species is as a result of high nutritional quality of fish feed used in fish culture (Auta et al. 2013) and also the percentage of individual ingredient in the formulated feed (Glencross et al. 2007). Higher values of Crude protein and lipids (45% and 14% respectively) in T4 agrees with Agokei et al. (2011) that protein content of 45% and lipid content of 12% significantly increased growth performance in fish species. Protein content is considered the major promoting factor for growth. Alin and Olomu (2020) observed that lower protein contents of fish feeds result to low weight gain while higher protein content of about 40% promotes higher weight gain in fingerlings of catfish hybrids. High fiber content can reduce the quality of utilizable nutrients in fish feeds (Mustapha et al. 2014) due to its decreased digestibility factor. Crude fiber content of <2% is optimal for increased growth rate of *Clarias gariepinus* (Agokei et al. 2011). This could be the reason for lower growth performances observed in T3 as a result of high fiber value of 5.0% which was significantly different from T1, T2 and T4. Adewolu and Akinola (2010) and Agbabiaka et al. (2013) reported lower growth performance in *Clarias gariepinus* fingerlings fed with feeds, high in fiber content.

Ash content of feeds usually makes up the mineral contents in a particular feed, thus higher levels of ash content of 9.3% could increase the growth rate of *Clarias gariepinus* (Mustapha et al. 2014). Analysis of ash content of formulated fish feeds gives the composition of various minerals such as copper, phosphorus, manganese, potassium, zinc etc. present in a particular fish feed. Minerals notably Calcium and phosphorus are required by fish species for metabolism and development of skeletal structure with nutritional requirements values of 0.3% to 0.4% respectively (Robinson et al. 2001). This could explain the high growth performance recorded in T4 with values of 10%, 1.7% and 1.0% of ash, calcium and phosphorus respectively, while T3 had values of 6.0%, 0.8% and 0.6% respectively and experienced lower growth performance as reported by Suigura et al. (2000). Ali and Jauncey (2004b) reported significant increase in growth performance of *Clarias gariepinus* cultured with fish feeds having 9.3% ash content. For better growth rate of *Clarias gariepinus*, ash content of fish feeds should not be less than 8% (Alan et al. 2012). This could explain the lower growth rate recorded in T1, T2 and T3 with ash content values of 7.0, 7.5 and 6.0%, respectively.

Lipids in fish feeds function as an ingredient for increased protein sparing effect (Hassan 2001) and to also increase palatability. Higher lipids content value of 14% recorded in T4 appeared to be higher than value (5-6%) recommended by Wilson (2018) for optimal growth in catfish production but falls in line with values (10-20%) recommended for optimal growth rate of freshwater fishes without excessive fatty deposition in the flesh (Cowey and Sargent 1979; Ali and Jauncey 2004b; Ali et al. 2012).

Feed conversion ratio (FCR) is an indicator of efficient feed utilization by cultured species. Lower feed conversion ratio equals higher weight gain. The significant decrease in the FCR value (1.17±0.01) of T4 showed efficient feed utilization in terms of increased weight gain.

Condition factor (k) indicates the physiological condition of cultured fish species in relation to their environment and lower values of condition factor reflects healthy status of fish fed with a particular fish feed (Iloba et al. 2020). Ujjania et al. (2012) observed that condition factor greater or equal to 1 signifies adequate feeding and optimum environmental condition. The K-values (0.77-0.89) obtained in this study were found outside the stipulated range (2.9-4.8) observed by (Bagenal and Tesch 1978) for matured freshwater fish. This could be as a result of feeding intensity and age of fish species used for this study, as it was reported that K-value of fish species could be affected by factors such as Age, size, sex, season, stage of maturation, feeding intensity, food abundance and life intensity (Bagenal and Tesch 1978; Ujjania et al. 2012; Gupta and Banerjee 2015; Getso et al. 2017).

5. Conclusion

Observations from the study showed the limitations of some fish feeds to promote maximum growth performance in fish culture due to improper combinations of fish feed ingredients used in feed formulation, hence macronutrients combinations of 45% Crude protein, 14% Lipids, 2.6% fiber content, 10.0% Crude ash, 1.7% Calcium and 1.0% phosphorus is recommended for optimal growth performance *Clarias gariepinus* juveniles as observed in T4. However, Fish farmers should be sensitized on how best to incorporate quality nutritional feed ingredients during fish feed formulation in order to maximize returns on their investments in aquaculture.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Author's Contributions

Ikeogu CF developed the theoretical framework and wrote article. Okpala-Ezennia Kenechi carried out the experiment under the supervision from Ikeogu CF. Egwudike Amara carried out Statistical analysis.

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