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Comparative Assessment on the Growth Performance of the African Catfish, *Clarias gariepinus* Fingerlings Fed Two Commercial Feeds in Nigeria

Emmanuel A. Essien[1]✉ • Aniefiokmkpong O. Okon[1] • Enenwan Precious Udoinyang[1] • Kenneth Prudence Abasubong[1] • Victoria Folakemi Akinjogunla[2]

[1] University of Uyo, Faculty of Biological Science, Department of Animal and Environmental Biology, Akwa-Ibom State, Nigeria; emeritusessien49@gmail.com; aniefiokmkpongo@gmail.com; enenwanudoinyang@uniuyo.edu.ng; kennethabasubong@outlook.com
[2] Bayero University Kano, Faculty of Agriculture, Department of Fisheries and Aquaculture, Kano State, Nigeria; vfakinjogunla.faq@buk.edu.ng

✉ Corresponding Author: emeritusessien49@gmail.com

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ABSTRACT

Catfish is a sufficiently rich protein source in man's meals. However, the operational activities, costs of managements and fish production have caused famers to leave the industry. Therefore, this study is aimed at assessing the growth performance of the African Catfish; *Clarias gariepinus* fingerlings fed two commercial feeds. Eighty randomly selected African sharp-tooth catfish (*C. gariepinus*) fingerlings of 2.25±0.24 g (mean body weight) were fed two different commercial feeds for 10 weeks to compare their growth performance. The feeds were Coppens (Treatment 1) and Vitafeed (Treatment 2). A completely randomized design and plastic aquaria with dimensions of (40×40×50) cm^3 were used for the experiment. The fingerlings were fed 5% of their body weight twice daily after seven days acclimatization before commencement of feeding trial. The fish were designed in duplicate of 20 fish per tank. Collected data from each parameter were subjected to a one-way analysis of variance (ANOVA) and 5% level of significance ($p<0.05$) mean of various results were compared. The growth parameters considered and physicochemical parameters measured and monitored and maintained at optimal levels respectively. The results obtained showed that fishes fed Coppens performed better in final body weight (53.10±1.37) while Vitafeed recorded (38.10±0.94g). Coppens showed better performance in all growth parameters with 100% survival rate. pH, temperature, and dissolved oxygen showed no significant difference ($p<0.05$) among treatments. They were maintained at of 6.3–6.5, 27.55–28.70°C and 6.5–6.9 mg\l, respectively, which were within the recommended physiochemical parameter ranges for proper fish growth. It is concluded that, although fish fed with Coppens recorded overall best performance, Vitafeed is equally recommendable since there was no significant difference in the overall growth performance. However, based on affordability Vitafeed is more favoured for farmers in order to ensure better returns on investment.

INTRODUCTION

Aquaculture is a rapidly growing industry that is of great importance to the development of the global economy. It targets fish production to provide protein for human food (Sugunan, 2002), income and research. Fish are cultivated for food and income as well as to accommodate the rapid growth of the human population, replenishing water resources in rivers and streams to limit shortages from wild and recreational catches (FAO, 2000). Fish is a generally accepted source of protein. They are easily digestible and have the ability to prevent and control heart disorders and neurological diseases (Tan et al., 2007). One of the major factors hindering fish farming in Nigeria is the high cost of fish feed ingredients, especially fishmeal and many fish farmers rely on quality imported fish feed which is often expensive (Omitoyin, 2007). Usage of these commercially formulated feeds is responsible for the increased cost of production, thereby reducing fish farmers' profit margins (Helfrich & Craig, 2002). The most commonly farmed species in Africa are tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) (Nyina-Wamwiza et al., 2010). African catfish live in many water bodies such as swamps, lakes and rivers. From a biological point of view, it is certainly one of the ideal candidates for aquaculture in the world. Its distribution is wide and it thrives in diverse environments and even adverse environmental conditions. It is a hardy, adaptable species and is ecologically important, mainly due to its ability to breathe air. They feed on variety of natural prey and can adjust its feeding habits depending on food availability. It can withstand adverse environmental conditions, is very abundant, and is easy to reproduce artificially in captivity. It can grow in difficult conditions, especially in muddy, turbid and hypoxic waters, thanks to its accessory respiratory organs (labyrinthine organs) that allow it to breathe atmospheric oxygen (Uys, 1989). It is recognized by its long dorsal and anal fins, giving it a shape similar to an eel. Good nutrition in livestock systems is needful for the economic production of a healthy and high-quality product. In fish farming, i.e., aquaculture, nutrition is an essential factor because feeds usually account for over 50% of variable production costs (Pruszyński, 2003). According to Daily Trust (2016), fish feed prices have increased by 80 to 100% and many fish farmers have been forced into bankruptcy, especially in Lagos State. Expensive animal feed will significantly increase production costs, poor productivity and low harvests, which in the long run may cause farmers to abandon the industry. With increased catfish production, the aquafeed industry has grown and evolved since the days when research into fish nutrition and feed began at the Institute of Oceanography and the Institute of Marine Research. Nigeria (NIOMR), where a laboratory-sized pellet mill was established for this purpose to a burgeoning industry with about 12 commercial fish feed manufacturers in Nigeria (Ayinla, 2007). Due to fluctuations in the dollar, imported fish feed is expensive, so there is an urgent need to find alternative and affordable Nigerian fish feed. Additionally, since the growth response of fish depends on the quality of their food; level of crude protein, lipid, ash content and other micro-components of the feed (Okon et al., 2020), the interest in finding unique sources for fish feed production to reduce costs is very important. Seeds of leguminous plant origin provide a promising alternative (Eromosele & Eromosele, 1993). One such seed is *Bauhinia monandra* (Kutz) which has potential for use as animal feed, including fish, with a crude protein content of 33.09% (Anhwange et al., 2004). Several factors influence the feeding rate of fish in culture system which includes fish size, fish species, rearing systems etc. (Cho et al., 2003). Feeding rate is also an influencing factor contributing to the presence of the nutrients in the feed (Mihelakakis et al., 2002). In quest for Nigerian-made affordable fish feed as an alternative to expensive foreign fish feeds, Bluecrown (Nigeria-made) gave a positive result (Okon et al., 2020).

MATERIAL AND METHODS

Experimental Site

The research was conducted in a designated and secured area in Vision Park fish farm, Uyo, Uyo, Akwa Ibom State, Nigeria.

Fish Collection

Eighty randomly selected African catfish fingerlings (*C. gariepinus*) of average weight of 2.25±0.24 g, average total length of 7.00±0.30 cm, and average standard length of 6.19±0.26 were obtained from Vision Park Farms Nigeria Limited, Uyo, Akwa Ibom State.

Experimental Procedure

Acclimatization of fish was done for 14days in the four tarpaulin tanks with dimension (40×40×50) cm^3. Two Tarpaulin Tanks were allocated to each treatment; T1 (1A and 1B) and T2 (2A and 2B). The allocated experimental feeds were Coppens (foreign feed) (Treatment 1) and Vitafeeds (Nigeria made) (Treatment 2) respectively. They were starved for 24 hours in order to empty their stomachs and prepared them for the trial. They were fed at 5% their body weight for the 10 weeks twice daily.

Sampling

The fish were randomly weighed and distributed into the tanks at a stocking density of twenty (20) fish per tarpaulin. Subsequently, body weight, total and standard-length measurements were taken bimonthly and the rations fed were adjusted to 5% according to the fish weight.

Fish Feeds Composition

The composition of fish feeds was given in Table 1.

Fish Feed Collection

The fish feeds were purchased from a distributor's shop, Spring Farm Enterprise, No. 4, Ukana Offot Street, Uyo, Akwa Ibom State, throughout the period of the experiment to ensure consistency in supply and quality of feeds.

Commercial Feeds

The two treatments and their respective crude protein levels were Coppens (Treatment 1) and Vitafeed (Treatment 2) of 56% and 42%, respectively. The proximate analysis for each feed was determined.

Water Quality Parameters

The water parameters monitored and recorded on weekly basis were pH, temperature and dissolved oxygen (DO) at 8 AM with the use of pocket-sized pH metre (Milwaukee-pH 600 Tester Kit) was used in the determination of water pH, mercury-in-glass thermometer for temperature in degree Celsius (°C) while DO present in the water was measured with the aid of portable DO meter (Milwaukee MW 600). Water was changed bimonthly, thereby removing the debris at the bottom of the tanks.

Calculation And Statistical Analysis

For the purpose of measuring growth parameters, all fish were measured for length (total length and standard length) and body weight. The lengths were measured in cm^2 using a measuring board; while weight was taken using 5 kg capacity weighing balance (Model Ashton Meyers). After each sampling, survival (%), specific growth rates (SGR), food conversion ratio (FCR) and growth rate (GR) of the fish were calculated using the formula given by Aderolu et al. (2010). Dead fish in each tank were recorded every 14 days. In order to determine significant differences ($p<0.05$) between the data, One-way analysis of variance (ANOVA) was used.

Table 1. Proximate analysis of the diets

Feed types	Nutrients							
	Crude Protein (%)	*Fat (%)*	*Ash (%)*	*Moisture (%)*	*Crude Fibre (%)*	*Calcium (%)*	*Phosphorous (%)*	*Sodium (%)*
Coppens (Treatment 1)	56.00	15.00	12.00	-	2.3	3.3	1.99	0.9
Vitafeed (Treatment 2)	42.00	12.00	10.00	8.00	5.00	1.80	-	-

Note: The details in the table above are manufacturer's information that were highlighted on the bags of feed.

Table 2. Effect on the growth performance of the African catfish, *C. gariepinus* fingerlings two (imported and homemade) commercial feeds

Growth Parameters	Treatment 1 (Coppens)	Treatment 2 (Vitafeed)
Mean Initial Weight (g)	2.30±0.92[a]	2.20±0.28[a]
Mean Final Weight (g)	53.10±1.37[a]	38.10±0.94[b]
Mean Weight Gain (g)	50.80±0.20[a]	35.90±3.17[b]
Mean Initial Total Length (cm)	6.95±0.78[a]	6.60±0.02[a]
Mean Initial Standard Length (cm)	6.12±0.78[a]	6.00±0.02[a]
Mean Final Total Length (cm)	19.10±1.69[a]	16.40±3.25[a]
Mean Final Standard Length (cm)	17.90±1.69[a]	13.60±3.25[a]
Mean Growth Rate (MGR)	0.96±0.04[a]	0.93±0.03[a]
Mean Daily Growth Rate (g)	0.72±0.07[a]	0.50±0.25[b]
Specific Growth Rate (%/Day) (SGR)	5.65±0.05[a]	5.06±0.75[b]
Feed Conversion Ratio (FCR)	2.20±0.07[a]	3.23±0.09[b]
Condition Factor (K)	0.76±0.07[a]	0.82±0.07 [a]
Initial Number of fish	40	40
Final Number of fish	40	39
Survival (%)	100	97.5

Note: In each row, mean with a common subscript are not significantly different (p ≠ 05).

To further investigate distinctions within means, Duncan's multiple range was conducted. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS).

RESULTS

The findings on the comparative evaluation on growth performance of the African catfish, *C. gariepinus* fingerlings fed two (imported and Nigerian made) commercial feeds of different crude protein levels showed maximum weight gained of 53.10 g and 38.01g for Treatment 1 and Treatment 2, respectively.

The mean initial weight, total and standard length for Treatment 1 and Treatment 2 were 2.30 g and 2.20 g, 6.95 cm and 6.66 cm and 6.12 cm and 6.05 cm, respectively. Treatment 1 had the highest final weight, total length and standard length of 53.10 g, 19.10 cm and 17.90 cm while Vitafeed, had final weight, total and standard lengths of 38.10 g, 16.40 cm and 13.60 cm, respectively. The daily and specific growth rates were best observed in Treatment 1 (0.72 g/day) and (5.65 g/day) while Treatment 2 recorded 0.50 g/day for daily growth rate and 5.06 g/day for specific growth rate. Initial numbers of fishes stocked and survival rate were shown in Table 2. After 10 weeks of the experiments, both treatments had a survival rate (40 and 39 fish, respectively). Feed conversion ratio was observed best in Treatment 1 (2.20). The condition factor (K) value recorded 22.03 and 32.00 for Treatment 1 and Treatment 2, respectively. The result obtained in this study revealed that fish in Treatment 1 produced the best growth in terms of length, weight, survival rate and growth rates. As shown in Table 3, the results of the physiochemical parameters of the Treatments revealed that the water pH ranged from 6.30–6.50. Mean water temperature was within the range 27.55°C–28.70°C and mean water dissolved oxygen was within the range 6.5 mg/l–6.9 mg/l.

Bimonthly growth rates of the fish are shown in Figure 1. Treatment 1 (Coppens) had the highest growth rate (Figure 1).

Table 2. Some physiochemical properties of the pond water

Parameter	T1	T2
pH	6.3±0.69[a]	6.5±0.77[a]
Temp (°C)	27.55±0.37[a]	28.70±0.19[a]
DO (mg/l)	6.9±0.015[a]	6.5±0.015[a]

Note: In each row, mean with [a] common letter are not significantly different (p ≠ 05)

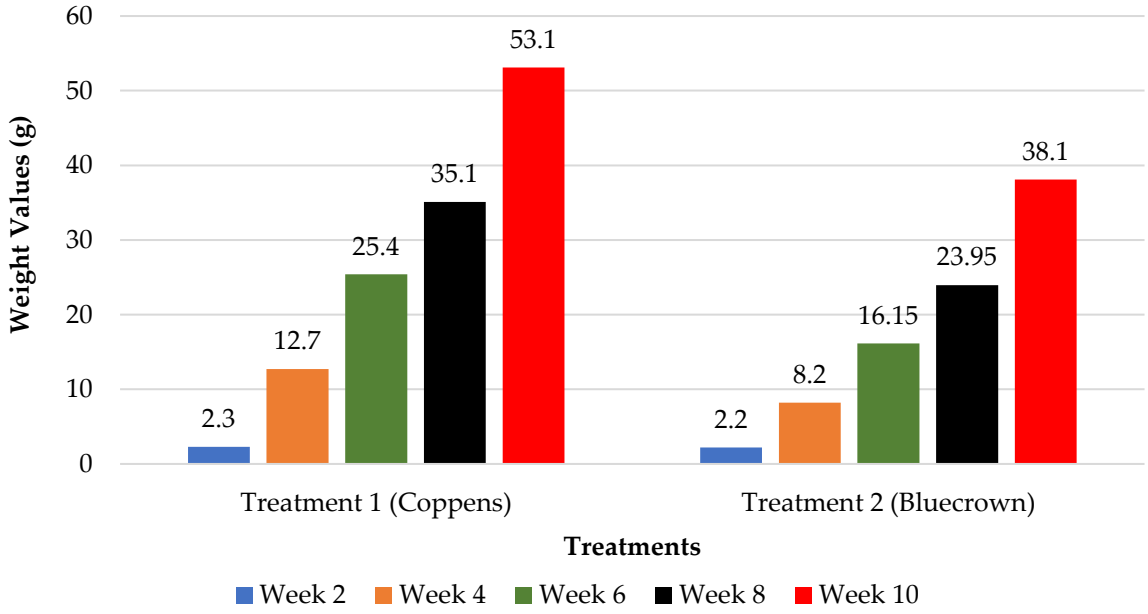

Figure 1. Bimonthly growth rate of *Clarias gariepinus* fed with two different commercial fish feeds.

DISCUSSION

Fish growth is dependent on the food intake and a host of intrinsic factors. Previous researches have shown that nutrient quality and composition of fish feed are directly proportional to the growth performance of the African catfish and many other fish species (Keremah & Esquire, 2014). The findings of this study revealed that *C. gariepinus* fingerlings fed with Coppens exhibited optimal growth with protein level 56%. According to (Okon et al., 2020), the SGR, GR, MFTL, MFSL, FCE and FCR reveal that Vitafeed was the best amongst the commercial fish feeds (Ecofloat, Bluecrown, Aqualis and Vitafeeds) in Nigeria. In this study, Vitafeed recorded no significant difference ($p<0.05$) with the performance of fish fed with Coppens. Therefore, since the growth of the fingerlings in both feed treatments did not differ when compared, it is inferred that the two feeds can be used in the culture of this species of fish. This study is supported by several studies on the growth performance with varying feeds of different crude protein levels on *C. gariepinus*. According to Craig & Helfrich (2017) the required protein levels in aquaculture feeds generally ranges between 35-40% for tilapia, 30-34% for catfish, 38-42% for hybrid striped bass, 30 to 35% for shrimp, and 40-45% for trout and other marine finfish. In this study, the crude protein levels were 56% and 45%; of course, the higher the crude protein level, the better performance in growth of *C. gariepinus*. The result of this study also revealed that fish fed with Coppens had the best bimonthly and overall weight gained. This result is in agreement to Kenneth et al. (2020) that reported Coppens and Multi feed (imported feeds) to have had the best growth performance against the Nigerian fish feeds (Vitafeed). Though Okon et al. (2020) recorded highest in all growth parameters considered in the absence of Coppens, Vitafeeds. Growth parameters like specific growth rate, daily growth rate, feed conversion ratio, lengths were not significantly different in both treatments. Regards to the difference in Crude protein levels of both feeds, they may be controversies on the comparison on the growth performance of fish fed with these feeds. On this view, the effective growth performance on Vitafeed comparable to Coppens is not strictly dependent on the CP level only, but in combination with other nutrients such as calcium, phosphorous, ash and fat levels which as stated above, are important constituents for effective fish growth (length and weight) in fish feed. This study supports Mogaji's (2019) report on the significant growth and weight gained in *C. gariepinus* fed with Skretting feed (foreign) that showed significant ($p<0.05$) higher weight increase, specific growth rate, protein

efficiency ratio and low food conversion ratio than fish fed with Bluecrown feed (Nigerian made) which is strongly attributed to the high CP level than the Nigerian made feed. In his research, there was a consistent survival rate in the culture of *C. gariepinus* in both treatments from week two till the end of the study. This is because of its resistance to water quality stress as well as diseases (Limbu, 2015). Comparing the weekly weight gained, the second week had the lowest, perhaps, and this was due to the condition of the fish to adjust to the initial feed after acclimatization. More so, nutrients were rather utilized for their survival instead of effective increase in fish length and weight. However, there was a stable growth rate in later weeks which is indicative of effective adaptation to the fish feed. The physical and chemical properties of the fish cannot be ignored; as they play important roles in the growth and survival of fish even in their natural environment. The physicochemical parameters obtained from this study are shown in Table 3. It revealed that the water temperature and pH were within the appropriate range required for efficient growth of catfish under cultured system (Musiba et al., 2014). The values of DO in both treatments fell within the allowable limits suitable for fish proper growth, development, maturation and gamete production (Okey-Wokeh et al., 2020). The increased in FCR for Bluecrown is totally a function of the total weight gained. Also, the 5% body weight for determination of feed allocation increased significantly in Coppens compared to Bluecrown.

CONCLUSION

Considering the current economical state of the country, imported fish are very expensive therefore this study suggests affordable Nigerian made fish feed (Vitafeed) for Catfish sustainability in the industry. Additionally, Aqua culturists and concerned stakeholders should equip and develop fish farmers in Nigeria with the technical know-how to formulate quality fish feed with available affordable local ingredients for more profit. Based on this study, Vitafeed is commendable to keep fish famers in the business. Regular studies on new feed are necessary to inform the farmers adequately in order to sustain the industry. In view of the limited knowledge among some farmers on the choice of feed, this work recommends the information gathered from this research for use by local farmer. In addition, further researches should be considered on other common feeds known to and used by farmers to determine their effectiveness on *C.gariepinus* fish farming in Nigeria. Also, conventional plant extracts should be studied to replace fish feed protein, thereby reducing the cost of fish feeds so sustain fish farming business in the industry.

Compliance with Ethical Standards

Authors' Contributions

EAE: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

AOO: Conceptualization, Data curation, ng acquisition, Investigation, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing

EPU: Methodology, Supervision, Validation, Writing – original draft

KPA: Validation, Writing – review & editing

VFA: Supervision

All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

The authors declare that the study was conducted in accordance with all applicable international, national, and/or institutional guidelines for the care and use of animals. The research did not involve blood extraction or sacrifice of fish samples. Additionally, the number of fish used (80 samples) did not exceed the threshold requiring ethical approval (200 samples and above) as per the local regulations. The study was performed on a private fish farm licensed by the State Government, which lies outside the jurisdiction of the Ethical Approval Research Committee in Nigeria. For these

reasons, no formal ethical approval number was issued for this study.

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Data Availability

The data that support the findings of this study are available from the corresponding author on request.

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