

Effects of different feeding frequency and feeding rates on fingerlings of *Clarias gariepinus* fed on commercial and formulated diets in semi-flow through system

Sydney Samson. M.¹, *Bagauda Dulyamba Alkeria² and Inuwa Hassan Emmanuel³

¹Federal University of Technology Yola, Adamawa State, Nigeria

²Department of Zoology, Federal University of Agriculture Markurdi Benue State Nigeria

³Department of Zoology, Federal University of Technology Yola, Adamawa State, Nigeria

Email: Sydneymakshas@gmail.com¹, eiuwahassan@gmail.com³, Phone Number: +2348039587545¹, +234806669772³

*Corresponding Author Email: Alkeria@yahoo.com², Phone Number: +23480885291576²



*Corresponding Author

Bagauda Dulyamba Alkeria

Department of Zoology, Federal
University of Agriculture Markurdi
Benue State Nigeria

*Corresponding Author Email:
Alkeria@yahoo.com, Phone Number:
+234808852915762

Abstract

Two hundred and thirty (230) fingerlings of *Clarias gariepinus* were sourced from reputable fish farm in Yola. The fish were randomly stocked at 10 fish per tank of 50 litres volume. The first set was on feeding frequency regime while other on the feeding rates. Two types of diet were used one was the formulated diet and the other was commercial diet. While the feed were supplied at frequency level the once, twice and thrice and feeding rates were 3%, 6% and 9% respectively. The weight and length data were collected on weekly basis. The dead fishes were removed from the tanks. Data generated were analyzed using t-test, ANOVA and graphical representations. The results of the experiment show that the biochemical analysis of crude protein was 44.6% and 45.0% for formulated feed and commercial feed respectively, There was no significant difference ($p > 0.05$) between the nutrients values of formulated diet and commercial diet, The ranges of values of the physicochemical parameters during the experimental period for different feeding frequency were as follows: pH 7.07 -7.39; dissolved oxygen 4.37 – 5.12 mg/L, Ammonia 0.0317 – 0.047 mg/L and temperature 28.68--28.87°C while for Feeding rates were pH 7.17 -7.69; dissolved oxygen 4.67 – 5.38 mg/L, Ammonia 0.0327 – 0.0463 mg/L and temperature 28.68--28.87°C. There were significant differences ($p < 0.05$) in the mean weight gain and specific growth rate of fish as the feeding frequencies and regimes varied most especially between ones and thrice. The growth performances and feed utilizations also varied significantly ($p < 0.05$) as the feeding rate increases between the formulated and commercial diets. The best Benefit Cost Ratio of 1.89 was recorded in *Clarias gariepinus* fed commercial feed thrice followed by twice and ones while highest of 1.98 in fish 9% commercial feed.

Introduction

Over the last decades, spectacular growth has taken place in aquaculture. Most of the production in developing countries is realized from pond-based or open-water

extensive, improved extensive and semi-intensive practices using polyculture farming techniques (Pantazi and Neififou, 2013). It is unequivocally agreed that global aquaculture production will continue to increase and much of the increased production in developing countries of Asia and

Africa is likely to be achieved through the expansion of semi-intensive small scale pond aquaculture. Nutrition and Feeding will play an essential role in the sustained development of this aquaculture (Hassan, 2001).

Due to the rapid increase in population of the world, especially in the developing countries, there is high demand for fish and fish products as the cheapest source of animal protein in human diet (FAO, 2000). Growth, Health and reproduction of fish and other aquatic animals are primarily dependent on an adequate supply of nutrients both in terms of quantity and quality, irrespective of the culture system in which they are grown (Hassan, 2001).

Fish need protein, minerals, vitamins, growth factors and energy sources, these nutrients could be available in the natural aquatic environment or applied as prepared feeds (Eyo, 2003). Nutrient is one of the most important factors influencing the ability of cultured fish to exhibit its genetic potential for growth and reproduction (FAO, 2000). Factors such as quality of feed, daily ration, size, feed intake or water quality also greatly influences the growth and reproduction of cultured fish (Nadir et al., 2007).

Fish has become an important source of animal protein in most parts of the world because some of the competing protein sources of animal origin, such as beef have been implicated with heart diseases (Owodeinde et al., 2013). The prices of others like poultry products are out of reach of the low income earners, which account for a larger percentage of the population (Owodeinde and Ndimele, 2011). Fish is an essential part of most meals in Nigeria and accounts for about 37% of Nigeria's total protein requirement (Ndimele et al., 2011). Fish production in Nigeria is dominated by the captured sector, especially artisanal coastal and artisanal inland fisheries and employs a lot of the riverine population. Over 80% of total domestic production representing about 510,000 tons per annum is contributed by this sector. Factors such as pollution and over-exploitation of the marine fishery resources have resulted in gradual depletion of the stock from the wild (Owodeinde et al., 2013).

Food and Agriculture Organization (FAO), (2013) reported that Nigeria, with an estimated population of over 150 million is one of the largest importers of fish in the developing world. Nigeria imports about 600,000 metric tons of fish annually. In order to minimize the gap, between fish supply and demand, Nigerians must be encouraged to embrace aquaculture.

Clarias gariepinus is very popular to fish farmers for its high market price, fast growth rate, good for conversion ratio, resistance to diseases and infection, ability to withstand adverse pond conditions especially low oxygen content and high turbidity (Ovie and Eze, 2013). The culture of *Clarias gariepinus* fry as seed for fish production is becoming increasingly essential as the fish is contributing to food abundance and nutritional benefit of farmers' health, income generation and employment opportunities (Omotoyin, 2007).

Adekoya et al (2001) reported that *Clarias gariepinus* is the most cultured and economically desired fish species by Nigeria farmers. They are reared all over the country,

especially in the south and have very good commercial value in Nigerian markets (Adewolu and Adoti, 2010; Owodeinde and Ndimele, 2011). Methods of artificial seed propagation of African mud fish (*Clarias gariepinus*) are very expensive in Nigeria due to the cost of the first exogenous feed (Artemia) that will be required after breeding exercise. This species do not readily breed in captivity and productivity in the wild is usually very low, thus making fingerlings collection from the wild not only time consuming and labour intensive but also uncertain (Ndimele, 2011).

Since the inception of fish culture technology in Nigeria, imported commercial fish feeds have been promoted as the most favoured feed for fish rearing because they support satisfactory growth in fish, however the prohibitive cost of imported fish feed made catfish feeding economically unattractive for the small-scale fish farmers, therefore the need for locally compounded feed that is nutritionally complete with ingredients less competed for by man nor animals but which would equally bring optimal growth. The expenses incurred in feeding cultured fish may be lower by utilizing locally available materials instead of imported feeds.

De Silva (2001) reported that as aquaculture becomes more intensified, fish feeding will be a significant factor in increasing productivity and profitability. Decades ago, the demand for fish in Nigeria has previously been amply supplied from the wild and via importation of exotic species. Although, recently there has been increased awareness among the nations citizenry to save scant foreign resources which has led to a drive for self-sufficiency. The resultant effect, therefore, is fish production within the private and government sectors (John, 2010).

African catfish *Clarias gariepinus* is a successful aquaculture species in Nigeria. The specie is widely accepted by fish farmers and consumers because of some biological characteristics (high food conversion ratio, fast growth rate readily accepting artificial feed, ease of artificial propagation, disease resistance), social factors (good market price, good table food quality) and physical characteristics (tolerant of a wide range of environmental conditions). This catfish is an important contributor to both inland fisheries and aquaculture in Nigeria (Jamabo and Keremah, 2009).

The production cost of African catfish farming tends to be higher in more tropical than in temperate countries with feed and fertilizers accounting for 54% of the total production cost especially in per-urban farms (FAO, 2011). The economic viability of the culture operation depends on feed and feeding frequency. Nutritionally well-balanced diets and adequate feeding are the main requirements for successful culture.

This research is aimed at determining the effect of different feeding frequencies and feeding rates on fingerlings of *Clarias gariepinus* fed with commercial and formulated diets.

Materials and methods

The experiment was carried out at Teaching and Research Fish Farm, Department of Fisheries, Modibbo Adama

University of Technology (MAUTECH), Yola, Adamawa State, Nigeria. MAUTECH is situated in Girei Local Government Area of Adamawa State, previously known as Federal University of Technology, Yola, located about 10km North of Yola City on Yola-Mubi road. Adamawa State is located at latitude 9.14°N, Longitude 12.38°E and an altitude of 185.9m. It has an average annual rainfall of about 759mm with a maximum average temperature of 38.70°C. The rainy season runs from May to October, while the dry season commences in November and ends in April. The driest months of the year are January and February when the relative humidity drops to 13% (Adebayo, 1999).

The research farm is located at the outskirts of the school staff quarters, and close to the school orchard. This research farm was established to boost research activities in the Department of Fishery. At the experimental site, the semi-flow through system is stationed beside the hatchery unit of the research farm.

Source of Fingerlings

Two hundred and thirty (230) fingerlings of *Clarias geriepinus* were sourced from reputable fish farm in Yola.

Duration of the Study

The study lasted for 12 weeks (84 days) from February to April 2018.

Experimental Design

The fish were acclimatized for 24 hours prior to the experiment. Two sets of experiments were designed. Twenty plastic bowls of 50L capacity were used for the experiment. The fish were randomly stocked at 10 fish per tank of 50 litres volume. The first set was on feeding frequency while other on the feeding rates. The feeding diets were formulated and commercial diets. While the frequencies considered were once, twice and thrice and feeding rates were 3%, 6% and 9% respectively.

Feeding of the Fish

The fish were fed on Commercial Feeds (Coppens) and Formulated feed starter at 5% body weight in the different three feeding frequencies. Those that were fed once are designated 'A' at 8.00 a.m, twice designated 'B' (8.00 a.m and 6.00 p.m), thrice designated 'C' (8.00a.m, 12.00p.m, 6.00 p.m) daily using the scatter feeding method as proposed by Rad et al.(2003).

On the feeding rates, feeding twice, which is a universal method according to Sogbesan et al. (2017) was adopted. They were fed 8.00am and 6.00pm. Uneaten feeds were removed by siphoning to control pollution. Fish weights were measured individually once a week and the quantity of feed adjusted based on the changes in body weight of fish for subsequent feedings using a Labtech Balance Numerique Compacted weighing balance.

Water quality Assessment

The water in the bowls was monitored on a weekly basis for pH, Temperature, Dissolved Oxygen and Ammonia. Water temperature was monitored daily using Mercury in glass thermometer calibrated in degree centigrade (°C) as outlined by Coche et al. (2008). The pH of the water was measured using a digital pH pocket sized pH meter. Dissolved Oxygen was measured using the Winkler's method in the laboratory, whereas free carbon (IV) oxide and total alkalinity were determined by methods stated by APHA (2005).

Growth and Feed utilization Indices

The following indices were measured using formulae adapted from Peterson and Small (2007).

Weight Gain (ΔW) = Final weight (W_f) – Initial weight (W_i)

Percentage Weight gain (%)

This is percentage increase in weight. Mathematically stated as $PWG (\Delta W/W_i) \times 100$

Specific Growth Rate (%/day)

Specific growth rate is the logarithmic exponent of weight gained by the fish per unit time expressed in percentage. The formula is: $SGR = \text{Loge} \{ (W_f - W_i)/t_2 - t_1 \text{ (day)} \} \times 100$

Feed Conversion Ratio (FCR)

FCR is a ratio of the dry weight of food eaten to the weight gained by fish. It is given as:
Dry weight of food eaten (g) / Fish weight gain (ΔW)

Protein Efficiency Ratio (PER)

Protein efficiency ratio is the ratio of weight gained by the fish to the crude protein consumed
Measured in grams, it is stated as: $PER = \{ \text{Weight gain (g)} / \text{Protein Intake} \} \text{ g}$

Statistical Analysis

The statistical analyses used are t-test, One-way ANOVA, Regression and Correlation. Line graph was also used to represent data for more clarity while means separation was shown in a tabular form.

Results

Proximate, Minerals and Gross Energy values of Formulated feed and Coppens

The formulated feed and Coppens proximate analysis, mineral compositions and gross energy values are

presented in table 1. The crude protein was 44.6% and 45.0% for Formulated feed and Coppens respectively. There was no significant difference ($p>0.05$) between the nutrients values of formulated feed and Coppens rather there was between the gross energy value for the two diets. The gross energy in the Coppens feed is higher than that of formulated feed.

Weekly Weight of *Clarias gariepinus* fed Formulated feed and Coppens

The weekly growth curve shows increase from the beginning of the feeding trials to the end. In Figure 1 the highest points

was recorded in fish fed commercial feeds thrice followed by twice and the least was in formulated feeds fed once while in Figure II, the highest weight was recorded in fish fed 9% per body weight on commercial feed followed by 6% commercial feed and the least was from 3% formulated feed.

Growth and Feed Utilization of *Clarias gariepinus*

The growth and feed utilization for each of the experiment is presented in Table 2 and 3.

Table 1: Proximate, Minerals and Gross Energy values of Formulated feed and Coppens

Parameters (%)	Formulated Feed	Coppens
Crude Protein (%)	44.6 ^a	45.0 ^a
Crude Fibre (%)	1.5 ^a	3.0 ^a
Crude lipid (%)	11.5 ^a	14.0 ^a
Ash	7.5 ^a	7.0 ^a
Calcium	1.3 ^a	1.5 ^a
Sodium	0.4 ^a	0.3 ^a
Phosphorus	0.85 ^a	0.9 ^a
Dry Matter	96.0 ^a	95.80 ^a
NFE	30.90 ^a	37.70 ^a
Moisture	4.00 ^a	4.20 ^a
Calculated Gross energy (kcal/100g)	469.01 ^a	522.97 ^b

Mean on the same row with different superscripts are significantly different ($p<0.05$)

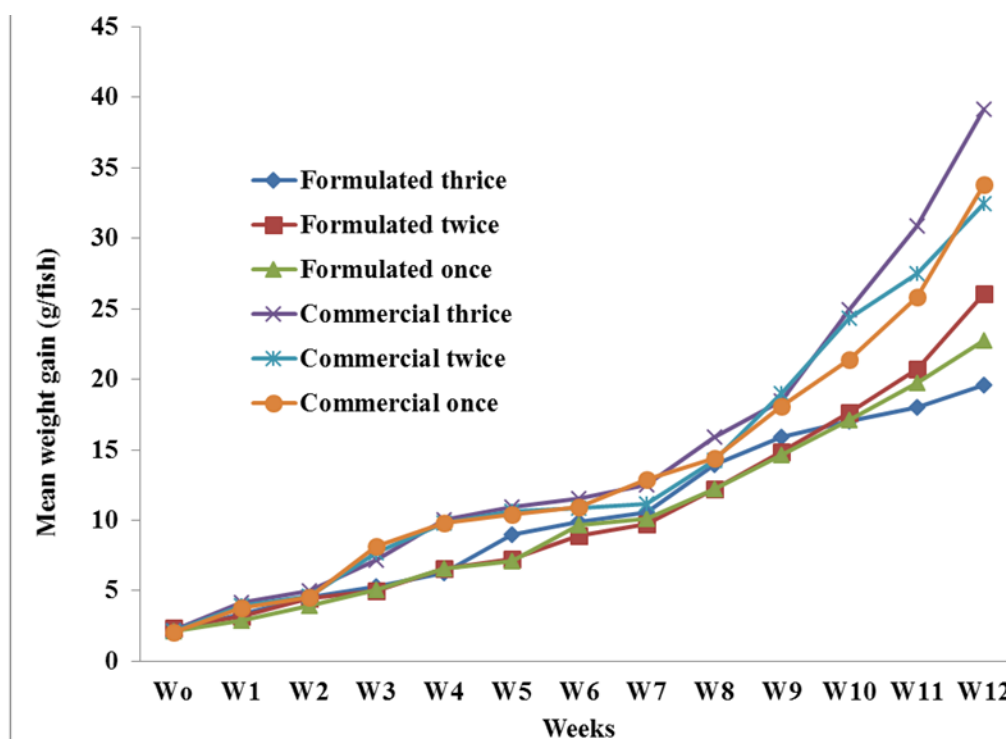


Figure 1: Weekly Mean Weight of *Clarias gariepinus* fed formulated and commercial feeds at different feeding frequencies

Table 2: Growth performances and feed utilization of *Clarias gariepinus* fed different feeding frequencies

Parameters	Feeding frequencies					
	FF thrice	FF twice	FF ones	CF thrice	CF twice	CF ones
Initial mean weight (g/fish)	2.25 ^a	2.33 ^a	2.16 ^a	2.22 ^a	2.14 ^a	2.08 ^a
Final mean weight (g/fish)	25.80 ^c	26.70 ^c	22.73 ^c	39.30 ^a	32.50 ^b	33.83 ^{ab}
Mean weight gain (g/fish)	23.60 ^c	24.37 ^c	20.57 ^c	37.08 ^a	30.36 ^b	31.75 ^b
Specific growth rate (%/day)	1.272 ^b	1.261 ^b	1.217 ^b	1.49 ^a	1.41 ^a	1.44 ^a
Relative growth rate (%)	1070 ^c	1045.9 ^c	952.1 ^c	1670.2 ^a	1418.7 ^b	1526.4 ^{ab}
Final length	13.29 ^c	13.65 ^b	13.11 ^c	14.28 ^a	13.57 ^b	13.82 ^{ab}
Condition factor	1.10 ^b	1.05 ^b	1.01 ^b	1.35 ^a	1.30 ^a	1.28 ^a
Survival	98.0 ^a	97.5 ^a	90.5 ^b	99.0 ^a	99.0 ^a	97.0 ^a
Feed Intake	39.71 ^b	36.69 ^b	35.06 ^b	47.34 ^a	45.40 ^a	46.67 ^a
Feed Conversion rate	1.68 ^a	1.51 ^b	1.71 ^a	1.28 ^c	1.50 ^b	1.47 ^b
Protein Intake (g/100g of diet)	17.70 ^b	16.36 ^b	15.63 ^b	21.30 ^a	20.43 ^a	21.00 ^a
Protein Efficiency rate	1.33 ^c	1.49 ^b	1.32 ^c	1.74 ^a	1.49 ^b	1.51 ^b

Mean of data with different superscripts are significantly different ($p < 0.05$). (FF= Formulated Feed and CF= Coppense Feed)

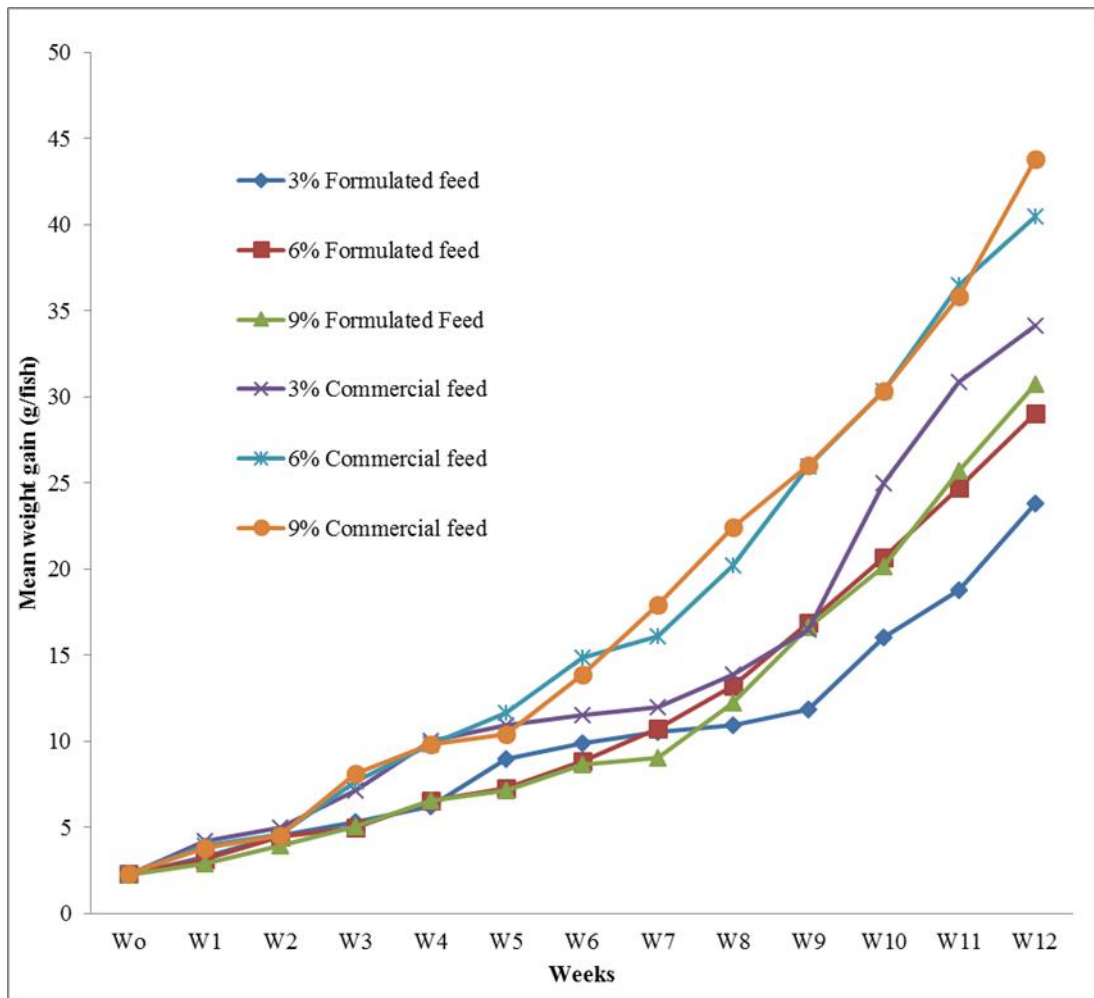


Figure 2: Weekly Mean Weight of *Clarias gariepinus* fed formulated and commercial feeds at different feeding rates

Table 3: Growth performances and feed utilization of *Clarias gariepinus* fed at different feeding Rates

parameters	feeding rate					
	3% ff	6% ff	9% ff	3%cf	6% cf	9% cf
initial mean weight (g/fish)	2.25 ^a	2.30 ^a	2.26 ^a	2.25 ^a	2.28 ^a	2.28 ^a
final mean weight (g/fish)	23.80 ^c	29.07 ^b	30.73 ^b	34.13 ^b	40.15 ^a	43.83 ^a
mean weight gain (g/fish)	21.55 ^d	26.77 ^c	28.47 ^{bc}	31.88 ^b	37.87 ^a	41.55 ^a
specific growth rate (%/g)	1.22 ^c	1.31 ^{bc}	1.35 ^b	1.41 ^a	1.48 ^a	1.53 ^a
relative growth rate (%)	957.78 ^d	1163.91 ^{cd}	1259.73 ^c	1416.89 ^b	1661.65 ^a	1822.37 ^a
final length	13.31 ^b	13.87 ^{ab}	14.00 ^a	14.17 ^a	14.79 ^a	14.92 ^a
condition factor	1.01 ^c	1.09 ^{bc}	1.12 ^b	1.20 ^a	1.24 ^a	1.32 ^a
survival (%)	89.5 ^b	97.0 ^a	90.0 ^{bb}	93.0 ^{ab}	96.0 ^a	98.0 ^a
feed intake	40.69 ^b	39.03 ^b	42.78 ^b	42.53 ^b	49.86 ^a	52.19 ^a
feed conversion rate	1.89 ^a	1.46 ^b	1.50 ^b	1.33 ^c	1.32 ^c	1.27 ^c
protein intake	18.14 ^b	17.40 ^b	19.08 ^b	19.14 ^b	22.44 ^a	23.49 ^a
protein efficiency rate (g/100g)	1.19 ^c	1.54 ^b	1.49 ^b	1.67 ^a	1.69 ^a	1.77 ^a

Mean of data with different superscripts are significantly different ($p < 0.05$). (FF= Formulated Feed and CF= Coppense Feed)

Discussion

Nutrition is an important factor affecting fish health, reproductive and performance Glencross 2009 and Kaushnik et al., 2011; Chong et al., 2004. The present study has showed that, growth performance of African catfish fingerlings can be significantly influenced by feeding frequency and feeding rates which strongly affect the feed ingestion and assimilation. The highest growth performance (final mean weight, Relative weight gain in percentage, and specific growth rate and Feed Intake) were recorded in fingerlings fed with twice/day formulated feed and thrice commercial feeds as shown in table 2 and 3. Fish that are fed less frequently can adapt to such conditions by consuming larger amounts of feed during each meal. If such a schedule is applied for a longer period, this can lead to increased gut capacity and to hyperhagia and reduction in the survival as presented in the result. Similar report was made by Sogbesan et al. (2010) when they fed Dutch *Clarias* at different feeding frequencies. Fish that are fed more frequently consume a larger amount of feed; however, when the intervals between meals are short, the food passes through the digestive tract more quickly, resulting in less effective digestion

Ahmad et al., (2018) reported that *A. arabicus* fed on 7% body weight per day in floating net cages produced better growth performance. Optimum feeding frequency for maximum growth of fish generally depends upon fish size, age and culture conditions including water temperature, food quality and amount of food provided. Sogbesan *et al* (2010) observed that in dutch *clarias*, best growth performance was recorded in fingerlings fed twice/day than fish fed once/day or thrice per day. In hybrid sunfish, fish fed once/day were smaller than fish fed 2, 3, or 4 times per day; however, there were no differences among the latter three feeding frequencies as documented by Gonzalez et al. (2013). The present study similar to Dada and Wonah (2003) who reported that exotic *Clarias gariepinus* fed twice/day had higher percentage weight gains, SGR and average final weight compared to fish fed once/day, once on alternate day and twice on alternate day. Data on Atlantic

salmon, *Salmo salar*, has shown that feeding regime has little influence on growth provided that the fish are fed at ad libitum. Ahmad et al., 2020 reported that fish *Acanthopagrus arabicus* show better growth performance when it fed with four time per day frequency. A study by Alanara also confirmed that frequent feeding with an automatic feeder had a negative effect on rainbow trout. Normally fish species exhibits a rapid increase in activity during feeding; this may suggest that frequent feeding is a stress factor that elicits great expenditures of energy thus reducing the fish growth.

With regards to food conversion ratio, low FCR values were recorded in African catfish fed with twice every other day followed by once a day and twice/day respectively whereas significantly no difference in FCR values observed in fingerlings fed with all the feedings regimes except once every other day fed groups. This indicates that the efficiency of feed utilization and feed conversion was not influenced by the feed frequency. This might indicate that African catfish fed more frequently might utilize diet less efficiently than fish fed less frequently. Teng and Chua (1998) reported the same in grouper fed once/day or twice/day had similar FCR values and that there was no difference in FCR Sogbesan *et al.* (2010a) stated that feeding frequency had little effect on FCR. This may indicate that food consumption is the growth limiting factor. As found for other fish species, the greater the feed intake, the greater the growth response and similar was recorded in this study. This was the expected result since a higher amount of nutrients in terms of Protein Intake (PI) become available to the fish when they are fed more often.

The water temperature, pH and dissolved oxygen recorded in this study fall between the acceptable range for fish growth and health. In the present study, survival rate ranged within 90.5% to 99.0% in frequencies feeding while those of feeding rate was 89.5% to 98.0% was observed in fingerlings fed with once every other day groups. However, no significance difference ($p < 0.05$) was in the survival difference observed in the other feeding regimes. This could be due to the time interval between the next meal is longer than the other feeding regimes that could have given more

appetite, aggressive behavior and cannibalistic behaviour in the once every other day fed groups. Survival in the present study was higher than the range reported by Agnese et al. (1995) in juvenile of *Heterobranchus longifilis* had survival rate between 62-75%. The survival rate range (68-90 %) was recorded in the catfish *H. longifilis* which is more or less similar to the present study.

In fishes, cannibalism is usually associated with heterogeneous size variation, limited food availability, high population densities, limited refuge areas, and light conditions. In the present study size variation and food availability are considered the primary causes of cannibalism. This study suggests that body composition of African catfish fingerlings is affected by the frequency of feeding. African catfish fed once a day and once every other day had less lipid content than fish fed twice/day and twice every other day. The results of the present study based on the growth performance and feed utilization suggests that *C. gariepinus* fingerlings should be fed at twice a day for maximum growth and better survival.

Physicochemical water quality parameters such as temperature, pH, Ammonia and dissolved oxygen were given in Table 1 These indicated variations within each of the treatments. The ranges of values of the physicochemical parameters during the experimental period for different feeding frequencies were as follows: pH 7.07 -7.39; dissolved oxygen 4.37 – 5.12 mg/L, Ammonia 0.0317 – 0.047 mg/L and temperature 28.68--28.87°C while for Feeding rates were pH 7.17 -7.69; dissolved oxygen 4.67 – 5.38 mg/L, Ammonia 0.0327 – 0.0463 mg/L and temperature 28.68--28.87°C. Mean temperature, pH and dissolved oxygen levels, were found to be not affected by feeding frequency during the four weeks feeding trial. The recorded mean values of all these parameters were within the acceptable limits for fish growth and health (Boyd 1979; Sogbesan et al. 2010b). Dissolved oxygen is known as an indicator of water quality, ecological status and pond productivity including the health status of fish. The fact that the Dissolved Oxygen recorded were within the recommended range shown in the condition factor of the fish given each of the treatments as all were above 1.0.

Conclusion

The highest specific growth rate of 1.49%/day was recorded in *C. gariepinus* fed commercial diets thrice. Highest Specific growth rate of 1.53%/day was also recorded in *C. gariepinus* fed commercial diets at 9% feeding rate. Lowest Feed Conversion rate of 1.28 and 1.27 were recorded from *C. gariepinus* fed commercial feed thrice and those fed commercial feed at 9% feeding rate respectively. The water qualities recorded were within the recommended rate for aquaculture.

Frequencies considered were ones, twice and thrice and feeding rates were 3%, 6% and 9% respectively. The crude protein was 44.6% and 45.0% for Formulated feed and Coppen respectively. There was no significant difference ($p>0.05$) between the nutrients values of formulated feed and Coppen rather there was between the gross energy

value for the two diets. The ranges of values of the physicochemical parameters during the experimental period for different feeding frequencies were as follows: pH 7.07 - 7.39; dissolved oxygen 4.37 – 5.12 mg/L, Ammonia 0.0317 – 0.047 mg/L and temperature 28.68--28.87°C while for Feeding rates were pH 7.17 -7.69; dissolved oxygen 4.67 – 5.38 mg/L, Ammonia 0.0327 – 0.0463 mg/L and temperature 28.68--28.87°C.

Therefore *Clarias gariepinus* fed on commercial diet with 9% body weight per day and a feeding frequency thrice per day produced better growth performance under giving rearing situation.

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