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The impact of feeding frequency on the growth and survival of *Clarias gariepinus* Fingerlings fed at different percentage body weight in four phases

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Abstract
Eight weeks feeding investigation was conducted to determine the impact of feeding frequency on the growth performance, food utilization and water parameter indices of *Clarias gariepinus* using standard method. A total of 120 fingerlings were used and distributed into 12 aquaria of 10 fingerlings each with 2 replicates for each Treatment(T).T_1 was fed once, T_2 fed twice, T_3 fed thrice and T_4 fed four times daily with 1% 2%, 3% and 4% body weight of feed for two weeks interval with 0.7mm Durante feed. Physicochemical parameters including pH, water temperature (°C) and dissolved oxygen (mg/L) were controlled within the acceptable range for fresh water fish culture. The mean initial weights of the fish were 4.70±0.05g while the mean initial lengths were 5.90±0.02cm for T_1-T_4. Growth performance indices showed that weight gain (g), growth rate (GR), specific growth rate (SGR), mean growth rate (MGR), percentage weight gain (PWG) and percentage survival (PS) of *C. gariepinus* fingerlings were significantly different (P<0.05) among treatments. From the result food utilization indices showed the trend $T_3 > T_2 > T_4 > T_1$ while food conversion ratio (FCR) varied significantly (p<0.05). Food conversion efficiency (FCE) and survival rate was not significantly (p>0.05) different among treatments. From the result of the study it can be recommended that fingerlings of *C. gariepinus* be fed three times with this treatment (T_3) at the beginning of their culturing (the moment the fingerlings are stocked to ensure optimum growth.

Keywords: Feeding, frequency, body weight, efficiency, fish, growth rate

1. Introduction
Fish is said to be the most easily affordable source of animal protein in every average Nigerian family [12] and in the world at large [18]. Reports have shown that fish accounts for more than forty percent (40%) of the protein diet of two-third of the global population [9, 18].
Feeding is the highest single cost item of most aquaculture operations, accounting for about 60% of the total cost of fish production [8, 18]. Over and underfeeding can be detrimental to the health of the fish and may cause a marked deterioration in water quality, reduced weight, poor feed utilization and increased susceptibility to infection [19]. These may also affect specific growth rates and efficiency of feed conversion as these have been reported to be directly related to feed ration and frequency [3]. Therefore, there is the need to obtain a balance between rapid fish growth and optimum use of the supplied feed in order for the operation to be economically viable and for the fish to be in good health.
Determination of the appropriate feeding frequency is required to give optimal growth and better survival rate. As the catfish industry expands, there is need to know what feeding frequency would be optimal at the least cost for better production. This is the aim of this study.

2. Materials and Methods
2.1 Collection of samples
The fingerlings of C. gariepinus were purchased from Benoso Farm, Amaobolobo, Afikpo. It was transported to the animal house of the Department of Science Laboratory Technology of Akanu Ibiam Federal Polytechnic, Unwana. This investigation took a period of three months.

2.2 Proximate composition of the experimental feed (Coppens feed)
Proximate analysis of the dry matter of the experimental feed (Durante feed) was performed using Near Infrared Spectroscopy (NIR) machine at Animal Care LTD laboratory, Asaba, Delta state, Nigeria which accuracy has been certified by FAO.

2.2.1 Experimental fish preparation
A total of 120 fingerlings were used after acclimatization treatment. The 120 fingerlings were kept in a 500 liters capacity canvas tank which was fitted to a flow through system for two weeks for acclimatization prior to the start of the experiment [7] and were fed with 0.7mm Durante feed for the period of one week. All the fingerlings used have the mean initial length and weight of 5.90±0.02cm and 4.70±0.05g respectively.

2.3 Experimental design
The experiment was carried out with four treatments each with two replicates. A total of fourteen (13) plastic bowels of 10L capacity were used for this experiment. After the one week acclimatization each of the bowel were stocked with 10 fishes of similar sizes to avoid cannibalism [16] during the feeding frequencies trial. The initial total length (cm) of individual fish was recorded before placing them in the rearing containers. The aquaria were covered with mosquito net to prevent fingerlings from jumping out, intrusion of insects and other foreign bodies. The water was changed every two days while the feed remains and their faeces were siphoned out gently. Water parameter indices like pH, temperature and Dissolved Oxygen where determined and recorded accordingly.
The fingerlings were fed at 4 different feeding frequencies (treatments) with 4%, 3%, 2%, and 1%, body weight respectively with the change in feeding schedules at every two weeks intervals. Treatment one (T_1) was fed once/day at 9.00h while Treatment two(T_2) was fed twice/day at 8.00h and 15.00h and Treatment three (T_3) was fed three times/day at 8:00h,12:00h and 16:00 while Treatment four (T_4) was fed four times/day at 8:00h,11:00h,14:00h and 17:00h respectively.
Growth performance indices were evaluated according to [8] as shown below:

i) Mean weight gain (MWG) (g): Final weight (W2) − Initial weight (W1)
ii) Length gain (cm): Final length (L2) − Initial length (L2)
iii) Growth rate (GR)(g/day): (Final weight− Initial weight) /(Number of days)
iv) Specific growth rate (SGR) (%/day): (final weight)− (Initial weight)/(Number of days) × 100
v) Mean growth rate (MGR)(g/day): [(Final wt − Initial wt)/0.5(Final wt + Initial wt)(Number of days)]× 1000
vi) Percentage survival (PV)(%): [(Number of fish survived)/(Number of fish stocked) × 100
vii) Percentage weight gain (PWG)(%): (Final weight –Initial Weight/Final Weight) x 100

2.4 Physicochemical parameters
Water quality parameters measured include pH, dissolved oxygen and temperature. pH and dissolved oxygen was measured using pH and oxygen meter, temperature was measured using mercury in glass thermometer [18].

2.5 Statistical analysis
Growth performance and food utilization indices data were subjected to one way analysis of variance (ANOVA) to determine the significant difference using SPSS computer program (SPSS, 2000, System for Windows, Version 10.0). Effects with a probability of (P<0.05) were considered significant. Duncan test was used to determine the differences among treatment means when F-values from the ANOVA were significant [3].

3. Results
3.1 Proximate analysis indices

Table 1: Proximate analysis indices of the fish feed (Durante) fed to the fingerlings during the period of the experiment

Parameter	Values
Protein	43.30
Moisture	8.0
Fibre	3.30
Fat	11.10
Ash	5.63

The result of proximate analysis of the feed (Durante) as shown in table 1 and demonstrated in figure 1 shows that crude protein content was 43.3%, Moisture content 8.0%, Fibre content 3.3%, Fat content 11.1% and Ash content was 5.63% respectively.

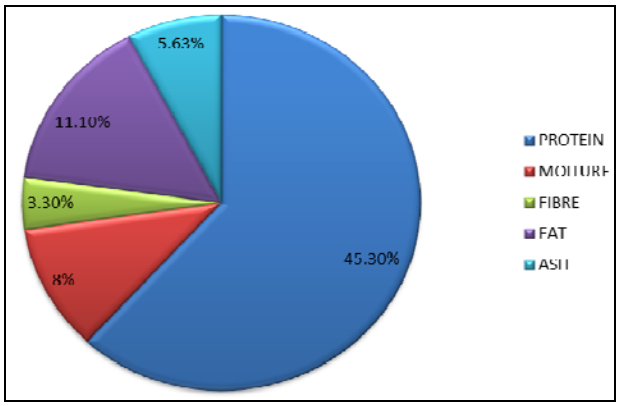

Fig 1: Proximate composition of experimental feed used

3.2 Water quality indices
The summary of water quality parameters (mean±SD) measured throughout the experimental period is presented in table 2 below.

Table2: Mean (±SD) values of water quality parameters of experimental Aquarium under four treatments.

Parameters	T_1	T_2	T_3	T_4
Temperature (^{0}C)	27.5±0.04	26.5±0.08	27.02±0.02	28.5±0.02
pH	7.1±0.013	6.8±0.011	7.0±0.009	6.9±0.06
Dissolved oxygen (mg/l)	6.20	6.40	6.30	6.90

The result of mean water quality determination are shown in table 2. Aquarium T_1, T_2, T_3, and T_4 recorded a mean temperature of 27.5±0.04, 26.5±0.08, 27.02±0.02 and 28.5±0.02, mean pH of 7.1±0.013, 6.8±0.011, 7.0±0.009 and 6.9±0.06, mean Dissolved Oxygen of 6.20, 6.40, 6.30 and 6.90 respectively.

3.3 Growth performance indices
The summary of mean growth performance indices of the four treatments of *C. gariepinus*

Table 3: Mean (±SD) values of growth performance indices of the four treatments

Growth Performance indices	T_1	T_2	T_3	T_4
Mean initial weight (MIG) (g)	4.4	4.4	4.4	4.4
Mean final weight(MFW) (g)	4.8±1.2	5.8± 0.08	6.0±2.1	7.0±1.1
Mean weight gain (MWG)(g)	1.34	1.74	1.97	3.18
Growth rate (GR)	0.024	0.031	0.035	0.057
Specific growth rate (SGR)	2.40	3.10	3.51	5.69
Mean growth rate (MGR)	5.22	6.10	6.78	10.06
Percentage weight gain (PWG) (%)	28	30	33	53
Mean initial length (cm)	6.10	6.10	6.10	6.10
Mean final length (cm)	6.38	6.94	7.24	7.05
Mean length gain (cm)	0.28	0.84	1.14	0.95
Mean daily length rate (MDLR cm/day)	0.005	0.015	0.020	0.017
Percentage length gain (PLG) (%)	4	12	16	13
Percentage survival (PV) (%)	87	89	89	91
Percentage Mortality (PM) (%)	13	11	11	09

The growth performance indices (Table 3) evaluated using weight gain (g), length gain (cm), growth rate (GR), specific growth rate (SGR), mean growth rate (MGR) and percentage weight gain (PWG) and % survival. Mean weight gain (g) of fingerlings for T_1, T_2, T_3 and T_4 was 1.34, 1.74, 1.97 and 3.18 respectively, mean length gain was 0.28, 0.84, 1.14 and 0.95; while GR was 0.024, 0.031, 0.035 and 0.057; SGR was 2.40, 3.10, 3.51, and 5.69; MGR was 5.22, 6.10, 6.78 and 10.06; PWG was 28, 30, 33 and 53 while the percentage survival rate was 87, 89, 89 and 91 respectively.

Weight gain, length gain, growth rate, SGR, MGR and PWG was significantly higher (P<0.05) in those that were fed thrice times daily (T_3) than other Treatments followed by T_2 and T_4 while T_1 had the smallest Growth performance indices.

3.4 Food utilization indices

Table 4: Food utilization indices of different treatments

Food utilization indices	T_1	T_2	T_3	T_4
Food consumed	2.37	5.35	10.58	14.05
FCR	1.76	3.07	5.39	4.40
FCE	57	33	19	23

Food utilization indices (Table 4) evaluated using food conversion ratio (FCR) and food conversion efficiency (FCE) showed that T_1-T_4 had food conversion ratio (FCR) of 1.76 ± 0.02, 3.07 ±, 5.39 ±, 4.40 and food conversion efficiency (FCE) of 0.57 ± 0.82%, 0.33±, 0.19± and 0.23 respectively. Food consumed was higher in T_4 (14.15 ± 02.05g), followed by T_3 (10.85± 03.0 g) while T_2 consumed 5.35 ±01.04 g) and T_1 consumed the lowest (2.37 ±06.00 g).

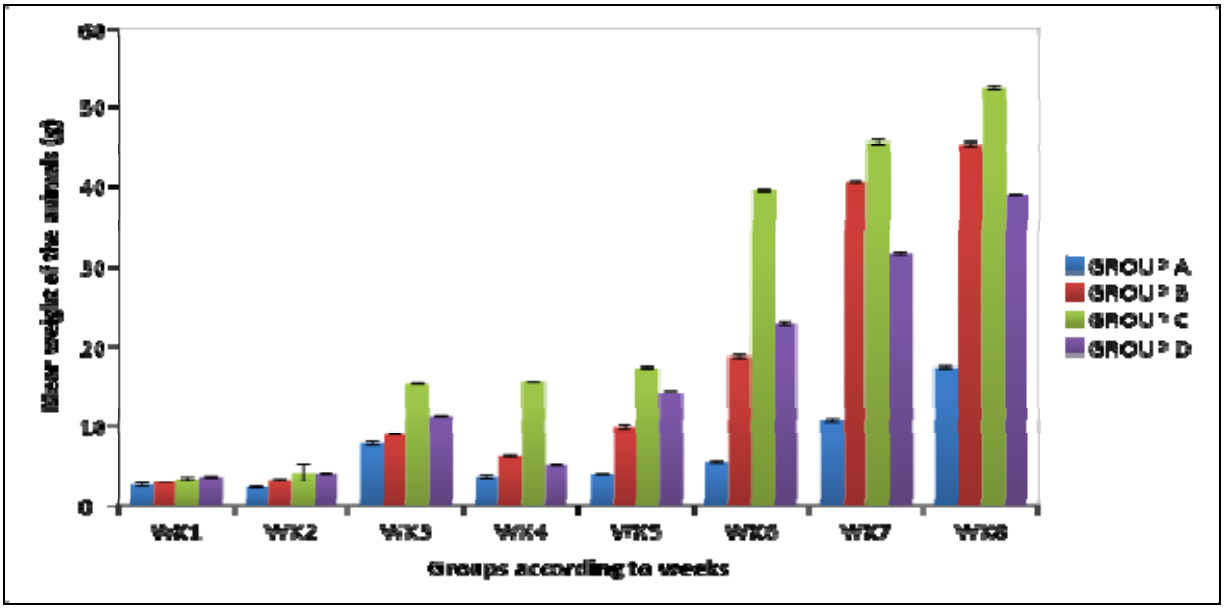

Fig 2: Mean weight of the animals according to the weeks N=2. Values are Mean ± SEM. P is significant at 0.05.

Group A (T_1): Fingerlings fed with 1, 2, 3 and 4% body weight feed once a day.

Group B (T_2): Fingerlings fed with 1, 2, 3 and 4% body weight feed twice a day.

Group C (T_3): Fingerlings fed with 1, 2, 3 and 4% body weight feed thrice a day.

Group D (T_4): Fingerlings fed with 1, 2, 3 and 4% body weight feed four times a day.

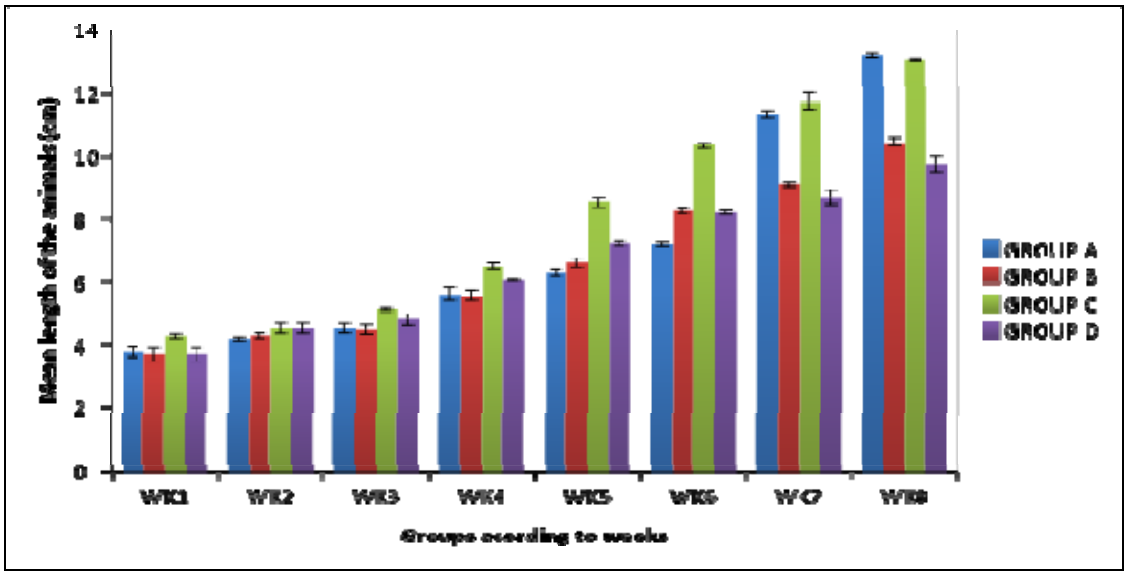

Fig 3: Mean length of the animals according to the weeks N=2. Values are Mean ± SEM. P is significant at 0.05.

Group A (T_1): Fingerlings fed with 1, 2, 3 and 4% body weight feed once a day.

Group B (T_2): Fingerlings fed with 1, 2, 3 and 4% body weight feed twice a day.

Group C (T_3): Fingerlings fed with 1, 2, 3 and 4% body weight feed thrice a day.

Group D (T_4): Fingerlings fed with 1, 2, 3 and 4% body weight feed four times a day.

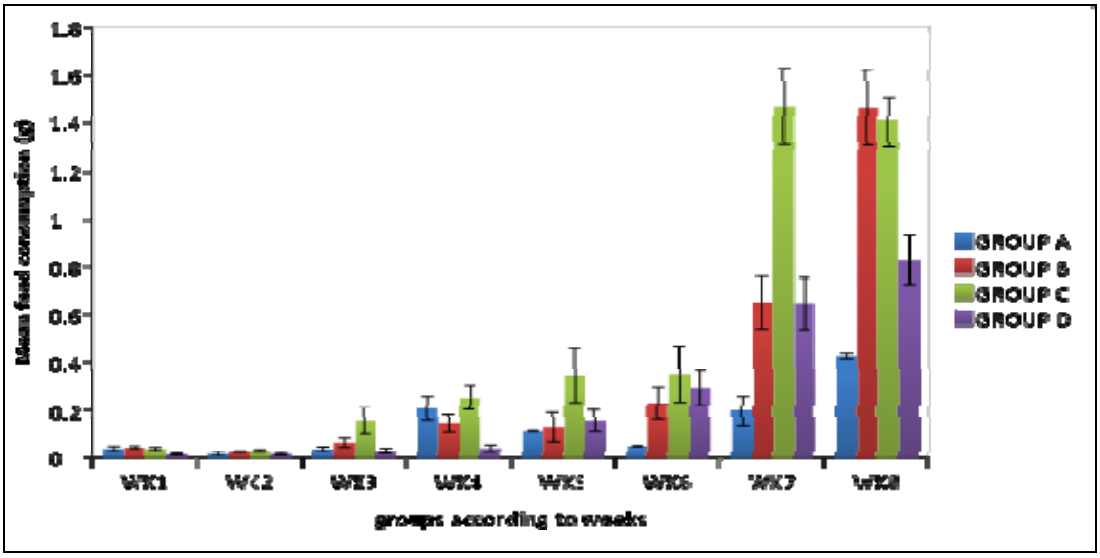

Fig 4: Mean feed consumption according to the weeks N=2. Values are Mean ± SEM. P is significant at 0.05.

Group A (T_1): Fingerlings fed with 4, 3, 2 and 1% body weight feed once a day.

Group B (T_2): Fingerlings fed with 4, 3, 2 and 1% body weight feed twice a day.

Group C (T_3): Fingerlings fed with 4, 3, 2 and 1% body weight feed thrice a day.

Group D (T_4): Fingerlings fed with 4, 3, 2 and 1% body weight feed four times a day.

4. Discussion

According to [1], temperature and other environmental factors dictate the progress of growth of the fish whether it will be at its optimum or not. When desirable levels of these factors are reached, growth will take place and if possible, optimum growth will be attained. In the present study, water quality parameters including pH, temperature and dissolved oxygen were maintained at optimum level for the treatments as recommended by [2]. Therefore, the water temperature, pH and dissolved oxygen recorded in this study fall between the acceptable range for fish growth and health [2, 10, 23, 24].

The variations in the recorded values showed that fishes that were fed at various body weights (1%, 2%, 3% and 4%) had variations in the growth performance (figure 2). But due to increment in number of times they were fed at lower percentage body weight, treatment three (T_3) recorded significant (p<0.05) increase in growth indices measured (Figure 2). The highest mean weight gain, growth rate and

specific growth rate recorded in this study or fish fed thrice times daily (Figure 2) were in agreement with the report of Ruohonen *et al.,* [20] using rainbow trout (*Oncorhynchus mykiss*) had higher growth rates when fed 3 times/day compared to fish fed once/day or twice/day, but were not different from fish fed four times/day.

However, reports show that feeding channel catfish once/day produced similar growth rates compared to fish fed twice/day when grown in cages [25] or in ponds [26]. Robinson *et al.* [20] reported that when channel catfish were fed once daily, time of feeding had no significant impact on growth, feed conversion or body composition. The mean weight gain and daily weight gain recorded in this study were very much lower than that reported for *Heterobranchus* and *Clarias* species in low input homestead concrete tanks and brackish water pond environment [5, 15], but similar to those observed by Gabriel *et al*., [10].

This study indicated that, fish fed at thrice daily had gained significantly more weight and added more length than fish fed at lower feeding frequencies. Fish fed at thrice daily consumed larger quantities of food than those fed less often, but individual meal size was smaller. This is consistent with studies conducted on other species [13], where fish fed fewer meals per day tend to eat more per meal. Fish accomplished this by increasing stomach volume and became hyperphagic [11, 14, 21]. Although fish fed at higher frequencies consumed larger quantities of food, when the interval between meals is short, the food passes through the digestive tract more quickly, resulting in less effective digestion [17].

Survival in the present study was within the range reported by [27] who observed that juvenile sunshine bass, *Morone chrysops* X *M. saxatilis*, had survival percentages between 87-91%. All mortalities may be attributed to handling stress after weekly parameters' handling. Despite the high survival rate, some mortality was recorded. Treatment 1 (feeding once a day) had the highest mortality rate (13%).

5. Conclusion

Fish fed at higher frequency (T_3) even though the percentage body weight was lower, had greater weight gain. Therefore, the present study has revealed that feeding frequency and percentage body weight at which feed was fed have strong effect on the growth performance indices of *C. gariepinus.* To improve on the culture of this fish (*C. gariepinus*), there is need for more information on the management method in the area of feed forms, percentage body weight given to fish and feeding frequency in order to produce fish within the shortest possible time and at minimum cost with good quality.

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