Original Research Article

Growth Response and Survival of *Clarias gariepinus* Fingerlings Cultured in Different Water Volumes

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Abstract

This study examined the growth performance and survival of African catfish, *Clarias gariepinus* fingerlings cultured in different water volumes (20, 15, 10, and 5 litres). A total number of three hundred sorted *C. gariepinus* fingerlings of 0.37±0.02g mean weight were stocked at twenty (25) fingerlings per treatment in three replicates of plastic tanks (52cm x33cm x33cm). Growth response, water quality parameters and length-weight relationship of experimental fish were monitored throughout the study. Fish were fed twice daily for six weeks with commercial pellet feeds (Coppens®) to satiation. Temperature and pH were at optimum levels for the fish. The results showed no significant differences ($p>0.05$) among the means of their triplicate values. The mean weight gained (MWG), percentage weight gained (PWG) and specific growth rate (SGR) were best in fish reared in 20 litres of water. MWG (g) of fish reared in 20 litres was 1.64±0.10, and the least was in 5 litres (1.30±0.25). PWG (%) of fish reared in 20 litres was 450.57±29.85, and the least was in 5 litres (385.80±88.12). SGR was also in the order 20 ≥ 15 ≥ 10 ≥ 5 litres, the values being 1.17±0.15, 1.16±0.20, 0.65±0.42 and 0.59±0.45 respectively. Fish reared in 10litres and 5litres of water had the best Feed conversion ratio. Percentage survival and length-weight relationships showed no significant differences ($p>0.05$) among treatmnts. The "b" values ranged from 3.1513 to 3.8633**.** In conclusion, the study revealed that fish reared in twenty (20) litres of water gave good growth and survival of *C. gariepinus* fingerlings.

Keywords: Survival, *Clarias gariepinus*, Specific Growth Rate (SGR), Feed conversion ratio (FCR)

Introduction

Fish are aquatic organisms, and so, are designed to live in water. Water is therefore an important resource for fish, as it is the medium in which the fish lives and depends on, derives its food, grows etc. For fish or other aquatic organisms to give maximum growth or production, optimal conditions of the water or aquatic environment must be met (Ajana *et al*., 2006). The environmental properties of water need to be conducive for fish to grow well. Consequently, an ideal water condition is a necessity for the survival of fish since the entire life processes of fish wholly depend on the quality of its environment (Ladon, 2000).

Fish perform all their bodily functions in water. They are totally dependent upon water to breath, feed, excrete wastes, maintain salt balance, and reproduce. The Aquatic environment determines the success or failure of an aquaculture operation (Ladon, 2000). The average growth rate for aquaculture has been 8.9% per year since 1970 compared to only 1.2% per capture fisheries and 2.8% for terrestrial formed meat production over the same period. In 2002, the total contribution of aquaculture towards total world fish requirement was 29.9% (FAO, 2004).

Fish is also a good source of thiamine, riboflavin, vitamins A and D, phosphorus, calcium, and iron. It is also very high in polyunsaturated fatty acids which are important in lowering blood cholesterol. It is therefore suitable for complementing high carbohydrate diets typical of low income group in Nigeria.

Catfishes of the family Claridae comprise the most commonly cultivated fishes in Nigeria. The growth of aquaculture in Nigeria now is largely being boosted by a steady rise in catfish culture. Inadequate availability of seed for stocking and feed used to be major problems. According to Dada and Wonah (2003), *Clarias gariepinus* is generally considered to be one of the most important tropical fresh water fish species for aquaculture whose aquaculture potential have been documented . *Clarias gariepinus* has also high fecundity rate, grows faster, and tolerates high density and environmental extremes. It also accepts a wide range of natural and artificial food, and adapts to a variety of feeding modes in expanded niches (Edward *et al.*, 2010).

The African catfish (*Clarias gariepinus*) as an important food-fish in Nigeria has remained an important candidate for research. The aim of this study was to evaluate the growth response and survival of *Clarias gariepinus* fingerlings cultured in different water volumes

Materials and Methods

Experimental Site

The hatchery facilities of a private fish farm known as Motherhood fish farm Ltd situated in Abeokuta was used for the study. Four plastic tanks (52cm x 33cm x 33cm) were used inside the hatchery with PVC water inlet and outlet devices. Water was supplied from a borehole with an overhead tank for water storage.

Experimental Layout

Four culture plastic tanks were used for the study. Each of these plastic tanks sections served as the experimental treatment. There were three replicates per treatment. Thus, a total number of twelve plastic tanks were used for the experiment. Water level of 5 litres, 10 litres, 15 litres and 20 litres respectively was maintained in each of the plastic tanks throughout the experimental period. Thus the volume of water in all the plastic tanks was approximately 50 litres. The component parts of each plastic tank were firmly glued together using clear sealant. All prepared tanks were tested for leakages before the commencement of the experiment.

Water to the plastic tanks was sourced from a borehole which was aerated for 24 hours before the tanks were stocked. To prevent pollution, the water in each tank was replaced with freshwater at two-day intervals after cleaning the tanks.

Fish Stocking and Feeding

Three hundred pieces of sorted fingerlings of *Clarias gariepinus* of average weight of 0.37±0.02g were purchased from a private commercial farm. Twenty-five *Clarias gariepinus* fingerlings were randomly stocked in each of the culture plastic tanks. The treatments were replicated thrice at equivalent stocking density. Throughout the study (six weeks duration), experimental fish were fed to satiation with commercial pellet (Coppens®) feed while adjusting the pellet size from 0.8mm initially. The uneaten feed and solid metabolic wastes were siphoned out daily. Weekly feed adjustment was based on respective weekly biomass measurements of their body weight.

Sampling Growth

The fish were sampled weekly between 8.00a.m and 9.00a.m to determine their increase in length and weight. Fish were weighed in grams using an electronic pocket scale (Model: EHA 501, specification: 0.01 to 100g), and total length taken in centimeters using a measuring board. The total length of fish was determined from the snout to the tip of the caudal fin as recommended by Reed *et al*. (1967). The values of the fish weekly weight changes were used to assess the growth performance of the fish as described by Olvera-Novoa *et al*. (1990) as follows:

Weight Gain: this was determined at the end of each week as Final weight - Initial weight.

Percentage weight gain was determined by expressing the difference between the final and initial weights as a percentage of the initial weight, as shown in the the following formula:

% Weight gain = 100(Final weight - Initial weight)/Initial weight

Specific Growth Rate: This was represented by:

SGR = 100(InW2 - InW1)/Time (days)

W1 = Initial weight gained at time T1

W2 = Final weight gained at time T2

In = Natural logarithm

Survival Rate, S (%): This was determined at the end of the culture period using the formula

Survival rate = 100(No. of fish still living at the end of the experiment)/Number of fish at the beginning of the experiment

Feed conversion Ratio (FCR): This was calculated using the formula

FCR = (Feed fed)/(Weight gained)

Mortality Rate;

M% =Dx100/NO

Where; M = Mortality

D = Total number of dead fish at the end of the experiment.

NO = Total number of fish stocked at the beginning of the experiment range record taken after taking three measurements.

Water Quality Parameters

The physico-chemical parameters of water measured were dissolved oxygen (DO), temperature, alkalinity, and pH. The pH and dissolved oxygen were measured with a pH metre and dissolved oxygen meter respectively. A mercury thermometer calibrated in degrees centigrade (0-100^{o}C) was used in the determination of water temperature. The thermometer scale was read off after dipping into water. When immersed in the water column it was allowed to stand for five minutes and reading was taken immediately it was removed.

Data Analysis

Data obtained from the field were subjected to statistical analysis, using the statistical package for social sciences (SPSS), version 16.0. Duncan multiple Range Test was used to compare the differences among the means. The significance level was set at 5%.

RESULTS

Generally, the results of growth response and survival of *Clarias gariepinus* fingerlings reared in four different water levels (20, 15, 10, 5 litres) showed no significantly difference ($p>0.05$) in the means of thier triplicate values (Table 1).

Growth Performance of Experimental Fish

The mean weight gained (MWG), percentage weight gained (PWG) and specific growth rate (SGR) were higher in fish reared in 20 litres of water than in other treatments of lower volume. Values obtained for MWG (g) of fish were 1.64±0.10, 1.63±0.14, 1.33±0.24 and 1.30±0.25 in 20, 15, 10 and 5 litres of water respectively. PWG (%) of fish reared in 20 litres was 450.57±29.85; corresponding values for fish reared in the 15-, 10- and 5-litre tanks were 445.73±28.05, 357.41±72.51 and 385.80±88.12% respectively. SGR was also in the order $20 \geq 15 \geq 10 \geq 5$ litres, the values being 1.17±0.15, 1.16±0.20, 0.65±0.42 and 0.59±0.45 respectively. For feed conversion ratio (FCR), on the other hand, fish reared in 10 litres and 5 litres of water had best FCR of 0.08±0.02, while the fish reared in 20 litres had the highest value of 0.19±0.16 ($p>0.05$).

Survival of Experimental Fish

Percentage survival did not have significant difference ($p>0.05$) in all the experimental fish (Table 1). However, fish reared in 20 litres of water had the highest survival (80.00±4.00), while the least survival was recorded for fish reared in 10 litres (74.67±4.62).

Table 1: Growth response and Survival of *Clarias gariepinus* fingerlings reared at different water levels

	Water Level (Mean±SD)			
Parameter	**20 litres**	**15 litres**	**10 litres**	**5 litres**
IMW (g)	0.36±0.01	0.37±0.03	0.37±0.02	0.34±0.03
FMW (g)	2.00±0.10	2.00±0.16	1.700.23	1.64±0.24
MWG (g)	1.64±0.10	1.63±0.14	1.33±0.24	1.30±0.25
PWG (%)	450.57±29.85	445.73±28.05	357.41±72.51	385.80±88.12
SGR	1.17±0.15	1.16±0.20	0.65±0.42	0.59±0.45
FCR	0.19±0.16	0.10±0.01	0.08±0.02	0.08±0.02
Survival (%)	80.00±4.00	76.00±4.00	74.67±4.62	77.00±4.22

No significant difference ($p>0.05$) existed aming the means of all the parameters across the row;
IMW = Initial mean weight; FMW = Final mean weight; MWG = Mean weight gained;
PWG = Percentage weight gained; SGR = Specific growth rate.

Length and Weight Relationships of the Experimental Fish

Results of the length and weight relationships of experimental fish reared in the four different water levels did not have any significant differences ($p>0.05$). Generally, all the result presented showed an allometric growth ($b<3.0$) of the experimental fish within six weeks of culture period (Figures 1 to 4). Fish reared in 20 litres had 'a', 'b' and 'r^2' values of 3.1513, -0.992 and 0.7351 respectively (Figure 1). Corresponding values for fish reared in 15 litres were 3.8633, -1.2051 and 0.9906 respectively (Figure 2), 3.7193, -1.147 and 0.947 respectively for fish reared in 10-litre tanks, and 3.8516, -1.0887 and 0.7578 respectively for fish in 5-litre tanks.

Water Quality Measurement

Mean parameters of physical and chemical water qualities measured during the experiment included temperature, pH, dissolved oxygen (DO), alkalinity and nitrite (Table 2). Temperature ranged from 23°C in the 10-litre tanks to 26°C in the 20-litres tanks, and pH from 6.5 in the lower-volume tanks to 6.7 in the 20-litre tanks. DO of all experimental groups was 5 mg/L. Alkalinity (mg/L) decreased steadily from 85 in the 20-litre tanks to 82 in the 5-litre tanks, while Nitrites (mg/L) were 0.42, 0.41, 0.41 and 0.40 in fish reared in 20, 15, 10 and 5 litres respectively. Treatment means were similar ($p>0.05$) for all the parameters.

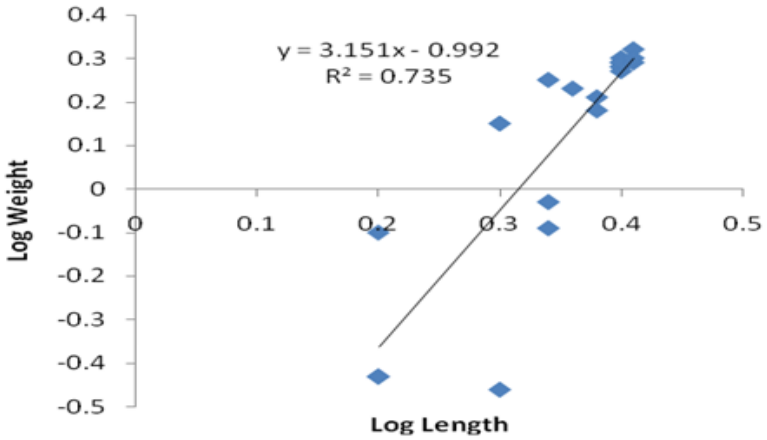

Figure 1: Graph of Log Weight against Log Length of experimental fish reared in 20 litres of water

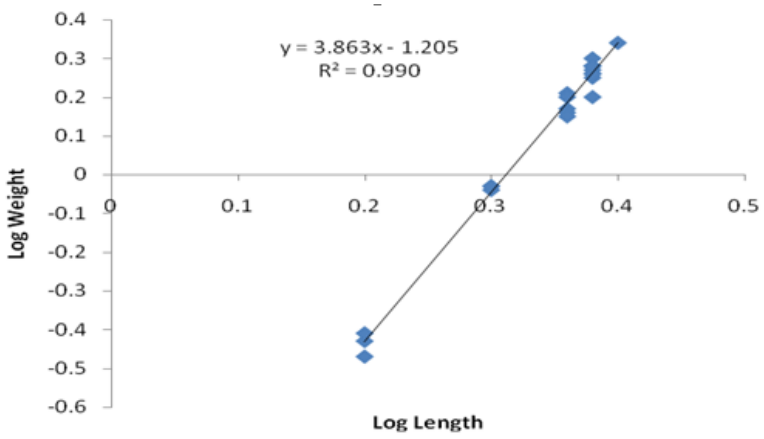

Figure 2: Graph of Log Weight against Log Length of experimental fish reared in 15 litres of water.

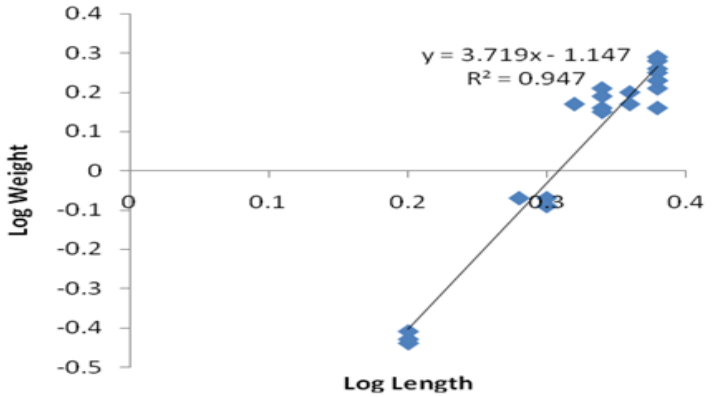

Figure 3: Graph of Log Weight against Log Length of experimental fish reared in 10 litres of water.

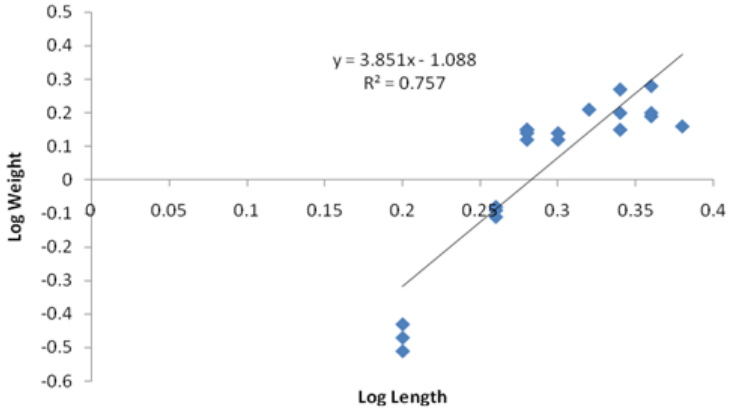

Figure 4: Graph of Log Weight against Log Length of experimental fish reared in 5 litres of water.

Table 2: Water Quality Parameters of Culture Trial in different water levels

	Water Volumes			
Parameters	**20 litres**	**15 litres**	**10 litres**	**5 litres**
Temperature (ºC)	26	25	23	24
Dissolved oxygen (mg/L)	5	5	5	5
pH	6.7	6.6	6.5	6.5
Alkalinity (mg/L)	85	84	83	82
Nitrite (mg/L)	0.42	0.41	0.41	0.40

Discussion

The higher growth rate observed in the fish stocked in the highest water volume (20 litres) compared to the other treatment (15, 10, 5, litres) conforms to results reported by Nlewadim *et al*. (2011) who recorded that higher water volumes favoured the growth and survival rate of *Heterobranchus longifilis.*

Feed conversion ratio is a measure of diet efficiency. The more suitable the diet the less feed is required to produce a unit weight of gain i.e. lower feed conversion ratio (Adebola *et al*., 2015). Feed conversion ratio of all the treatments ranged from 0.08 to 0.19. The feed conversion ratio values obtained in the treatment did not conform with the findings of Marimuthu *et al.* (2011) who reported values that ranged between 1.00 and 1.34. This may be due to the difference in initial weights of fish used**.** An understanding of the relationships between Feeding rates, growth and food conversion is fundamental in optimizing feeding the fish (Nadir *et al.*, 2007)

Survival rate recorded in this study was generally high, and was also dependent on the water volume. The high survival rate may be attributed to proper handling of fish and good water quality parameters (De Graaf *et al*., 1995).

Water quality parameters obtained in this study were within the required levels recommended for successful fish culture, and are in agreement with FAO (2002). Temperature (^{o}C) values recorded in this experiment were within the required levels as reported by Adeniji and Ovie (2003) that the best temperature range for optimum growth of African catfish *Clarias gariepinus* is 25-31^{o}C. Afzal *et al*. (2007) recommended a temperature range of between 25 and 32^{o}C for good performance of fishes, while Sikoki and Veen (2004) noted that fish and many other aquatic organisms grow best at temperatures of 25-32^{o}C especially in the tropics.

pH is an indicator that determines the quality of water required for aquaculture production. The range of pH values obtained in this study agrees with those in the studies of Bhatnagar and Devi (2004). They recommended that optimum pH level in ponds should be between 6.5 and 9.

Length-weight relationship of fish is an important fishery management tool. Its importance is in estimating the average weight of fish at a given length group (Davies *et al*., 2013). All maximum values for "b" (change in log-weight of fish per unit change in log-length) in the different water levels were recorded, and showed allometric growth. The "b" values obtained in this study are supported by studies of Anyanwu *et al*. (2007) that reported "b" values of 1.2713 for *Clarias gariepinus* males. Such differences in "b" values can be ascribed to one or a combination of factors including differences in the number of fish examined (Moutopoulos and Stregiou, 2002).

Clarias gariepinus in the study had regression equations for the different water levels (Figures 1 – 4). From length-weight parameters (a, b), fishes are affected by a series of factors such as habitat (water), stomach fullness, health and annual differences in environmental conditions (Froese, 2006).

Conclusion

The study revealed that the higher the water volume the higher the growth performance of African catfish (*Clarias gariepinus*) fingerlings. Similarly, In terms of survival, the study revealed that fish cultured in twenty (20) litres had the highest survival compared to other volumes of water (15, 10 and 5 litres). The study showed that the experimental fish had an allometric growth for the period of the experiment.

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