Comparative Studies on the Growth and Survival of African Catfish, *Clarias gariepinus* (Burchell, 1822) Juveniles Reared in Cages Suspended in Concrete Tank and Earthen Pond in Umudike, Abia State

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Abstract

Comparative studies were carried out to evaluate the growth and survival of African catfish, Clarias gariepinus reared in cages suspended in tank and pond of surface area 24m^2 and 450m^2 respectively. The result showed that growth was better in pond than in tank. At the end of the culture period, the percentage survival was 97.96 % in tank and 93.88 % in pond and this did not differ significantly (p>0.05) among the stocking densities. There was no significant difference in food conversion efficiency (FCE) and protein efficiency ratio (PER) at different stocking densities between the two systems. Fish stocked at 7m^{-3} grew better than those stocked at higher densities (14m^{-3} and 28m^{-3}). Statistical analysis of the data collected showed significant difference (P< 0.05) in the specific growth rate. The analysis of the labour cost required for the adoption of net cage culture in both concrete tank and earthen pond systems, proved it to be more efficient and profitable for juvenile catfish production.

Keywords: Growth and survival, catfish, cage and tank, comparative.

Introduction

Fish culture is presently an innovative technology whose target is to produce large quantities of fish for the nations increasing populace. Considerable interest has been generated in the potential of catfish *genus Clarias* for aquaculture in Nigeria. The catfish species are very important for the sustainability of the aquaculture industry in the country (FAO, 1987).

The *genus Clarias* is widely spread in Africa and also in South East Asia and its utilization for fish culture has significantly increased during the last few years (Bard *et al.*, 1976). Clarid catfish has been one of the most popularly cultured freshwater fish in the South East Asia and the present annual production in Thailand is estimated to be 50,000 tonnes/ha^{-1} and as air breather, catfish can grow at extremely high density with standing crop in culture reaching as high as 100 tonnes ha^{-1} (Areerat, 1987).

The African catfish *Clarias gariepinus* Buchell, 1822 was soon recognized to be one of the most suitable fish species for aquaculture in Africa (Hogendoorn, 1979). The species *C. gariepinus* was reported as a very important fish for food in Nigeria (Ayinla, 1985). Attempts to breed this species in captivity met with varying level of success for both farmer and researchers. The development of a reliable method for the production of *C. gariepinus* fingerlings was one of the priorities of aquaculture research in Africa (FAO, 1987) due to the fact that the seasonality of spawning posed a major problem in the reproduction of African catfish. *C. gariepinus* and also low survival rate which has been reported by many authors and confirm to range from zero to thirty percent (0 – 30%) (Viveen *et al.*, 1986).

Growth studies in fish have been carried out ranging from ecological factors influencing growth through physiological factors to studies concerned with increase in production through different fish culture systems (El - Block, 1975).

High mortality of fry and fingerlings have been attributed to factors such as predation by frog and aquatic insects, cannibalism by jumpers on smaller ones etc (Madu *et al.*, 1988). In natural fish populations, cannibalism plays a regulatory role which turns out to be a major problem in high density fish culture (Craig and Kiplins, 1983).

The nursing of *C. gariepinus C. gariepinus* under different stocking densities using different culture system have been reported by various workers. Bombeo *et al.* (2002) reported that *C. gariepinus* reared in ponds grew faster, with a specific growth rate (SGR) of 14.6 % day^{-1} than those in cages suspended in tanks (SGR) range 11.3% day^{-1}) at stocking densities 285, 571 and 1143 fry m^{-3} in tanks and 114, 228, 457, fry m^{-3} in ponds.

Campbell *et al.* (1995) also reported a harvest 85 fingerlings m^{-3} with initial stocking density of 250 larva m^{-3} giving 30% survival for *C. gariepinus* reared in earthen ponds of 10 x 10 x 1m and 30 cm water depth completely covered with a nylon net of mesh size, 4mm

Moonfish (*Citharinus citharinus*) reared in hydro-electric reservoir grew better (1.92g/day) than in the drinking water reservoir (0.90g/day) (Otubusin, 2003). Thus, a reliable source of broods tock and fingerlings for grow-out has been a major constraint on the development of *Clarias* farming. Because of a renewed interest in catfish farming there is a high demand for fry and fingerlings of *C. gariepinus*.

Mass and large-scale catfish farming requires a regular fry supply. Several workers have tested different holding systems and stocking densities for production of juvenile catfish. For African catfish, *C. gariepinus* fingerling production was carried out in tanks (Jansen, 1989) at stocking densities ranging from 50 to150 fry L^{-1}, which resulted in survival ranging from 20 % to 90 % (Haylor, 1991). *Clarias macrocephalus* was grown at a stocking density of 30 - 50 fry L^{-1} in aquaria (Fermin *et al.,* 1995). *Clarias lazera* another name for *C. gariepinus* was reared in concrete tanks at a stocking density of 9 fingerlings m^{-3} (Omar, 1996). In ponds *C. batracus* has been reared at 350 - 400 fry m^{-3} (Areerat, 1987). Other stocking densities include *Clarias macrocephalus* at 250-350 fry m^{-2} (Sinha, 1989).

The aim of the present study was to determine and compare the growth and survival of *C. gariepinus* juveniles reared at different stocking densities in cages suspended in tanks and earthen ponds.

Materials and Methods

Two weeks old hatchery produced African catfish juveniles *(C. gariepinus)* were purchased from Nwagbo Fish Farm, Ltd, Ndoru-Ibere, Ikwuano L.G.A; Abia State, Nigeria. They were transported in plastic container 160-L capacity to Michael Okpara University of Agriculture, Umudike, Fish Farm with the aid of ice chips to lower the temperature and reduce stress. Further acclimation took place in a 200-Litre capacity tank for two weeks.

Six 1 x 3 x 1 m outdoor concrete tanks were used for the experiments. The series of tanks had concrete partitioning with separate water inlets and drains. Ten days prior to stocking of the experimental fish, a jute bag' containing 10 kg of dried cow dung was suspended 70 cm below the water surface to enhance growth of zooplankton. The bag was suspended in the tank throughout the rearing period. Two 1 x 1 x 1 m net cages with a mesh size of 0.5 – 1.00mm were installed in each tank. Three stocking densities of 7, 14 and $28m^{-3}$ with four replicates each were randomly assigned in all 12 cages at two cages per tank. An artificial shelter made of bundled plastic netting materials and tied to a sinker was placed at the bottom of each cage. Fish were fed daily with the 40.57 % crude protein formulated feed; with a particle size of 300 µm.

Food composition and proximate analysis are shown in Table 1. The fish were fed at 20 % body weight per day during the first week, 15 % per day during the second week and 10 % per day during the third and fourth week. Daily rations were divided into two: one each for morning (09.00h) and afternoon (15.00h) feedings. Feed amounts were adjusted weekly based on the average weight of 20 fish sampled per cage. About 5 % of the water volume was exchanged each time that the fish were sampled for length and weight increment. Dissolved oxygen, pH and water temperature were monitored weekly (APHA, 1990). Fingerlings were harvested after 28 days of culture.

A $450.5m^2$ (26.5 x 7.00 x1m) earthen pond was prepared by sun drying and then liming with two 50 – kg bags of agricultural lime (calcium hydroxide) as a disinfectant water from the dam was introduced into the ponds 3 days after liming. Two sacks of cow dung (3035 kg) of the pond. Nine 1.35 x 1.85 x 1m (water volume inside the cage = $1.75 m^3$) hapa net cages with a mesh size of 0.5 – 1.00 mm were suspended on a bamboo posts inside the pond.

Catfish juveniles taken from the same batch as those reared in the tank nursery were stocked at densities 7, 14 and $28m^{-3}$ each with three replicates. A 1- m distance between cages was maintained. The bottom of the cage was submerged to at least 10 cm of the pond mud. Water was replenished when necessary to maintain a 70 – cm depth inside the cage throughout the culture period. Feeding and adjustment of feed amounts were the same as in the tank experiment. Water temperature, dissolved oxygen and pH were monitored weekly following the same procedure as in the tank nursery.

Table 1: Diet Composition and Proximate Analysis of experimental diet

Diet Composition Ingredients	%
Soybean meal	25
Fish meal	35
Wheat bran	20
Bread flour	10
Groundnut oil	5
Bone meal	2
Salt	1
Starch	2
Proximate Analysis of feed	
Moisture	3.20
Crude protein	40.57
Crude fat	10.23
Crude fibre	3.83
Nitrogen free extract (NFE)	32.04
Ash	10.13

Fish and Plankton Sampling: Water samples were taken on the day of stocking and weekly thereafter and were fixed in 5% formalin. Whole body samples of fish were likewise fixed in 10% formalin at the end of the experiment and the content of the gut were examine. Fish body weight (BW) and total length (TL) were measured using a top – loading meter balance to the nearest 0.01g. Plankton sample composition was determined under a dissecting microscope (Orth, 1983).

Data Analysis: Data on mean total length (TL), mean body weight (BW) and specific growth rate (SGR) were analyzed using analysis of variance (ANOVA) for completely Randomized Design (CDR) followed by Duncans Multiple Range Test (DMRT) at a 5% level of significance to determine significance differences among treatment means (SAS, 1991).

Results

The result of the water quality analysis is shown in Table 2. The graphical representation of the growth of the African Catfish fingerlings reared in cages suspended in tank and pond is shown in Figures 1, 2, 3a, and 3b. Figures 1 and 2 show their growth in the form of total length (TL) in centimeters. Generally, the fish reared in the earthen pond grew better than those reared in the tank, with the fingerlings in pond attaining the highest mean total length of 11.95 cm and mean body weight of 28.6g while that of the tank is 11.2 cm and 26.5g respectively confirming the higher growth rates in the pond. The figure 3a and 3d represents their growth in the form of body weight (BW) in grammes and also confirms the heavier fish biomass in pond. From the growth curves in the figures 3a and 3b, the growth rates within each stocking density could be seen to be uniform and continuous at each stage (week) and this could be attributed to the fact that feeding was regular, and stress, which could be an environmental factor was drastically reduced.

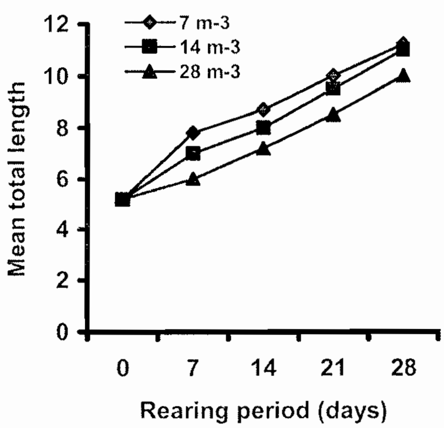

Fig. 1: Total length against rearing period of *C. gariepinus* fingerlings reared in cages suspended in tank.

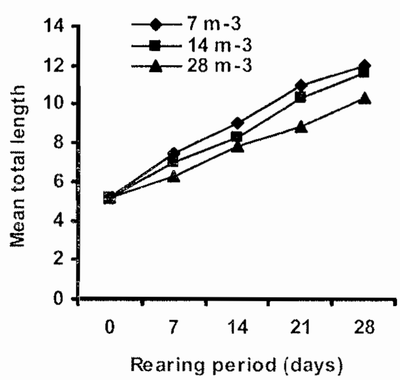

Fig. 2: Total length against rearing period of C. gariepinus fingerlings reared in cages suspended in pond

Table 2: Water quality parameters in the both experimental culture systems

Parameters	Tank	Pond
PH	6.89 ± 0.41	6.89 ± 0.31
Dissolved oxygen (mgL^{-1})	4.54 ± 0.39	4.39 ± 0.41
Temperature (^0C)	27.66 ± 0.56	27.86 ± 0.59

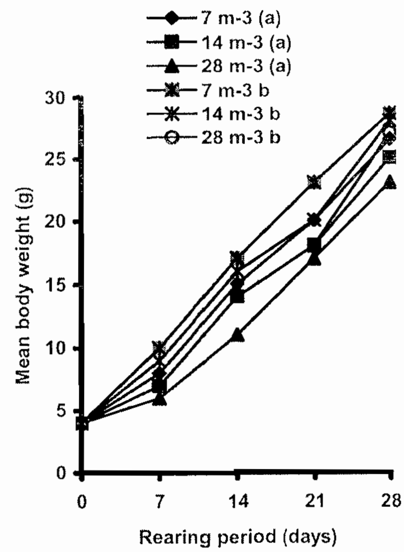

Fig. 3: Body Weight against Rearing Period of *C. gariepinus* Fingerlings reared in cages suspended in (a)tank and (b) pond

The specific growth rate (SGR) of fingerlings stock at $7m^{-3}$ was significantly higher than those stocked at both $14m^{-3}$ and $28m^{-3}$ at ($P<0.05$) in the both culture systems. The specific growth rate of the catfish fingerlings reared at the different stocking densities throughout the culture period is shown in table 3. The food conversion efficiency (FCE) and the protein efficiency ratio (PER) did not show any significant differences among the stocking densities and between the two culture systems at ($P>0.05$). There was no significance difference between the physiochemical variables in the two culture systems at ($P>0.05$), however as significant difference was observed between the physiochemical variables and the SGR at ($P<0.05$). Specific Growth Rate (SGR) was higher in pond system compared to tank system in all physiochemical variables measured. Plankton analyses showed that rotifers were predominant in tanks while copepods and Cladocerans (moina) were more populated in pond. Figures 4 and 5 depict the plankton species composition throughout the culture period in tank and pond respectively. This more variety of natural fish food in pond could explain the reason for better growth in pond which is due to the substrate (pond bottom) type.

Table 3: The Specific Growth Rates (%/day) of Catfish Fingerlings reared throughout the 28 day culture period

Stocking density fish m^{-3}	Tank	Pond
7	3.80 ± 0.03	4.19 ± 0.14
14	3.70 ± 0.03	4.02 ± 0.14
28	3.29 ± 0.03	3.76 ± 0.14

Survival of catfish fingerlings cultured is expressed in percentages. Two fingerlings were recorded dead in tank and six dead in pond out of 98 stocked, giving 97.96% survival in tank and 93.88% in pond, giving high survival rates. Higher percentage survival seen in the tank was due to a better cage suspension obtained. The mortality in the tank was observed immediately after transferring. But in the pond system, cage suspension was not very conducive for the fingerlings because, the net cages were folding due to shallow depth of the pond water, so this caused the net materials to be hooking their spines as they navigate causing death in some that were not rescued.

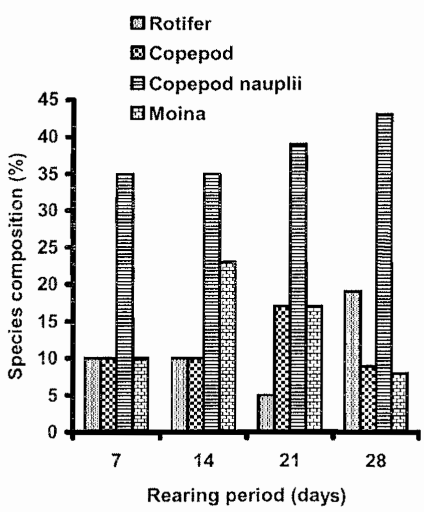

Fig. 4: Zooplankton Species composition in Tank

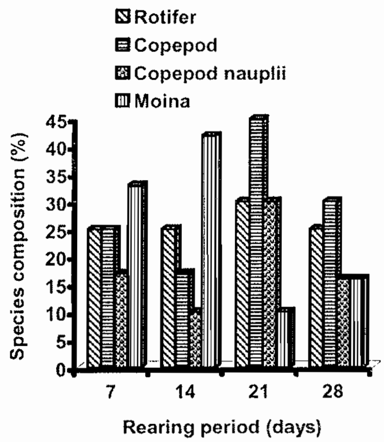

Fig. 5: Zooplankton Species Compositions in pond.

Discussion

The differential growths obtained at different stocking densities of weekly sampling and at the end of the experiment showed the effect of stocking densities on growth as also confirmed by Aluko *et al.* (2001). Fingerlings reared at $7m^{-3}$ were bigger with mean body weight for pond and tank respectively (18.71 ± 0.22)g and (16.45 ± 0.18)g and mean total length (9.79 ± 0.06)g and (9.28 ± 0.05)g for pond and tank respectively than those reared at $14^{-3}m$ with body weight (17.93 ± 0.22)g and (16.25 ± 0.1)g and total length (9.34 ± 0.06)g and (8.86 ± 0.05)cm for pond and tank respectively which were in turn bigger than those at $28m^{-3}$ with body weight (16.75 ± 0.22)g and (15.03 ± 0.18)cm and total length (8.48 ± 0.05)cm for pond and tank respectively.

Micha (1976) observed a similar result with *C. gariepinus* reared in an open pond stocked at $2m^{-2}$, $10m^{-2}$, $20m^{-2}$ and $50m^{-2}$. Several other workers have reported similar cases with the same of different species of catfishes. Their findings showed that there was differential growth rates which increased as stocking density decreased. Bombeo *et al.* (2002) and Areerat (1987) reported better growth rates at lower densities with *Clarias macrocephalus* and *C. bathracus* respectively.

The result showed that pond culture system was more productive than tank, which could be attributed to higher boost of natural fish food due to the pond bottom substrate which was revealed on plankton analyses of the pond and tank water samples. Therefore, the fingerlings reared in cages suspended in pond grew better attaining the highest mean total length of 11.95 cm and mean body weight of 28.6 g than their tank counterparts with the highest mean total length of 11.2 cm and mean body weight of 26.5 g similar to the observation of Bombeo *et al.* (2002). Linanon (1981) agreed that zooplanktons are the natural food of juvenile catfish in the natural environment, therefore the higher growth rate obtained in pond due to more varieties of zooplanktons which includes copepod adult (21 – 28.6 %), copepod nauplii (7.1 – 38.5 %), moina (15.4 – 42.9 %), rotifer (0 – 15.8 %) and others (7.7 – 21.4 %) in contrast to tank which consisted of copepod adults (0 – 12.5 %), copepod nauplii (9.1 – 25 %), moina (9.1 – 20 %), rotifer (37.5 – 45 %) and others (10 – 36 %).

High survival rates have also been confirmed by Bombeo *et al.* (2002) after working with a *C. macroephalus*. These high survival rates obtained in the study could be attributed to the fact that the young fish reared were protected from predation and cannibalism (Aluko *et al.*, 2001) which was as a result of growing apart syndrome. The growing apart syndrome was discouraged by intensive feeding and even feed distribution obtained in cage culture (due to confinement of the fish reared).

Handling of fish reared in cages have several advantages which include easy sampling which made fish monitoring possible, easy feeding, which also made feed distribution even and intensive. Easy harvesting was also made easier at the end of the experiment. The use of net cages improved the survival of the African catfishes fingerling reared by protecting them from predators, improving feed intake by reducing the distance traveled in search of food in other words, little energy is expended in that direction, hence, more energy to convert to flesh. The Food Conversion Efficiency (FCE) and the Protein Efficiency Ratio (PER) did not differ significantly at (P<0.05) between the different stocking densities and the two culture systems. This could be as a result of the same feed fed all the fish and at the same 5% body weight.

Throughout this experiment, the result obtained for the water quality parameters showed that the parameters did not fall outside the ranges recommended by Stickney (1979) for warm water fish culture. This showed no significant different at (P>0.05) after the analysis of the data, indicating that the fish were reared at the tolerable ranges for the African catfish. The 40.57% crude protein is in line with the recommendation of Eyo (1999) for catfish fingerlings for optimal growth.

In conclusion, the three stocking densities of $7m^{-3}$, $14m^{-3}$ and $28m^{-3}$ are alright for fingerling production but for the fact that growth is density dependent, stocking at $7m^{-3}$ is the most effective density compared to $14m^{-3}$ and $28m^{-3}$. Fish farmers are advised to stock fingerling at $7m^{-3}$. This research also recommend the use of net cage system in their nursery production with constant monitoring of the fish to enhance survival which result in maximization of fish production.

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