Vol. 2 (3), pp. 82-92, April 2017
International Standard Journal Number ISJN: A4372-2601
Article Number: DRJA160835880

http://directresearchpublisher.org/journal/drjvmas

ISJN

Research Paper

Effect of stocking on the growth and survival of *Clarias gariepinus* grown in plastic tanks

SULEIMAN, M. A. and *SOLOMON, R. J.

Department of Biological Sciences, Faculty of Science, University of Abuja, Abuja, Nigeria.
*Corresponding author E-mail: johnsol2004@yahoo.com .

Received 7 February 2017; Accepted 24 March, 2017

ABSTRACT

The experiments were conducted in tanks to determine the effect of increased stocking density on the growth and survival of catfish *Clarias gariepinus.* A two month experiment was therefore conducted from September 10 to December 4, 2012. Three different stocking densities 10, 20 and 30 fingerlings/tank (70 L round plastic troughs) with mean weight of 3.7±0.2 g were assigned treatment I, II and III respectively. The fish were fed 4% coppens (with proximate analysis of 42% crude protein, 13% crude fat, 1.9% crude fibre. 1.1% phosphorus, 33.6% nitrogen free extract and 9.5% ash). The survival, mean body weight, mean length and specific growth rate were stocking density dependent. The result of the density experiment showed significantly ($p<0.05$) highest growth and survival rate in treatment I (10 fish/aquaria). While significantly lowest growth and survival was recorded in treatment III (30 fingerlings/aquaria). Although the result obtained indicated that the stocking density applied do not have an impact on fingerlings growth or survival in the first week of rearing. The water quality parameters and their weekly fluctuation recorded throughout the study period were found within suitable range for fish culture. The result of this study showed that fingerlings of *Clarias gariepinus* can produce at each of the three stocking densities, but the stocking density of 10fingerlings/aquaria appears to be optimum as long there is good water quality and adequate feeding since the aim of growing at different stocking density is to achieve the best growth for profit maximization to the farmer.

Key Word: *Clarias gariepinus,* stocking density, growth performance

INTRODUCTION

Aquaculture is the rearing of fish and other aquatic organisms in man-made ponds reservoirs, cages or other enclosures in lakes and coastal waters. In addition to its primary function for food production of fish through control larvae, fingerlings, production and rearing. The production of fast growing fingerlings is therefore very vital for the development of a viable aquaculture venture. Aquaculture practices in Nigeria have increased drastically as seen in other parts of the world because of the increasing demand on fish protein. Rivers state, Nigeria has a great potential for sustainable aquaculture development. The initiation of fish culture seems to be one means of providing clear demand for fish protein can be met when capture fishery is supplemented by aquaculture.

African walking catfish is a successful aquaculture species in Nigeria. The species is widely accepted by fish farmers and consumers in Nigeria because of some biological, social reason. Other attributes, such as desiccation and ability to endure long drought and scarcity of food have endowed this fish species with amazing capacity to survive. Thus *Clarias gariepinus* was chosen for this study because of its ready availability, economic and ecological advantages being an important contributor to both inland fisheries and aquaculture in Nigeria.

A review of world of world fisheries indicated that the contribution of aquaculture can only be realized if a number of issues including stocking density of aquaculture species are addressed (FAO,1995). Successful aquaculture requires not only careful selection of species, appropriate feeding and water quality management but also a great extent, the density to which the fish are stocked as compared to the food ration and extent of management (Beveridge, 1984). Huissman and Ritcher (1987) describe stocking density as an important parameter in fish culture as the health, growth and survival of the fish depend upon this factor. Huissman and Ritcher (1987) also noted that *Clarias gariepinus* has high consumer preference in ranking; therefore the need to shift emphasis of aquaculture of such resources cannot be overemphasized. One of the ways to increase the production and growth rate of *Clarias gariepinus* is through a reliable stocking density so that consumers and farmers can actualize their desired objectives which is usually growth for economical and profit maximization.

Stocking density is thus an important parameter in fish culture operation, since it has direct effect on the growth, survival and production. (Alatise, 2006). Stocking density has also been found to one of the principal factors in regulating aquatic behavior of *Clarias gariepinus.* Aggressiveness seems to increase at lower densities and decreases at higher ones in some species while others shows greater levels of aggression and even cannibalism when stocking density increases (Otubusin, 1999). There is above a clear relationship between stocking density, oxygen requirements and metabolic waste production. Therefore stocking density is known to have a profound influence on growth, survival and production behaviour of fish. However in larvae and early fingerlings of *Clarias gariepinus* stocking density has no effect.

The study was therefore designed to investigate the effect of stocking density on the growth and survival of *Clarias gariepinus,* reared in 70L round plastic troughs with a view of complementing existing information to assist fish farmers on better culture methods. It is hoped that the results will contribute significantly to the knowledge of culture requirements of the species. The present study focuses on growth of the African catfish, *Clarias gariepinus* reared in 70L round plastic trough in ambient temperature at Biological department of the University of Abuja.

Biology of *Clarias gariepinus*

Clarias gariepinus is a member of the claridae family. *Clarias gariepinus* is well appreciated in many African countries. The clarids exhibit many qualities which makes them suitable for culturing. They have a high fecundity, faster growth rate, disease resistance; can withstand hand stress as well as been highly palatable (El-Sayed, 2002). They are very adaptive to extreme environmental conditions and can withstand low oxygen level and pH in the range of 6.5-8.0 (Huisman and Ritcher 1987, Fagbenro et al., 1992). They are able to live in very turbid waters and can tolerate temperatures (8 – 35) °C. The optimal temperature for growth is (28- 30)°C. *Clarias gariepinus* has a long-based rayed dorsal fin without an adipose tissue; two pairs of nasal and maxillary barbies on its dorso ventrally flattened head, elongated body with fairly long dorsal and anal fins and smallish eyes. This species can attain length of up to 1.7m including the tail and can weigh 59kg when fully grown. Their colour ranges from dark grey to black dorsally and cream coloured ventrally (Skelton, 1993). It comprises of species such as *Clarias anguillaris, Clarias gariepinus*, *Clarias lazera and Clarias mossambicus*. The African catfish are omnivorous, feeding on a large variety of plant and animal materials like weed, planktons, small insects, small fishes, crustaceans, snails, worms etcetera (Bakare, 1968) but they have high tendency towards been a carnivore as adults. Catfishes are therefore said to be opportunistic feeder, feeding on virtually everything that comes their way.

Stocking density and culture

Stocking Density is one of the main factors determining the growth and the final biomass harvested. Environmental variables, farming conditions and food availability are other factors that can affect fish growth. In terms of the fish production in aquaria, stocking density which is related to the volume of water or surface area per fish is an important factor. Increase in stocking density results in increasing stress, which leads to higher energy requirements, causing a reduction in growth rate and food utilization. Contrarily, in case of low stocking densities fish may not form shoals/group together and feel comfortable. Consequently, identifying the optimum stocking density for a species is a critical factor not only for designing an efficient culture system, but for optimum husbandrypractices. Controlling the fish size and production are two different tasks to meet the market demands. The effects of stocking density on growth and survival have been studied on some African catfishes such as *clariasgaripinus* (Haylor, 1991) and some hetebranchus longifilhis. The effects of stocking density on tilapia production as reported by Otubusin and Opeloye, (1956) in Kigera III reservoir New Bussa, Nigeria shows that fish growth generally decreased with an increase in stocking density. The slow growth of the fish observed in the study may be attributed to low productivity of the Kigera III reservoir. High density aquaculture has been by the united states of the aquaculture the most extensive from farming practiced in large scale today.

Native range

The African catfish is the most widely distributed fish in Africa. It native range extend from South African through central, west and north African into the middle east and eastern Europe. It is indigenous to many rivers from the Nile to the Orange River.

Habitat and habits

Being a fresh water fish, it is always found in rivers, dams, lakes, swamps, muddy waters, flood plains and other sources. They can be found in depths between 4cm – 8cm. it is able to bury itself in river bed where there is a decrease in water or drought is occurring. They have been known to stay in muddy grounds of ponds gulping air directly using their accessory breathing organ instead of gills. They are unlikely to survive in ground that has dried completely. They have been known to walk over the land when there are damp conditions or look for food and they survived extreme conditions and harsh environment. It can survive low oxygen concentration in water or temperature extreme from 8-35°C with salinity between 0 and 10% as well as a wide tolerance of pH range.

Breeding

*Clarias gariepinus*is a non-guarding, substrate-spawner which awaits optimal conditions before spawning commences. Breeding of this species occurs in very shallow, weedy waters normally after heavy rains and usually once the fish migrated upstream. Courtship and egg deposition takes place at night with the peak spawning times between 8pm and 2:30 am. Tray fertilized egg, hatch out between 24 to 36h of being attached to plants and debris in the water. The larvae swim after 50hours and begin to feed at 80h. The fry live in inshore vegetated zones. The medium, minimum population doubling time is between 1.4 and 4.4 years. This catfish can walk short distances to new breeding areas or through very shallow damp path ways. African catfish reach maturity at the end of their first year of age when they are approximately 20-25 cm in length.

Feeding and behaviour

These fish are voracious predator and eat almost anything. Literature includes insects, crabs, plankton, snails, fish, amphibian, reptiles, rotting flesh, plants and fruit in the diet. It is normally an individual bottom feeder, however they are known to be adaptable to condition and feed in groups at the water surface. Catfish are opportunistic feeders and will take any fish species which is abundant. They respond quickly to new available food sources and will change their feeding patterns to match organism freely available (Lovell, 1980).

Socio economics

This species is a nutritive food source in Africa. It can be housed in higher densities than most fish species; it is a hardy, quick growing and tasty fish. It is marketed fresh and frozen in Africa and is eaten boiled, fried and baked.

Physiochemical Parameters

Fish and other aquatic organisms such as shrimps and crayfish are known to be very rich in protein and the need to cultivate these in clean water in the locally is highly needed aquatic commodity cannot be overemphasized. The productivity of a given body of water is determined by its physical chemical and biological properties. The environmental properties of water need to be conducive for fish to grow well; therefore an ideal water condition is a necessary for the growth and survival of fish (Abolude, 2007). A number of physiochemical parameters were monitored and measured daily for the first week of the experiment to determine the maximum number of period of accumulation to toxic levels and subsequent at 2 days interval to misappropriate of water quality. The water quality parameters were analyzed to check for parameters such as temperature, dissolved oxygen both surface water temperature and atmospheric temperature was read to the nearest 0°C with the aid of digital thermometer. Dissolved oxygen was determined once a week by filtration wit 0.1 (sodium hydroxide) pH was determined using combo strip kit. The physiochemical parameter of water is given in (Table 1).

Table 1. Types of physiochemical parameters.

Parameter	Permissible list standard
pH	6.0-9.0
Temperature	20-33°C
Dissolved oxygen	6.8
Ammonia	2.2-1.37- pH dependent
Nitrate	0.06 (Adeogun, 2004)

MATERIALS AND METHODS

10 weeks long experiment was conducted to check the effect of stocking density on the growth and survival among African catfish *(Clarias gariepinus)*. The experiment was carried out at the faculty of science, biological science department of the University of Abuja.

Experimental location and system

The study was conducted in rearing tanks (70 L round plastic troughs) at the faculty of science, department of biological sciences, University of Abuja, Abuja Nigeria. It was conducted for the period of 10weeks from September 10 to 4th of December.

Experimental design

The experimental set-up consisted of three rearing tanks of size 70 L situated at the outdoor space of Faculty of

Science, University of Abuja. The rearing tanks were cleaned and treated with $CaCO_3$ which is judged to be a good disinfectant (Bolurundunro, 2006) before stocking the fish. The 3 aquaria were then stocked with three densities of 30 fingerlings, 70L 20 fingerlings, 70L and 10 fingerlings/70l. For each aquarium designated as treatment III, treatment II and treatment I respectively. Treatment I was used as the control experiment. Water level in aquarium was maintained at 50L. The top of aquaria were covered with nets to prevent the fingerlings from jumping out of the tank. Aerating machine was not used and this leads to frequent change of the water in the tank which was done manually.

Measurement

Effective management of any fisheries requires considerable knowledge regarding population parameters such as length, weight, age and growth, mentality and recruitment of the exploited stock. Thus length-weight relationship (LWR) and population dynamics are studied with the major objective being the rational management and conservation of the resources. Initial weight of the juvenile was measured using automated top leading balance and length was measured beginning from snout to the end of the tail prior introduction of juvenile into the aquarium. Fishes used are of the same age group (weight 3.5-8.5g and length 3.5-8.0 cm).

Experimental fish

60 fingerlings of length 3.5-8.0 cm and average weight 3.5-8.5 g were procured in Gwagwalada and transported to the department of biological sciences, University of Abuja in two 20L open plastic containers. They were acclimatized for 7days in 70L round plastic troughs while been fed with coppens (an artificial pelleted floating feed containing 42% crude protein) twice daily, 6-7 am in the morning and 6-6.30 pm in the evening. Each treatment was done under control conditions and the dead fishes were picked and mortality rate recorded.

Feeding

The fish fed with 42% commercial crude protein diet (coppens). Fish in all the treatments were fed 2 times a day at the rate of 5% body weight per day. Feeding allowance was adjusted in accordance with increase in the body weight (Haylor, 1992) and diet allotments were increased weekly after the length-weight determination.

Monitoring water quality

Careful monitoring of the water quality parameters were necessary in order to know how to manage and maintain condition with acceptable limit as recommended by Branco and Senna (1996). The dissolved O_2 in each experimental tank was monitored and determined using the dissolve O_2 test kit. Temperature was determined using mercury glass bulb thermometer. pH was determined using the pH meter and ammonia using the ammonia test kit. Waste water was completely drained and replaced after every three days.

Growth response

To determine the growth response of the fish, the following parameters are calculated

i. Mean weight gain % this was calculated as

$$MWG\ \% = \frac{\text{Final mean weight x 100}}{\text{Initial mean weight}}$$

ii. Specific growth rate (SGR) this was calculated from data on the changes of body weight over a given time.

SGR = (LnWf - LnWi x100) / t

Where :

LnWf = the natural logarithm of the final weight
LnWi = the natural logarithm of the initial weight
t = time (days) between LnWf and LnWi (Solomon, 2006)

iii. $$\text{Relative Growth Rate (RGR)} = \frac{\text{Weight gain by fish}}{\text{initial body weight}} \times 100$$

iv. Length gain = Initial length – final length (L1 – L2)
v. Length-weight relationship
The conventional formula described by LeCren (1951) was used for calculating the length-weight relationship.

$W=aL^b$……………… (1)

The above equation (1) and data were transformed into logarithms before the calculations were made, therefore, equation (1) becomes

LogW=Loga+LogL……………… (2)

Where W= weight of the fish
L=standard length of the fish
a=constant
b= an exponent.

vi. Condition factor (k): the condition factor was also calculated for individual for individual fish for each week using the conventional formulae by Worthington and Richard (1930). It reflects information on the physiological state of the fish in relation to its welfare

$$C_K = \frac{100 \times W}{L^3}$$

vii. $$\text{Survival \% (s)} = \frac{N_1 \times 100}{N_0}$$

Where N_1= final no of fish at the end of the experiment
N_0= Initial no of fish at the beginning of the experiment.

Table 2. Mean of some physiochemical parameters in all the treatments for the cultured period.

Weeks	pH	Temperature °C	DO	NH_3	Nitrate
1	6.9	25.2	8.4	1.4	0.065
2	7.1	26.3	4.8	1.4	0.079
3	7.4	24.4	4.7	1.7	0.079
4	8.1	25.4	7.1	2.0	0.068
5	8.4	27.6	8.6	2.1	0.120
6	7.9	27.8	6.4	1.9	0.100
7	7.8	32.2	8.3	1.9	0.090
8	6.6	31.3	11.8	1.4	0.080
SD	0.627353	2.862941	2.319136	0.291548	0.017972

Table 3. Summary of the Mean Growth performance at different stocking densities of *Clarias gariepinus* cultured in plastic tanks.

Growth Parameters	Treatment I	Treatment II	Treatment III
Mean Initial Length (cm)	5.21±0.28	5.2±0.56	5.2±0.14
Mean Final Length (cm)	18.0±0.70	16.0±0.28	14.0±0.70
Length gain (cm)	12.8±0.56	10.8±0.34	8.8±0.70
% Length gain	246±2.61	207.96±2.39	169.23±1.75
Mean final weight (g)	9.41±0.58	9.4±0.33	9.4±0.14
Mean initial weight (g)	25.8±0.84	20.1±0.28	18.2±0.42
Mean weight gain (g)	16.4±0.53	11.7±0.35	8.8±0.28
% weight gain	174.46±2.06	113.82±2.57	82.97±1.74
RGR % day	0.48±0.014	0.36±0.014	0.31±0.013
FCR	2.57±0.23	3.61±0.19	4.08±0.13
Survival Rate	100±0.00	90.0±2.0	80.0±3.5
C.f	2.27±2.09	2.13±2.09	2.52±2.02

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) used to determine the level of significance among treatments. Standard deviation was calculated to identify the range of mean.

RESULTS

Water quality parameters

Water quality characteristics monitored throughout the study period are summarized in the appendix.

Temperature

The water temperature in all treatments ranged between 24.5° – 32.6°C. The temperature of water in the cages was highest in November (32.6°C) and lowest 24.5°C in September.

Hydrogen ion concentration (pH)

The hydrogen ion concentration mean values in all tanks were ranged from 6.8-8.5 and decreased with increasing stocking densities. The pH 8.5 was highest in November and lowest 6.8 in October. This parameter was not affected by treatments ($p>0.05$).

Dissolved Oxygen

Dissolved oxygen during the culture period ranged from 4.6 mg/l to 12 mg/l. dissolved oxygen increased from May to October, and the highest (12 mg/l) was in September. Values of DO were significantly lower ($p<0.05$) in treatment II and III as compared to I.

Nitrate

The nitrate contents during the culture period ranged from 0.05 to 0.12. The results were significantly higher ($p<0.05$) in treatment II and III.

Ammonia

The Ammonia contents in all treatments ranged between 2.2 and 1.37. Ammonia content was highest (2.2) in November and lowest (1.37) in September. The results were also significantly higher ($p<0.05$) in treatment II and III (Table 2).

Growth performance of *Clarias gariepinus*

The summary of the growth performance of *Clarias garipinus* are shown in (Table 3).

Table 4: Anova table for condition Factor.

Source of Variation	SS	df	MS	F	P-value	F crit.
Weeks	89.67685	7	12.81098	849.1121	2.66E-17	2.764199
Treatments	0.645775	2	0.322888	21.40099	5.53E-05	3.738892
Error	0.211225	14	0.015087			
Total	90. 53385	23				

Mean weight gain (MWG)

The mean initial weight in all the treatments was 9.4±0.23 g; range was between 5.4-7.0 g while the mean final weight ranged from 25.8 – 18.2 g. The daily weight gain show an inverse relationship; as stocking density increased, the Treatment I had the highest final mean weight of 25.8 g than 20.1g in treatment II and the least 18.2 g was recorded in the treatment III. Daily weight gain was low in all treatment in the first 15days, but gradually increased and the highest was recorded from day 35-60 in all the treatments. There was no significant difference in the daily weight gain in all treatments.

Relative growth rate (RGR)

Relative growth rate in all the treatments was high, treatment I (14.71) followed by treatment II (12.95) and the least was in treatment III (11.11). There was significant difference (P>0.05) in relative growth rate in all the treatments. The specific growth rate decreased with increase in stocking density while the highest value was 3.33% in treatment I, treatment II 3.25% and the least 3.14% was in treatment III.

Feed utilization

Table 2 shows the feed utilization of *Clarias garipinus* at different stocking densities.

Food conversion ratio (FCR)

The analysis of the food conversion ratio, which expresses the efficiency of the fish in converting food to flesh, was best in treatment I (2.57) while the least (4.08) was recorded in treatment III. There was no significant difference in the FCR in all treatments.

Condition factor

No significant difference in condition factors between treatments were found at the beginning of the study. Significant differences were found at the end of the study for condition factor between treatments.

Survival rate

The mean survival rate ranged between 80% and 100%. Tank I had the highest survival rate followed by tank II while the lowest was in tank III. Fish escaped during sampling was first observed in tank 2 in the fourth week, while mortality was recorded in treatments II and III at the fifth week.

Length-weight regression analysis

There was not much more variation in the total length and the wet weight of fingerlings stocked at the different stocking density during the first half of the rearing period. Fingerlings stocked at 10/70 L attained the significantly (P<0.05) highest mean total length and mean body weight. In return, the lowest values were obtained in the higher stocking densities of 20 and 30 fingerlings/70 L. The rate of growth of *Clarias garipinus* was therefore influenced by stocking density. There was not much variation in the total length and weight of fingerlings stocked at different stocking densities during the first half of the rearing period (Tables 3 and 4). During the second half of the rearing period, fingerlings stocked at 10/70 L and 20/70 L attained the significantly (p<0.05) highest mean total length and mean body weight. In return, the lowest values were obtained in the highest stocking density.

Economic Analysis

The profit index was significantly different (P<0.05) in all treatments. The cost of producing plastic 70 litre troughs including cost of materials: nets, ropes, thermometer, manual scale, feed, plastic sieve. Transportation and labour was #2910 while the cost of producing 60 fingerlings of *Clarias gariepinus*at #20/fish was #1500. The value of fish was estimated in relation to the size of the fish at #400 for *Clarias gariepinus* as the period of the experiment. The amount of feed used during the experiment period was determined by using the feeding adjustments recorded during each sampling period. Feed consumption increased as the stocking density increased. The cost of feed was based on the market price for coppens #5500 as at the period of experiment and cost per kg per feed was used to calculate the total cost of feed used in each treatment. The total cost of production was determined by the summation of the cost of using a plastic tank/trough, fingerlings and cost of feed used, while the gross profit was determined by subtracting the values of the cost of production from the value of fish cropped per treatment (Table 5). The cost of production increased as the stocking density increased, a profit index of 3.27 in treatment II was highest while the

Table 5. Summary of cost benefit analysis.

	Treatments		
Production period (days)	**60**	**60**	**60**
Stocking Density (per aquarium/plastic trough)	10	20	30
Net Production (fish/60 days)	10	18	21
Value of Fish @ #400.00/fish	4,000	7,200	8,400
Feed Input (kg)	5.11	7.8	10.7
Cost of Feed/kg	220	220	220
Cost of feed Used	1,124.2	1,716	2,354
Cost of fingerlings	250	500	750
Cost of aquarium/plastic trough + net +ropes	970	970	970
Total cost of production	2,344	3,186	4,074
Gross profit	1,656	4,014	4,326
Profit index	2.42	2.26	2.06

least 3.09 in treatment III.

DISCUSSION

The survival of *clarias gariepinus* ranged between 100-80% which was comparable to similar work done by Otubusin, (2000). The high survival rate recorded in all the treatments could be attributed partially to the physiochemical parameters of the water body and also due to the good health condition of the fish. This result also indicates an inverse relationship between survival rate and stocking density; it was noticed that as the stocking density increases, the survival decreases. This could probably be due to stress experienced as a result of aggressive feeding behavior where energy meant for growth is used up in frenzy feeding activities. The low mortality (2.3%=7 fish) recorded in this study is an indication of proper handling of experimental procedures, though death and escape of fish during sampling in the plastic troughs cannot be ruled out (Madu and Tsumba, 1988).

The water temperature range in this study falls within the ideal temperature required for catfish culture in fresh water. The temperature range of 24.5-32.6°C also agrees with the work of Adeogun, (2004) on the culture of *Heterobranchus and Heteroclarias*in pond water.The water pH range of 6.8-8.5 reported during the experiment falls within tolerable range for fish cultivation and also compares with the pH ranges observed by Khattab *et al*. (2000) and Otubusin and Olaitan (2001).The dissolved oxygen of 8.3mg/l recorded in this study indicates that it was not limiting in the plastic troughs and similar value was reported by Otubusin and Olaitan (2001) in a similar work on *clarias gariepinus*but in bamboo net-cages.

The growth and mortality of *clarias gariepinus* cultured at various stocking densities were not initially affected by density but, the overall harvest productions in terms of final weight and size were directly related to the stocking density. Cannibalism among *clarias gariepinus* fingerlings is primarily caused by differential growth of fish in a population. Fish measurements were fairly uniform with each treatment during each sampling and were fed regularly at 6am and 6pm daily according to their body weight. Thus, no cannibalism was observed in the treatment. As the stocking density increased, the weight gain decreased; this depicts an inverse relationship as was observed in similar works by Otubusin and Olaitan (2001). Growth is a manifestation of the net outcome of energy gains and losses within an environment. Weight gain is one of the important indices for measuring growth which was obvious among different treatments. The feed conversion ratio in this study showed that treatment III had the best conversion ratio of 3.43 while treatment II had the lowest of 4.99; the ability of *clarias gariepinus*to utilize feed nutrients as maximum biochemical efficiency allows for higher feed conversion ratio. This study shows that at higher stocking density fish expend more energy due to aggressive feeding than converting it to flesh. The overall weight gain at stocking density of 30fish/m^3 per plastic trough was low and may be attributed to high energy being expended during feeding (aggressive feeding), whereas at lower stocking density (10 fish/m^3), higher conversion to flesh and weight was obvious. The values of food conversionratio in this study shows that stocking density has an effect on the ability of fish to convert its feed into flesh and may also be attributed to the feeding technique, quality of feed and temperature variations.

The relative growth decreased with an increase in stocking density. The growth rate of 3.2 g/day observed in this study was lower than 4.2 g/day reported for *clarias gariepinus*in net cages by Otubusin and Olaitan (2001) and 7.3 g/day as reported by Otubusin et al, (2002), but higher when compared with other culturing system like concrete tank monoculture for hybrid catfish; 2.6 g/day as reported by Boujard et al. (2002) and 0.0 12 g/day by Egwui, (1986) in home stead concrete tanks. This result is similar to the findings by Otubusin, (1997) who reported 3.28 g/day for *clarias gariepinus*in a polyculture study in net-cages. Growth rate according to Auta, (1993) is determined through the combined effects of quantity and food quality. The quality and quantity of a given food or feed is directly proportional to its ability to support growth.

Fish production increased as the stocking density increased. The high production obtained in all treatments in this study could be linked to the favourable physiochemical condition of water and maximum utilization of feeds and design of the plastic troughs. It could also be attributed to the high crude protein content of the feed. In this study, the effect of stocking density on growth (RGR and WWG) was highly significant at higher stocking density, while there was no significant variation among RGR, WWG. Production and final weight were positively correlated and highly significant at P<0.01. The mean production in this study indicates an optimum production performance at stocking density, where yield is significantly higher.

In fact, under crowded conditions at higher stocking densities, fish suffer stress as a result of aggressive feeding interaction and eat less, resulting in growth retardation (Bjoemsson, 1994). This indicates that in *clarias gariepinus* fingerlings, stocking densities above 20 fish/70 L may delay growth.

In a study on the influence of population stocking density in *clariasbatrachus* larvae reared in tanks, Alatise, (2006) reported a similar effect of high stocking densities on growth and RGR. This result suggests that, at lower stocking densities all larvae received adequate amounts of food, compared to those of higher densities. Higher stocking densities resulted in lower RGR.

FCR decreased in high stocking densities. Food conversion ratio, production and weight gain were negatively correlated with stocking density in *clarias gariepinus*fingerlings.

This result indicates that high stocking density reduced feed efficiency. Similar results have been recorded in both *Cyprinuscarpio*larva (Jha and Barat, 2005) and Torputitora larvae (Rahman, *2001).* However, Haylor (1991) reported that the stocking density did not affect survival of *clarias gariepinus* larvae reared in floating cages. Some encountered problems during the course of this study include algal growth around the inner side of the plastic troughs.

The foul smell by algae and the weeds growing around the plastic troughs attracted various insects, lizards and frogs. Strong winds were encountered in early to November during the course of the study which generated strong currents resulting in tree and may have contributed to the sudden sharp fall in the growth rate observed in that month (fish were obviously stressed and therefore suffered a retarded growth) although growth improved subsequently and such disruption by strong winds have been reported by Beveridge (1984).

Conclusions

In conclusion, stocking density of 10-30 juveniles per 70L tank having a mean weight, 5.9±0.23 g was successfully. Stocking density of 10/L had the highest economic return in the study in terms of final size and weight obtained. Therefore commercial catfish culture in reservoirs or tanks and other water bodies which are abundant in Nigeria as a means of increasing the domestic production and allowing land meant for arable farming to boost the economy is encouraged.

REFERENCES

Abolude DS (2007). Physiochemical Properties Of Selected Fish Pond In Nigeria; Implication For Artificial Fish Culture. Department Of Physical Severe,University Of Technology Minna, Nigeria.

Adeogun OA (2004) Effects of methanolic extract of Raphia hookeri (Mann & Wendl 1804) on life stages of Clarias gariepinus (Burchell, 1822).PhD Thesis University of Ibadan, Nigeria, pp.306.

Alatise PS (2006). An Assessment OfJackbean (CanavalisEnsiforms) Meals An Ingredient In The Diets For The *Claarias Gariepinus* Fingerlings Fish Nutrition And Fishfeed, Technology In Nigeria. Processing's Of The First National Symposium On Fish Nutrition And Fish Technology, Lagos. Pp. 89-94

Auta J (1993). Communication From The Commission To The Council And The European Parliament Commission European Commission Brussels. P. 20

Bakare E (1968). Growth response of *Clarias gariepinus* on siloge-based diets.Nig. Inst. Oceanography and marine res. Tech. paper. No 37p.19.

Beveridge MCM (1984). Algae Blooms In Commercial Fish Production Ponds. Southern Regional Aquaculture Centre (SRAC), Publication No. 406

Bjoemsson B (1994). Potential of genetics for aquaculture development in Africa. NAGA.

Bolurundunro PI (2006) Performance evaluation of growing rabbits feed varying levels of rumen content mixture. Nig.J. Animal Prod. 32;67-72.

Boujard, T., Labbe´, L. and Aupe´ Rin, B., 2002: Feeding behaviour, energy expenditure and growth of rainbow trout in relation to stocking density and food accessibility. Aquac Res , 33, 15: 1233–1242. ISSN 1355-557X.

clarridae.Tropical Zoology, 6:77-79

Egwui PC, Ogbonna UD, Anyanwu GA, Emelanam OO, Uchegbu Mc, Etuk EB, Udedible ABL (1986). Evaluation Of Performance, Organ Characteristics And Economics Analysis Of Broiler Finisher Feed Dried Rumen Digesta Int. J. Polutsci 5;116-118

El-Sayed CR (2002). Chemical Composition And Amino Acid Content Of Commonly Available Feed Stuffs Used In Fish In Nigeria. Fish Nutrition And Fish Feed Technology, Fison, Pp. 14-25

Fagbenro OA, Adedire CO, Owoseeni EA, Ayotunde EO (1992).Studies on the biology and aqualture potential of feral catfish, *Heterobranchusbidorsalis*(Geofferoyst.Hilaire, 1809)

FAO (1995). Food For All Poor Issued On The Occasion Of World's Food, Summit In Rome. FAO Rome P64

Haylor GS (1991). Alternate protein sources for Salmon and Trout Diets. Anim. Feed Sci. Technol., 59:71-80.

Haylor GS (1992). Fish Feed Development And Production, Pp. 12-36, In TA AjayiGzawa BL (Eds) Processing's Of The Fourth Annual Seminar Of The Committee Of Directors Research Institutes For Oceanography And Marine Research Lagos. P. 46.

Huissman FA (1987). Controlled Propagation of the African Catfish *Clarias gariepinus*. Reproduction biology and field experiments UNDP/FAO fish culture development project: Aquaculture 17 Eisvue Scientific Publishing Company Amsterdam.

Jha P, Barat S (2005). A strategy assessment of warm water fish farming potential in Africa CIFA Technical Paper NO. FAO Rome P.67.

Khattab YA, Kamal E, Amin, Khalid HS (2000).Deltamethrin-induced oxidative stress and biochemical changes in tissues and blood ofcatfish (Clarias gariepinus): antioxidant defenseand role of alpha-tocopherol. *BMC Veterinary Research P65-7.*

Lovell RT (1980). Aquaculture Department and Coodination programme. Fish feed Technology Lectures presented at the FAO/UNDP Training course in Fish Feed Technology, held at the College of Fisheries.

Madu CT, Tsumba DB (1988). Preliminary observation on Growth of Clarias gariepinus Fry Indoor Hatchery. KLRI Annual Greport, Pp. 120-125.

Otubusin, S. and Opeloye, G.O. (1956) Algae Blooms In Commercial Fish Production Ponds. Southern Regional Aquaculture Centre (SRAC), Publication No. 406.

Otubusin, S.O (2000) Performance evaluation of growing rabbits feed varying levels of rumen content mixture. Nig.J. Animal Prod. 32;67-72.

Otubusin SO, Anyanwu UD, Emelanam GA, UchegbuMc OO, Etuk EB, Udedible ABL (2001). Evaluation Of Performance, Organ Characteristics And Economics Analysis Of Broiler Finisher Feed Dried Rumen Digesta Int. J. Polutsci 5;116-118

Otubusin SO (1997). Potential of genetics for aquaculture development in Africa.NAGA.

Rahman MA (2001). Chemical Composition And Amino Acid Content Of Commonly Available Feed Stuffs Used In Fish In Nigeria. Fish Nutrition And Fish Feed Technology, Fison, Pp. 14-25

Solomon JR (2006). Polyculture of Heterobranchus/ Clarias hybrid with Tilapia niloticus using Extensive and Semi-intensive feeding Regime Best Journal.3(4) 8894.

APPENDIX

Mean + Standard deviation (sd) of in-tank water temperature (t), PH, dissolved oxygen (DO), nitrate (NO_3) and ammonia (NH_3) recorded during fingerlings rearing in tanks. Each mean represents sample collected at weekly intervals during study period.

Source of Variation	SS	df	MS	F	P-value	F crit
Weeks	162.6396	7	23.23423	86.58718	1.92E-10	2.764199
Treatments	0.603333	2	0.301667	1.124224	0.352544	3.738892
Error	3.756667	14	0.268333			
Total	166.9996	23				

pH

	Treatment I	Treatment II	Treatment III
Week 1	6.9	6.8	7
Week 2	7.2	7.3	6.9
Week 3	7	7.8	7.5
Week 4	7.9	8.3	8
Week 5	8.5	8.4	8.2
Week 6	8.2	7.6	7.9
Week7	7.8	7.7	8
Week 8	6	6.9	7

ANOVA for PH

Source of Variation	SS	df	MS	F	P-value	F crit.
Weeks	7.753333	7	1.107619	12.07528	5.68E-05	2.764199
Treatments	0.115833	2	0.057917	0.631408	0.546328	3.738892
Error	1.284167	14	0.091726			
Total	9.153333	23				

Dissolved Oxygen

	Treatment I	Treatment II	Treatment III
Week 1	9.2.	8.3	7.6
Week 2	5	4.8	4.5
Week 3	4.6	4.9	4.6
Week 4	7.2	7	7.1
Week 5	9.5	8.4	8
Week 6	8.7	5.4	5.1
Week7	8.3	8.6	8.1
Week 8	12	11.9	11.4

ANOVA for PH

Source of Variation	SS	df	MS	F	P-value	F crit
Weeks	112.845	7	16.12071	33.17751	1.14E-07	2.764199
Treatments	4.210833	2	2.105417	4.333088	0.034296	3.738892
Error	6.8025	14	0.485893			
Total	123.8583	23				

Ammonia

	Treatment I	Treatment II	Treatment III
Week 1	1.42	1.37	1.47
Week 2	1.57	1.62	1.42
Week 3	1.47	1.87	1.72
Week 4	1.92	2.1	1.97
Week 5	2.2	2.15	2.07
Week 6	2.15	1.77	1.92
Week7	1.85	1.82	1.97
Week 8	1.41	1.42	1.47

Body Length

	Treatment I	Treatment II	Treatment III
Week 1	5.21	5.2	5.2
Week 2	6.81	6.79	6.4
Week 3	8.41	8.35	7.5
Week 4	9.02	9.05	8
Week 5	10.9	10.5	9.2
Week 6	13.05	13	10.7
Week7	16.9	15.2	12.9
Week 8	18	16	14

ANOVA for Body Length

Source of Variation	SS	df	MS	F	P-value	F crit
Weeks	315.1472	7	45.02103	70.98236	7.39E-10	2.764199
Treatments	13.70501	2	6.852504	10.80399	0.001452	3.738892
Error	8.879592	14	0.634257			
Total	337.7328	23				

Body Length

	Treatment I	Treatment II	Treatment III
Week 1	9.41	9.4	9.41
Week 2	11.91	10.89	10.6
Week 3	14.4	12.38	11.77
Week 4	15	13.05	12.12
Week 5	17.9	14.58	3.2
Week 6	20.88	16.14	14.52
Week7	23.25	18.79	16.73
Week 8	25.8	20.1	18.2

ANOVA for body weight

Source of Variation	SS	df	MS	F	P-value	F crit.
Weeks	89.67685	7	12.81098	849.1121	2.66E-17	2.764199
Treatments	0.645775	2	0.322888	21.40099	5.53E-05	3.738892
Error	0.211225	14	0.015087			
Total	90.53385	23				

Condition factor for all treatments

	Treatment I	Treatment II	Treatment III
Week 1	6.65	6.69	6.70
Week 2	3.77	3.45	4.00
Week 3	2.42	2.13	2.79
Week 4	2.04	1.76	2.38
Week 5	1.38	1.26	1.70
Week 6	0.94	0.73	1.20
Week7	0.48	0.54	0.78
Week 8	0.44	0.49	0.66

Length weight regression values.

Standard Length <11.60	Standard Length>11.60
Length=2cm	Length=12cm
Weight=18.3g	Weight=60.7g
Length=4cm	Length=14cm
Weight=29.1g	Weight=67.3g
Length=6cm	Length=16cm
Weight=38.1g	Weight=73.6g
Length=8cm	Length=18cm
Weight=46.2g	Weight=79.6g
Length=10cm	Length=20cm
Weight=53.7g	Weight=85.4g